The Municipal Art Society of New York

MASNYC

Greening NYC's Historic Buildings

Green Rowhouse Manual

Cover photo: Washington Park Rowhouses,
Fort Greene Historic District, Brooklyn, NY

The Municipal Art Society of New York

MASNYC

LETTER FROM THE PRESIDENT

Dear Fellow New Yorker,

I am pleased to present the Greening NYC's Historic Buildings manual, an integral part of The Municipal Art Society of New York's (MAS) campaign to demonstrate that any historic building restoration can and should include energy efficiency measures. This manual was developed as part of MAS's Preservation and Climate Change Campaign, which promotes the environmental benefits of retaining New York City's older buildings and improving their efficiency to fight climate change. This manual is intended to help owners of historic rowhouses in New York City and elsewhere make energy efficiency gains, while following best historic preservation practices. We hope that you find the guidelines, references and images straightforward and useful.

A whopping 75% of New York City's greenhouse gas emissions come from the operation of buildings, and over half of the city's building stock was constructed before 1940. So, increasing the energy efficiency of the city's older buildings is the fastest, most cost-effective way to reduce greenhouse gas emissions. Property owners who follow these guidelines can improve the appearance and energy performance of their buildings and help fight climate change at the same time!

MAS has long been a respected champion for historic preservation. We have been at the forefront of the city's – and the nation's – most significant preservation victories and policies, from pioneering the Landmarks Preservation Law in 1965, to leading battles to save some of our city's most treasured historic places, including Grand Central Terminal and Radio City Music Hall. Recognizing the importance of major monuments is a key part of 21st century preservation, which also fills a broader role – to ensure our city's livability. New York City's historic and diverse buildings contribute to our city's vitality and to an improved environment as well.

This manual was produced for MAS by Cook+Fox Architects and Terrapin Bright Green, under the guidance of the New York City Landmarks Preservation Commission, and made possible through the support of the J.M. Kaplan Fund, the National Endowment for the Arts, The National Trust for Historic Preservation's Elizabeth and Robert Jeffe Preservation Fund, the New York Community Trust and the Witkoff Group.

For more information and to download digital copies of the manual, please visit our website, MAS.org.

Sincerely,

Vin Cipolla, President
Municipal Art Society

Greening NYC's Historic Buildings

Green Rowhouse Manual

The Municipal Art Society of New York
MASNYC

THE MUNICIPAL ART SOCIETY OF NEW YORK

The Municipal Art Society of New York, founded in 1893, is a non-profit 501(c)3 membership organization that fights for a more livable New York and advocates for intelligent urban planning, design and preservation.

ABOUT

This report was carried out in 2012 for The Municipal Art Society of New York (MAS). Preparation was conducted by Terrapin Bright Green and Cook+Fox Architects under the supervision of MAS and with valuable input and guidance from the New York City Landmarks Preservation Commission. The opinions and conclusions in this report are solely those of the authors and do not necessarily reflect the views of the sponsoring or supervising agencies.

SUPPORTERS

MAS is grateful for generous funding provided for this manual by the New York Community Trust, the J.M. Kaplan Fund, the National Endowment for the Arts, the National Trust for Historic Preservation's Elizabeth and Robert Jeffe Preservation Fund and the Witkoff Group.

J.M. KAPLAN FUND

NATIONAL ENDOWMENT FOR THE ARTS
A great nation deserves great art.

NATIONAL TRUST FOR HISTORIC PRESERVATION

THE NEW YORK COMMUNITY TRUST NYCT

THE WITKOFF GROUP

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Lafayette Street Rowhouses, Fort Greene Historic District, Brooklyn

Greening NYC's Historic Buildings

Rowhouses

INTRODUCTION

New York City's many historic neighborhoods and landmark buildings contribute greatly to its unique character. In light of today's environmental challenges and increased awareness, we must, as stewards of these irreplaceable resources, properly maintain them by utilitizing both inherent and new green design measures to maximize potential building performance. "Greening"—achieved by improving the energy efficiency and sustainability of these historic buildings—is good for the environment, saves money, reduces energy bills, and helps make them more comfortable and pleasant places to live and work.

This manual is one of a series that provides instructions for improving the efficiency and sustainability of New York City's smaller (less than 50,000 square feet) residential and commercial historic buildings. This series can be used for buildings that are designated as landmarks by the New York City Landmarks Preservation Commission or listed on the National Register of Historic Places, as well as the many other older buildings that are not officially designated as landmarks. The purpose of this manual is to show that it is possible to make green improvements while still following best practices for historic preservation.

The Green Rowhouse Manual is specifically written for the owners of historic rowhouses found in any of the City's five boroughs. The manual explains the various opportunities for improving energy efficiency, provides recommendations, and identifies the resources available to help support the work. This manual will help you assess what work can be done on your own, what work requires a professional, and how to communicate your retrofit goals and intents to architects, contractors, and other building professionals.

The manual is organized into eleven sections related to specific building elements, each exploring the low-, moderate-, and higher-cost opportunities for retrofit projects. It also covers operational best practices and regulatory processes, as well as financial incentives and programs.

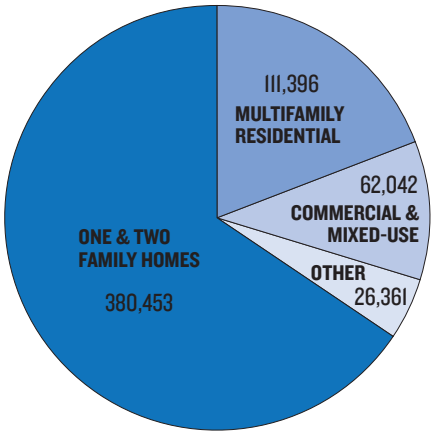
BENEFITS OF RETROFITS

There are many qualitative and quantitative benefits of energy efficiency and sustainability retrofits, some of which are more easily captured than others. Some key benefits include the following:

- Reducing utility bills
- Retaining character and relevance of historic design
- Prolonging life of building materials and components
- Reducing water, energy, and carbon impacts
- Improving return on investment
- Improving occupant comfort and health
- Making building systems quieter

It takes many years for new residential buildings that are 30% more efficient than the average-performing historic building to overcome, through efficient operations, the negative climate change impacts related to the construction process.

Preservation Green Lab, a program of the National Trust for Historic Preservation



Historic buildings by use type. One- and two-family homes represent more than 55% of New York City's pre-1940 stock of historic buildings under 50,000 ft^2.

Data: Based on PLUTO database (2012) of the New York City Planning Commission. Graphic © Terrapin Bright Green

HISTORIC PRESERVATION AND CLIMATE CHANGE

Historic buildings are inherently efficient

Older buildings incorporate many characteristics that make them energy efficient, including features that maximize natural light and promote passive heating and cooling. Typically constructed out of locally sourced, durable, and renewable materials, rowhouses have endured for many years and with proper care will continue to do so. However, since modern lifestyles and technologies require more operating energy, even historic rowhouses must improve their energy efficiency.

Building construction requires a considerable amount of energy, including the energy to produce building materials and the energy used in the construction process itself. This embodied energy is a valuable asset and should be retained. That is why the aspect of historic preservation that includes retaining and repairing buildings and materials is inherently sustainable. Preserving buildings prevents demolition, keeping materials out of landfills and preventing the need for new materials to be produced.

Energy efficiency is a critical part of fighting climate change

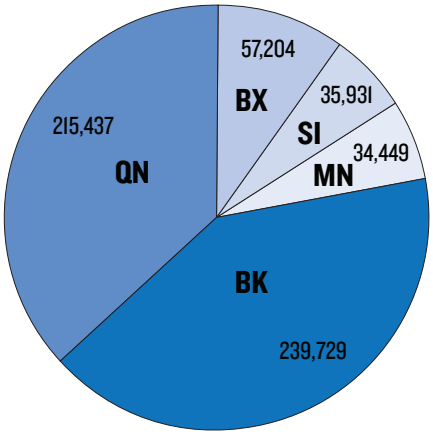
The building sector is one of the nation's largest energy consumers. In fact, 39% of total energy consumed nationally results from the operating energy of residential and commercial buildings (National Trust of Historic Preservation, 2007). In New York City, the construction and operation of buildings account for almost 80% of the greenhouse gas emissions that cause climate change. Unless we reduce our greenhouse gas emissions, by 2030 the average temperature is expected to rise by as much as 3˚F in New York City and sea level is projected to rise up to 23 inches (New York City Panel on Climate Change 2010, Climate Change Adaptation in New York City).

New York City can greatly reduce greenhouse gas emissions by increasing the energy efficiency of all of its buildings. Today more than 50% of the city's building stock is comprised of small buildings constructed before 1940 (approximately 580,000 structures). Integrating efficiency improvements into these buildings will yield a substantial environmental benefit. While saving energy and preventing negative environmental impacts, improving efficiency will also enhance the city's iconic landmarks and historic neighborhoods for the benefit of generations to come.

While recent local laws and code changes address the city's larger buildings and small city-owned buildings, few actions have been taken to improve the efficiencies of the majority of existing smaller buildings. Improving the energy efficiency of New York City's small and historic buildings are initiatives outlined in the updated PlaNYC 2030 agenda set forth by the Mayor's Office of Long-Term Planning and Sustainability. Among other goals, the plan aims to reduce building consumption and meet the City's overall carbon reduction target of 30% by 2030. This manual will help accomplish the City's goals to improve air quality, conserve water, reduce carbon emissions and increase renewable energy. These efforts will also improve the reliability of the electricity grid and reduce the potential for brownouts and blackouts during hot summer months.

EMBODIED ENERGY

Embodied energy is the total energy required to manufacture a product. In real estate, it refers to the energy used to construct a new building, rather than the energy used in the operation of a building. Building products like steel, concrete, brick, and glass are greenhouse gas intensive to manufacture. Environmentally friendly building products like concrete made with fly ash or recycled aluminum are gaining ground in the marketplace, but still require energy to produce. By extending the life of our existing buildings, and refurbishing rather than replacing, we get the most out of existing building components and the energy embodied in them.



Historic buildings by borough. Brooklyn and Queens are home to more than 75% of New York City's pre-1940 stock of historic buildings under 50,000 ft^2.

Data: Based on PLUTO database (2012) of the New York City Planning Commission. Graphic © Terrapin Bright Green

WHAT TO DO FIRST

With the right background information, improving your building's performance does not have to be a daunting task. Owners are urged to review this manual before applying for permits, selecting a contractor, or starting any work. Depending on the size of your project, there may be regulatory, structural, and cost issues to consider, as well as scheduling issues. All work should be evaluated based on its effect on your historic building as well as its potential to increase energy efficiency. Please keep in mind that this manual is not a substitute for Landmarks

Preservation Commission (LPC) or New York City Department of Buildings (DOB) policies or regulations. To help ease the process, consider the steps below before beginning a new project.

Know Your Building

Understand designation status and regulatory requirements. Determine if your building is locally designated as a New York City landmark or as part of a City historic district, or is listed on the National or State Register of Historic Places (see the Regulatory Overview section of this chapter). Most alterations or repairs to the exterior of City landmarked buildings require LPC review. Historic properties may also qualify for specific incentives that can help pay for renovation costs. If your building has been designated by the city, refer to the LPC and DOB regulatory considerations and consider the implications early on in your project. This will minimize potential misunderstandings and costly last-minute changes.

Conduct an energy audit. An energy audit will help determine which measures will work in your particular building. An audit evaluates how much energy a building consumes over the course of a year and calculates which energy-saving investments will help make it more efficient and achieve the greatest payback. An audit will analyze the building envelope (roof, doors, windows, walls, and insulation); mechanical systems (HVAC, hot water systems, equipment size, condition, and efficiency); and electrical and lighting issues, and make recommendations for improvements. The resulting recommendations will help you establish priorities, choose cost-effective and affordable measures, and develop a workable sequence for your retrofit project. In New York State and City there are a number of free energy audits for homeowners. If possible, choose an energy auditor with historic building experience. See the section on Walls & Roofs for the types of diagnostic tests conducted during an energy audit.

Start Small

Consider user behavior. User behavior greatly affects energy consumption and should be considered before developing an energy efficiency plan. Reducing plug loads—the amount of electricity appliances such as computers, space heaters, microwaves or cable boxes use while on standby—is one easy way to save energy. See the sections on Lighting & Electrical and Appliances & Plug Loads for more guidance.

Take advantage of the "passive systems." The methods and devices that can be integrated into a building to help heat or cool the building with little or no assistance from electrical or other nonrenewable energy sources can also be a cost-effective method to reduce energy consumption. One example is placing awnings or shutters over windows to provide shade and reduce cooling requirements. Heavy drapery placed over windows in the winter helps block drafts, and simply rearranging furniture can block or enhance air circulation. See the Heating & Cooling section for more guidance.

Weatherize your building. Weatherization is a low-cost and easy way to decrease building energy losses and improve comfort. Weatherization includes work such as sealing and weatherstripping windows and sealing holes in the walls. This should be done before considering more extensive options such as adding insulation. See the sections on Walls & Roofs and Windows & Doors for more guidance.

Plan Ahead for Long-Term Opportunities

Organize your work. After the energy audit, determine the sequence of operations for a renovation project. Consider which improvement steps should be completed first, or concurrently, for the best long-term outcome. For example, window and wall upgrades should be done before HVAC replacement so that the equipment is properly sized (see section on Heating & Cooling).

ENERGY AUDITS

The energy audit is a detailed evaluation of your building's systems and identification of energy conservation opportunities. Utility bills are collected for a 12- to 36- month period to allow the auditor to evaluate your building's energy demand rates and energy usage profiles. The auditor may discuss the systems with you to get a better understanding of how you use them and to gain insight into short- and longer-term energy consumption patterns.

In addition to identifying all energy conservation opportunities appropriate for your building, a detailed financial analysis may be performed for each measure based on implementation cost estimates, building-specific operating cost savings, and your investment criteria. The information gathered in this effort can be used to develop your building's maintenance plan and project capital budget for building operations.

QUICK GUIDE FOR REFERENCE TOOLS TO GET TO KNOW YOUR BUILDING

Blower door test	see section on Walls & Roofs
Energy audit	see sidebar above
LPC Designation Reports	see www.nyc.gov/landmarks
Thermal imaging test	see section on Walls & Roofs

Determine payback. The initial price of a product or design approach is only part of its true cost; operational costs often far exceed the initial cost. Consider long-term savings, ease of maintenance and conservation when budgeting for your retrofit.

Repair versus replace. A preservation rule of thumb is to repair features when possible, and replace only when a feature is beyond repair. This principle helps retain authenticity and historic integrity, and is also good for the environment. New York City generates 10 million tons of construction and demolition waste annually— 60% of its total waste output. Repairing and reusing buildings and materials helps minimize this waste.

While replacement and upgrade opportunities are discussed in the manual, the majority of opportunities presented deal with optimizing existing elements, such as applying sealants or ensuring that cross-ventilation is not inadvertently blocked. These opportunities capitalize on economic, historic, and environmental resource preservation for the benefit of the owner and the community. Many of the improvements suggested in this manual do not require a permit from the Department of Buildings or the Landmarks Preservation Commission, but still have an impact on energy use.

REGULATORY OVERVIEW

Historic preservation is a nationwide movement to maintain buildings, landmarks, and landscapes that are significant to local or national history. The National Historic Preservation Act of 1966 and the New York State Historic Preservation Act of 1980 established the National and State Registers programs. New York City's preservation agency, the Landmark Preservation Commission (LPC), is one of the country's most active preservation bodies. The LPC was established in 1965, one year after the historic Pennsylvania Station was torn down to make way for Madison Square Garden. Designated buildings must be at least thirty years old.

Early days of historic preservation. The first historic preservation efforts began in 1850 with Hasbrouck House in Newburgh, NY, which served as George Washington's headquarters during the Revolutionary War. The building was designated a National Historic Landmark in 1961.

Photo © David Malantic

What Is a Landmark?

The State and National Registers of Historic Places recognize buildings, structures, districts, objects, and sites that are significant in the history, architecture, archeology, engineering, and culture of New York and the nation. In New York City, a landmark is a building, property, or object that has been designated by the Landmarks Preservation Commission because it has a special character or special historical or aesthetic interest or value as part of the development, heritage, or cultural characteristics of the city, state, or nation.

Preservation Agencies

In an effort to supoort the historic fabric of New York City, codes and regulations manage and track environmental and cultural preservation, as well as the quality, performance, maintenance, and safety of construction measures. City, state and federal programs and agencies are both regulators and resources for your renovation project.

- ***Federal***: National Park Service (NPS)
- ***State***: New York State Office of Parks, Recreation & Historic Preservation (SHPO), Energy Conservation Construction Code of New York State (ECCCNYS)
- ***City***: New York City Landmarks Preservation Commission (LPC), New York City Department of Buildings (DOB), New York City Department of City Planning (DCP)

See Appendix A for more information about these agencies and the services and oversight they each provide, such as obtaining restoration guidance, understanding permit processes, or determining whether your building is impacted by a landmark designation.

GREEN LIGHT APPROVAL

95% of all applications to the Landmarks Preservation Commission are reviewed and approved at staff level. The vast majority of energy efficiency and greening actions fall into this category of approvals, or are not subject to LPC review or regulations at all. Each section of the manual provides examples of actions that will or will not require LPC review.

KEY RESOURCES

COMMON ACRONYMS

DCP	New York City Department of City Planning www.nyc.gov/planning
DEP	New York City Department of Environmental Protection www.nyc.gov/dep
DOB	New York City Department of Buildings www.nyc.gov/buildings
DOE	US Department of Energy www.eere.energy.gov
ECCCNYS	Energy Conservation Construction Code of New York State
EPA	US Environmental Protection Agency www.epa.gov
FSC	Forest Stewardship Council www.fsc.org
HVAC	Heating Ventilation and Air Conditioning
LED	Light emitting diode
LEED	Leadership in Energy and Environmental Design www.usgbc.org/LEED
LPC	Landmarks Preservation Commission www.nyc.gov/landmarks
MAS	Municipal Art Society www.mas.org
OSHA	Occupational Safety and Health Administration www.osha.gov
PlaNYC	Mayor's Agenda for a Greener, Greater New York City www.nyc.gov/planyc2030
SHPO	New York State Historic Preservation Office www.nysparks.com/shpo
VOC	Volatile Organic Compound
NPS	National Park Service
NRHP	National Register of Historic Places www.nps.gov/nr
NYCECC	New York City Energy Conservation Code
NYSERDA	New York State Energy Research & Development Authority www.nyserda.ny.gov
WBDG	Whole Building Design Guide, National Institute of Building Sciences www.wbdg.org/resources/

PROFESSIONAL SERVICES

In addition to familiar trade experts, such as plumbers and electricians, there may be good reason to consult a professional to address your specific renovation challenges. The following is a list of professionals and the primary services they could provide for an historic building renovation:

- ***Architect (licensed professional).*** Designing basic interiors to comprehensive renovations, advising on the construction, and providing guidance on the selection of materials finishes. Architects with experience working on high-performance or green projects or historic renovations are more likely to be able to meet your project goals.
- ***General Contractor.*** Overseeing the day-to-day activities of the construction site, managing subcontractors (plumbers, electricians, etc.), and communicating information to you.
- ***Craftsperson.*** Making decorative or practical objects, such as tile work, millwork, or metalwork. Some craftsmen specialize in environmentally responsible materials and processes and can assist you in identifying a desirable product while minimizing the impact to the indoor environmental quality of your home.
- ***Energy Auditor.*** Inspecting, surveying, and analyzing the energy flows of your building to maximize its comfort, health, safety, durability, and energy efficiency.
- ***Structural Engineer (licensed professional).*** Assessing the structural integrity of your existing building, including the roof, which may be necessary and possibly required if installing an extensive vegetated roof.
- ***Sustainability Consultant.*** Assessing your goals for the project and identifying appropriate strategies and experts required, facilitating project integrative design with your various consultants and contractors; some sustainability consultants also provide LEED or Passive House certification services.
- ***Exterior Wall Consultant.*** Assessing the condition of your existing exterior walls, including moisture problems, airflow, and the viability of adding interior or exterior wall insulation.

KEY RESOURCES

- ***Energy Basics***
  The U.S. Department of Energy's (DOE) basics about renewable energy and energy efficiency technologies and how they work, what they're used for, and how they can improve your life, homes, and business
  www.eere.energy.gov/basics
- ***EnergySavers***
  A DOE program that provides tips for reducing your energy usage
  www.energysavers.gov
- ***Energy Star®***
  A DOE program identifying energy efficient appliances
  www.energystar.gov
- ***Building Green***
  The online hub for Environmental Building News, a resource for articles, products, and case studies pertaining to various building systems and products
  www.buildinggreen.com/menus
- ***Building Performance Institute***
  The certification body for energy auditors
  www.bpi.org
- ***Department of Buildings***
  The New York City agency in charge of regulating buildings
  www.nyc.gov/buildings
- ***Landmarks Preservation Commission Designation Reports***
  www.nyc.gov/html/lpc/html/forms/reports.shtml
- ***NPS Secretary of the Interior's Standards for the Treatment of Historic Properties,*** with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings
  www.nps.gov/history/hps/tps/standguide/
- ***Whole Building Design Guide***
  A program of the National Institute of Building Sciences
  www.wbdg.org/resources
- ***NYSERDA***
  The New York State Energy Research and Development Authority offers incentives for upgrading energy-using systems
  www.nyserda.ny.gov/residential

WALLS & ROOFS

The potential energy savings from reducing drafts in a home may range from 5% to 30% per year.

US Department of Energy

A home's energy efficiency depends on a balance of air sealing, insulation, moisture control, and ventilation. Air infiltration—the exchange of air through cracks and gaps in the outside shell of a building—increases heating and cooling costs and reduces comfort for occupants. New York City's climate is generally moderate, but is subject to extremes in the summer and winter. A well-insulated wall and roof system will help keep your home comfortable year-round. It will also manage moisture effectively so as to avoid freeze-thaw damage to the walls, mold growth, and associated indoor air quality issues.

Any work done to your walls and roof should be evaluated based on its effect on the historic character of the building and its potential to increase energy efficiency. It is very important to first perform less invasive wall and roof repairs such as sealing and weatherstripping before adding insulation or other extensive work. Consult with an energy auditor before undertaking any major work.

Auditors use diagnostic tools to evaluate the condition of your walls and roof as well as many other aspects of your building. A qualified home energy auditor will include an insulation check as a routine part of a whole-house energy assessment. Test results help determine where you have the most air infiltration and where to make improvements for achieving energy savings and greater comfort. Some typical tests include:

- ***Blower door test.*** A blower door test uses a powerful fan mounted on your exterior door to help determine the airtightness of your home. Uncalibrated blower doors can only locate leaks in your home, whereas a calibrated blower door will quantify the amount of air leakage and determine the effectiveness of your existing air-sealing. The test will help you identify air leaks and drafts, moisture condensation problems, and potential for indoor air contamination. The results of the test will help you prioritize weatherization and moisture management efforts.
- ***Thermal imaging test.*** Thermography measures surface temperatures by using infrared cameras. The results of an interior thermographic inspection will help detect where warm air is escaping through walls and joints.

Blower door test.

A blower door test can determine how effectively air-sealed a home is.

Photo © David Cunningham Architecture Planning

Typical wall and roof assemblies found in pre-1940s buildings

- ***Masonry:*** Rowhouse building walls of this period generally consist of a multi-wythe masonry wall of brick or a mix of brick and other masonry block. The exterior of the wall could be faced with brick or natural stone. The roof generally consists of a wood framed structure with either slate, asphalt, or wood shingles, sheet metal or terra-cotta tiles for sloped roofs or a built-up bituminous (tarpaper) roof for flat roofs. Generally the interior wall finish was originally plaster on wire or wood lath, possibly with a coating acting as a vapor barrier at the masonry. Larger buildings occasionally have steel structural frames with masonry infill.
- ***Wood:*** Rowhouses can also be a wood-framed structure with wood clapboard siding or shingles. The roof generally consists of a wood-framed structure with slate, sheet metal, or wood shingles. The interior wall finish was traditionally plaster on wood lath.

Key issues with walls and roofs in historic buildings

- Less invasive repairs and sealing are often undervalued by the homeowner. Unaware of the potential for immediate payback, air leaks are left unaddressed until it is time to undertake more extensive work such as adding insulation.
- Problems caused by water damage or neglect compound over time, as do

the costs for repair or replacement. Regular maintenance of gutters, roofs, walls, and exterior openings will extend the life of your building envelope by preventing water infiltration.

- The U.S. Department of Energy has found that 31% of air infiltration occurs at the floors, walls, and ceiling. Cracks between the house and the foundation, gaps around plumbing, and electrical penetrations are also typical sources for leaks.
- Insulating historic building walls is a technically complex undertaking. Masonry walls in particular are difficult due to the potential for freeze-thaw damage related to the moisture balance within the wall. Have your building evaluated by a professional before installing insulation.
- Moisture, mold, and mildew create physical damage as well as indoor air quality and occupant health issues. Properly maintaining the exterior wall and roof are critical to preventing moisture intrusion.

OPPORTUNITIES—LOW/NO COST

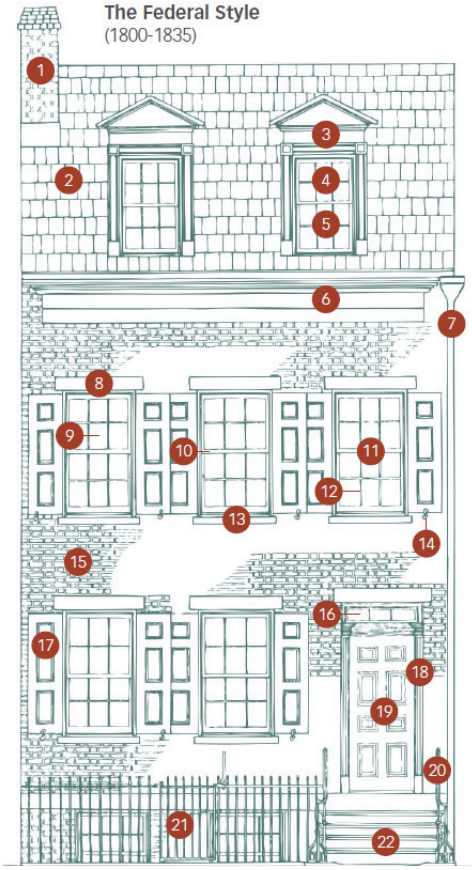
Evaluate the condition of your walls and roof

Your energy audit should include the evaluation of your building's current thermal performance and the identification of any deficiencies in the building envelope or mechanical systems. Assess the condition of your building exterior by inspecting areas where different building materials meet, such as at corners where siding and chimneys meet and areas where the foundation and the bottom of exterior brick or siding meet.

Weatherize your home

Weatherization involves implementing a series of cost-effective measures to reduce air infiltration and make a building envelope more energy efficient. Weatherizing a historic building requires undertaking those measures in ways that has minimal impact on the building's design and materials. Although reducing drafts is recommended, it is not advisable to seal a historic building too tightly. Be sure to allow an adequate level of ventilation to avoid causing damage to your building. See the National Park Service web site for more information (www.nps.gov/tps/sustainability/energy-efficiency/weatherization.htm).

- ***Repair or seal exterior wall areas.*** Properly maintained exterior walls can reduce deterioration, moisture damage and energy loss. After evaluating the condition of your walls and roof, consider the following actions:
  - › Plug and seal holes or penetrations for faucets, pipes, exhaust ducts (remember to use high-temperature sealant if it is a pipe or duct that gets hot), electric outlets, and wiring with the appropriate material.
  - › Check wood components like fascias or eaves for deterioration.
  - › Repoint masonry by removing deteriorated mortar from the joints of masonry walls and replacing it with new mortar. The mortar creates a watertight seal at the joints between individual masonry elements. Check wood components like fascias, window trim, and siding for deterioration. Replace wood components and any associated flashing to prevent water damage and minimize air infiltration.
  - › Clean masonry walls regularly. Refer to resources section later in this chapter for information on techniques and best practices for cleaning your masonry walls in a sustainable and water efficient manner.
- ***Seal seams and gaps in the basement and attic.***
  - › Prevent drafts along the floor by caulking along the sill plate and rim joist—the wood beam that closes off the floor beams. At the rim joist, seal the top and bottom of the inside of the cavity created by the joist. See the chart on page 15 for more on insulating at the rim joist.



Building facade terminology. For additional information on common architectural styles in New York City, see the LPC Rowhouse Manual.

1. Chimney
2. Peaked Slate Roof
3. Dormer
4. Upper Sash
5. Lower Sash
6. Cornice
7. Leader
8. Stone Lintel
9. Window Pane
10. Meeting Rail
11. Six-over-six, Double-hung Window
12. Muntin
13. Stone Sill
14. Shutter Dog
15. Brick Laid in Flemish Bond
16. Transom
17. Paneled Wood Shutters
18. Colonnette
19. Paneled Wood Door
20. Iron Stoop Railings
21. Iron Fence
22. Stoop

Graphic courtesy of LPC, Rowhouse Manual

RECOMMENDED R-VALUES FOR NEW YORK CITY

The R-value is a measure of thermal resistance used in the building and construction industry. An R-value indicates a level of resistance of an insulation to heat flow, including conduction, convection, and radiation. The higher the R-value, the greater the effectiveness of the insulation. R-values for insulation vary depending on the material used, and its thickness and denseness.

The table below is the Department of Energy's (DOE) R-value recommendations for existing homes in Zone 3 of the United States, which includes New York City. Higher R-values mean greater insulating power. Savings will vary for each application, but the recommended values are based on comparing future energy savings to the current cost of installing insulation.

INSULATION ZONE	R-VALUE
Attic—Uninsulated	R30-R60
Attic—Floor	R19-R25
Cathedral Ceiling	R22-R38
Wall Cavity	R13-R15
Floor	R19-R25

Source: Adapted from DOE/CE-0180 2008, Insulation Fact Sheet

MODERN SIDING

Modern replacement aluminum or vinyl siding installed over original wood siding covers and damages the historic building materials and often requires the removal of trim details and other decorative features. This reduces the integrity and character of historically and architecturally significant buildings. Instead, damaged wood siding or shingles should be repaired or replaced. Occasionally homeowners are tempted to install insulation and siding over masonry for increased thermal value or the promise of reduced maintenance. Faulty installation does not allow the masonry wall to breath, causing damage to the masonry that cannot be detected once it is covered.

  - Use mineral wool or cotton batt for larger openings, such as plumbing chases and attic hatch covers, with special attention to potential flammability concerns.
- ***Seal around windows and doors.*** See the section on Windows & Doors for specific information about sealing and weather stripping.

Manage moisture

Discoloration on a wall, wet or deteriorating walls, or bubbles behind paint or wallpaper are all signs of possible water damage. If signs of water damage are apparent, it is critical to identify the water source. Plumbing, roof, walls, and window frames are likely sources of water in the home. Water damage should be addressed as soon as it is detected to minimize potential extent of damage, mold growth and repair costs.

Seal basement walls

Silicate mineral paints and coating systems help preserve the structure of your building, maintain the appropriate moisture balance, and resist indoor pollution. Consider applying high-quality breathable paints, coatings, and repair mortars to exterior basement wall surfaces to restore and protect natural stone and masonry and mitigate damage from salts and rising damp.

Reduce heat loss through your chimney

- Keep your damper closed when not in use.
- Install an energy saving fireplace damper. Energy efficient dampers are generally mounted to the top of the chimney and have a tight gasket seal. By providing a tighter seal, they reduce downdrafts, making them 90% more effective than traditional dampers.
- If your fireplace is no longer functioning, seal the flue, install a well-sealed fireplace damper, or fill in the chimney to prevent unnecessary heat loss.

Reduce heat island effect of your roof

Black rooftops contribute to radiant heat gain within your house and solar heat gain at the exterior. Implementing the measures below will help reduce your building's heat gain.

- ***White roofs:*** Painting your dark roof white or silver is an inexpensive way to reduce temperatures, keep heat from radiating to areas below.
- ***High-albedo membranes:*** Upgrade membrane roof with light-colored (high-albedo) materials. Replace old or degraded roofing materials with light gravel, pavers, or other solar reflective material. Look for opportunities to install Energy Star rated or other roofing materials with a solar reflectance index (SRI) of 78 or greater to cover building roof areas. For usable rooftops, light-colored materials make for a more comfortable outdoor space and better environment for plant life to flourish and also contribute to longer-lasting roofing materials.
- ***Green (vegetated) roofs:*** Not only will a green roof cool your building, it will also detain and absorb stormwater and promote biodiversity. The complexity of your green roof will determine your expense. Investigate the structural capacity of roof framing with a building professional (architect or structural engineer) before implementing an extensive green roof system.

	INSULATION APPLICATION	INSULATION TYPE / MATERIAL	COMMENTS
ROOF AREAS	**Attic/Ceiling**	Blow-in; Spray Foam; Blanket	Professional guidance is recommended when determining the correct location for insulation for low-slope/flat roofs.
	Unvented Roof (low-slope/"flat" roof)	Rigid/Board	
	Vented Roof	Blow-in: mineral wool and fiberglass; Blanket.	
WALLS	**Enclosed/Finished Walls**	Blow-in, Spray Foam	Pay special attention to wet areas where moisture control is a concern; trapping moisture can lead to mold or mildew growth. Vapor barriers are generally recommended for high-humidity areas.
	Unfinished Walls	Rigid/Board; Blow-in; Spray Foam; Blanket	
	Wet Areas (bathrooms and kitchens)	Rigid/Board: XPS and mineral wool; Blow-in; Spray Foam	
FOUNDATION	**Unvented crawl spaces**	Rigid/Board; Blanket	Be certain your foundation/basement walls are not damp. If moisture is trapped, it will defeat the insulation's value and possibly encourage mold growth.
	Walls/Basement	Rigid/Board: XPS and mineral wool; Blow-in; Spray Foam; Blanket: fiberglass or mineral wool with furring	

Source: Based on DOE EERE EnergySavers.gov

OPPORTUNITIES—MODERATE/HIGHER COST

Deciding to further insulate your home depends on your budget, where and how much you insulate, and the savings you'll realize in energy bills. The US Department of Energy's Zip Code Insulation Calculator, located online, provides insulation cost estimates and a rate of return on your investment. See the sidebar for recommended insulation values on page 14. If you have high heating and cooling bills, improving your insulation will pay for itself over time.

Insulate your attic or pitched roof

- ***Inspect your roof, attic and attic floor area for existing insulation.*** Use the tools on the US Department of Energy's web site to determine the insulation's R-value and whether it was correctly installed. If you think you have vermiculite insulation, a grayish material that resembles gravel, there is a chance it could contain asbestos. Consult a professional asbestos removal company before taking any action.
- ***Insulate your roof or attic.*** It is less invasive and often less costly to insulate your attic rather than the walls of your building. Considerable heat loss can occur through an uninsulated roof, so a layer of insulation in your attic could have a significant impact on energy bills. Determining the correct location for the insulation is critical. If your attic is unheated, insulating the attic floor will allow better air sealing, more insulation, a more cost-effective retrofit, and lower energy use.

Insulate your flat or low-slope roofs

Flat roof insulation is typically installed below the roof membrane. There are many systems and types of rigid insulation available. If you are removing the original roof assembly there is also the opportunity to insulate between the roof's structural members. Professional guidance is recommended.

It is also possible to insulate at the underside of the roof between the ceiling rafters. This should be undertaken with care, and it is advisable only when the rafter space is a nonventilated area. If your low-sloped roof is ventilated and adding insulation would interrupt the airspace, moisture can be trapped. Spray foam or dense pack cellulose insulation is recommended for this application.

Insulation applications. While fiberglass insulation is the standard in the industry today, cellulose and cotton fiber insulation have competitive R-values per square inch and tend to have lower environmental footprints with very low embodied energy and negligible pollution from manufacture. Pay particular attention to old wiring such as knob-and-tube, and adjacency of electrical fixtures. Care should also be taken not to cover ventilation such as attic vents.

LPC PERMIT EXAMPLES: ROOFS

No Permit Required

- Replacing or installing caulking around skylights and other roof penetrations
- Replacing or repairing flat built-up roofs
- Installing insulation at the interior side of roofs
- Applying white roof coatings on flat roofs

Permit Required

- Replacing roofing materials other than flat built-up roofs
- Installing exterior insulation
- Applying white roof coatings on sloped roofs
- Installing green roofs
- Installing skylights

Source: Landmarks Preservation Commission

Insulate basement floor and crawl spaces

Most people don't realize how much heat is lost through uninsulated foundations. If the basement or crawl space is unheated, unfaced batts can be used to insulate between the overhead floor joists (support beams). If using faced batts, staple them into place and allow the facing to serve as a vapor barrier.

If the basement is heated and regularly used, insulate the basement walls. The simplest method is to build wooden frames against the masonry foundation walls, pack them with rigid insulation, and install drywall. A moisture barrier should be installed under the drywall to prevent damage to the walls. You can hire a contractor or do this yourself by consulting a good do-it-yourself manual.

INSULATION TYPE / MATERIAL		COST	PERFORMANCE & COMMENTS
RIGID / BOARD	**Polyiso (Polyisocyanurate)**	High	High insulating value for relatively little thickness.
	EPS (Expanded Polystyrene)	High	Can block thermal short circuits when installed continuously over frames or joists.
	XPS (Extruded Polystyrene)*	High	An effective vapor barrier.
	Mineral wool (semi-rigid board, rock or slag)**	High	Foil-faced mineral wool and fiberglass when taped provide an interior vapor barrier.
BLOW-IN (loose or dense-fill)	**Cellulose**	Low to Moderate	Good for adding insulation to existing finished areas, irregularly shaped areas, and around obstructions.
	Mineral wool (rock or slag)**	Low to Moderate	Good for adding insulation to existing finished areas, irregularly shaped areas, and around obstructions.
	Fiberglass (formaldehyde-free recycled content)	Low to Moderate	Energy performance of cellulose fill is comparable to high-density fiberglass batts, and more effective than batts at controlling air leakage and convective and radiant heat. Cellulose can have high recycled content, very low embodied energy, and low/no-toxicity fire retardants.
SPRAY FOAM (low density)	**Icynene™ Soy Cementitious foam (Aircrete) Polyurethane Foam (closed-cell)***	Moderate to High	Good for adding insulation to existing finished areas, irregularly shaped areas, and around obstructions.
BLANKET (batts & rolls)	**Mineral wool (rock or slag)****	Low	Suited for standard stud and joist spacing, which is relatively free from obstructions.
	Cotton	Low	Suited for standard stud and joist spacing, which is relatively free from obstructions; low- or no-toxicity fire retardant.
	Cellulose	Low	Can have high recycled content, very low embodied energy, and low- or no-toxicity fire retardants.
	Fiberglass (formaldehyde-free recycled content)	Low	Does not provide the degree of air seal that blown cellulose does.

Source: Based on DOE EERE EnergySavers.gov

**Extruded polystyrene (XPS) and closed-cell spray polyurethane foam (SPF) typically use blowing agents for installation that are harmful greenhouse gases.*

*** Mineral wool is naturally fire resistant, and some brands are produced with high post-consumer recycled slag content. Mineral wool insulation is used frequently in Europe and is being rediscovered in the US market.*

NOTE: At the time of this publication, Aerogel, a synthetic material with very low thermal conductivity, is being developed as insulation in multiple forms. Currently it is most readily available as Thermablock™ strips, which are adhered to wall framing to prevent thermal bridging from exterior to interior.

In wood framed houses, insulate the rim joist in the ceiling of the basement. After sealing the rim joists you can take it one step further and insulate the cavity around the joist with rigid foam or blanket insulation.

Insulate the exterior walls

In general, adding insulation to the walls of historic buildings is not a cost-effective treatment, nor does it handle historic wall structures delicately. Adding blown-in insulation to historic wall assemblies may trap moisture within the wall and accelerate deterioration of the structure.

Properly installing wall insulation involves the removal of historic finishes that can be damaged in the process. It is best to limit insulation to attics and basements where it can be installed with minimal damage to your building. If walls are so

deteriorated that complete replacement is required or if you find that your walls are uninsulated, insulation can be properly installed with a vapor barrier as the wall is repaired.

Insulating exterior walls is very challenging in historic buildings, particularly with masonry buildings. If your project involves extensive application of insulation and vapor barriers, proceed with caution and consult with an exterior wall consultant or architect experienced with historic building issues before taking action.

From Interior:

- ***Uninsulated Walls.*** In historic masonry buildings, thick (multi-wythe) load-bearing brick walls were rarely insulated. Insulating these exterior walls can be tricky and, if not implemented properly, could increase the building's vulnerability (including bricks, end joists, and beams) to freeze-thaw damage during cold and damp winters. Assess the quality of the original bricks and the orientation of the wall—is it routinely exposed to rain? If insulating exterior masonry walls is important for your home, proceed with caution and hire an experienced professional. See section on Rating Systems & Performance Standards for a background on Passive House standards for insulation. Passive House methodology focuses on stringent and sustainable insulation specifications, as well as on the airtightness of the building envelope, in order to achieve 50-70% less energy use than a conventional building.
- ***Existing Insulated Walls.*** If your exterior wall is already insulated, determining whether your insulation is adequate depends on where it is installed, what material is used, how it is installed, and how much is installed. If your wall insulation is substantially less than what is recommended, additional insulation may be a worthwhile investment, but it can be expensive. Where your insulation is already adequate, adding more insulation may not be the best investment. If your exterior building walls abut adjacent buildings, there may be significant heat transfer. Feel these walls in the winter to see if they are warm—if so, you are essentially getting free heat, so insulating these walls may be to your disadvantage. The greater advantage may be in insulating front and rear exterior walls from the inside.

From Exterior:

- ***Wood Structures.*** In historic wood buildings, there are numerous options to blow in loose-fill insulation from the exterior of the wall. Infrared cameras or thermal imaging can be used to verify whether wall cavities are adequately filled. If you are recladding your building, adding rigid/board insulation beneath the new cladding could provide immediate improvement to your building's energy performance. The benefits of adding exterior wall insulation will depend on the quality and extent of existing insulation materials as well as the potential for impacting the moisture balance of the wall system. Be aware that rigid insulation could negatively impact the proportions of exterior historic features such as the depth of opening and trim details.

INSULATION AND VAPOR CONTROL INSTALLATION TIPS

- *Make sure you take proper health and safety precautions!*
- *Keep in mind that for insulation to work effectively, it must be a continuous layer of material with no gaps, cracks, or air bypasses. Consult a good do-it-yourself manual or hire a reputable contractor to ensure the job is done properly.*
- *If insulation is installed incorrectly it will lose its effectiveness, regardless of the R-value. Do not squeeze batts to fit into a space, and make sure that blown-in insulation is the right depth.*
- *Do not leave gaps around openings for pipes, wires, and other utilities; remember that you should not cover electrical equipment.*
- *When using rigid insulation, tape and seal the joints of the insulation panels.*
- *When using rigid insulation, an interior vapor diffusion retarder should not be installed, allowing the interior wall to dry to the inside.*
- *Additional vapor diffusion control can be provided by using semi-permeable latex interior wall paint.*

REGULATORY CONSIDERATIONS

Landmarks Preservation Commission (LPC) Regulations

If your property is a City landmark or a building in a City historic district

Alterations or repairs to exterior walls and roofs may affect the character or physical integrity of your building and its site, and typically requires LPC review. For example, adding insulation to exterior side of exterior walls or replacing wall or roof cladding will require a LPC permit; installing a white roof coating on a flat roof or sealing around existing wall or roof penetrations will not require a LPC permit.

LPC PERMIT EXAMPLES: EXTERIOR WALL SURFACES

No Permit Required

- Installing insulation at the interior side of exterior walls
- Replacing or installing caulking around wall penetrations and sealing small holes

Permit Required

- Installing exterior insulation
- Replacing or repairing masonry, siding and other wall surface materials
- Cleaning exterior wall surfaces
- Applying coatings to exterior wall surfaces

Source: Landmarks Preservation Commission

Department of Buildings (DOB) Regulations

Generally, larger-scale work such as altering or adding a building opening, or enlarging the building, requires a building permit from the DOB. Ordinary repairs and maintenance such as cleaning, painting, and repointing do not require DOB review or permits. If the work you are proposing requires a DOB permit, and your property is a City landmark or a building in a City historic district, a LPC permit will also be required. Certain types of work (alterations, renovations, or repairs), related to the building thermal envelope, need not comply with the provisions of the NYCECC if the applicant can demonstrate that such NYCECC compliance would create a hazardous or unsafe condition, or would overload an existing building system.

DOB Rule 101-14 establishes categories of work that may be classified as a minor alteration or ordinary repair and therefore may be exempt from the permit requirements of the New York City construction codes. If you are not sure whether the work you intend to do requires a permit, consult the DOB web site, www.nyc .gov/buildings, or call the DOB office in the borough where the property is located.

RESOURCES

Masonry repair techniques

State Historic Preservation Office (SHPO), for best practices in preserving historic facades

www.nysparks.com/shpo

National Parks Service, includes the Secretary of the Interior's Standard for the Treatment of Historic Properties, which can provide insight on appropriate and inappropriate alterations to historic building facades

www.cr.nps.gov/local-law/arch_stnds_8_2.htm

Preservation Briefs: www.nps.gov/tps/how-to-preserve/briefs.htm

Preservation Tech Notes: www.nps.gov/tps/how-to-preserve/tech-notes.htm

Roofs and heat island

NYC °CoolRoofs, program includes information and incentives on white or green roofs

www.nyc.gov/html/coolroofs

Weatherization, Insulation & Air Sealing

Home Energy Saver is a do-it-yourself energy audit tool produced by Lawrence Berkeley National Laboratory's Center for Building Science

www.homeenergysaver.lbl.gov

Energy Star: Sealing Air Leaks provides guidance on sealing your basement

www.energystar.gov/index.cfm?c=diy.diy_sealing_basement

Building Science Corporation provides guidance and articles on wall assemblies, insulation, and retrofits

www.buildingscience.com

Insulation Contractors Association of America (ICAA) can help you find a qualified contractor to add insulation to your historic building

www.insulate.org

North American Insulation Manufacturers Association (NAIMA) provides a guide to different types of insulation, incentives, and industry developments

www.naima.org

Fireplace dampers. Lock-Top and Lyemance are the some of the better-known insulating fireplace dampers

www.dukefire.com/lyemancedampers.html

National Parks Service provides information on weatherizing historic buildings

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

National Trust for Historic Preservation can provide help navigating the competing demands of energy performance and historic preservation

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

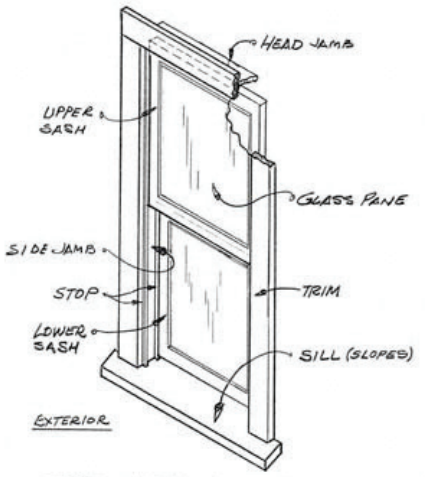
WINDOWS & DOORS

According to the U.S. Department of Energy, doors and windows combined account for 21% of a typical building's air infiltration, which contributes to increased heating and cooling costs and reduced comfort levels. New York City is known for its hot, humid summers and long winter months where temperatures often hover below freezing. Preventing air infiltration is key to keeping down energy costs and maintaining a comfortable indoor environment year-round. The good news is that there are many ways to make existing windows and doors more energy efficient. Simple measures such as caulking, weatherstripping, and upgrading deteriorated glazing minimize air leaks and reduce air infiltration. Installing storm windows also improves the performance of existing windows.

Always consider repairing and enhancing doors and windows before replacement. This will ensure that less material is wasted. Repairing historic elements will also help retain the character of your building.

Key issues with windows and doors in historic buildings

- It is a common misconception that old windows which have deteriorated over time must be replaced with new windows. In many cases, weatherizing and repairing your existing windows may be more cost-effective.
- Improving energy efficiency must be considered in tandem with maintaining the historic integrity of a building. Inappropriate window choices can seriously damage the historic and architectural character of a building.
- Poorly installed or poorly maintained windows and doors represent a major source of unwanted heat loss and discomfort and can lead to water damage and other moisture problems in the walls of the building.
- Not all windows are made equally. High-performance windows and doors are strong and durable with thermally broken frames for energy efficiency and condensation resistance. Frames that are not thermally broken perform less effectively and may not age as well because of continual damage from condensation.



Window Terminology. A typical wooden window has several components that affect a building's thermal insulation, solar heat gain, and airtightness. Upgrading one or more parts of the window, even without replacing the entire window, can improve the energy efficiency of a building.

- The **head** represents to top of the entire window.
- The **jamb** supports the outer edge of the window.
- The **frame** is the entire outer portion of the window in which the sashes and other parts move.
- **Glazing** is any process or material applied to panes of glass.
- **Panes** are individual units of glass, divided by muntin bars.
- A **sash** is an entire assembly of panes and is the part that moves.
- The **sill** is the lower portion of the window, which usually protrudes out from the wall.
- **Muntin bars** (also known as grilles or windowpane dividers) separate individual panes.

Source: Grand Window and Repair

OPPORTUNITIES—LOW/NO COST

Secure window locks

While locks on double-hung and casement windows provide security, they are also a weatherization device. If a lock does not close completely, the window will leak air. Secure all locks to maximize the seal and prevent unnecessary heating or cooling losses. Replace locks that are damaged or missing.

Weatherize windows and doors

Reducing air leaks will make your home more comfortable, and also save energy—up to 30% per year (US Department of Energy). First determine the obvious air leaks such as from window-mounted air conditioners, the gaps around windows and doors after installation, windows that rattle, and daylight visible around the frames. Insulation that is simply stuffed into cracks does not stop airflow. Check to see if the existing sealant and weatherstripping were applied properly and are still in good condition. The following weatherization materials and methods will help make your windows and doors more efficient:

- ***Seal or reseal gaps and cracks.*** There are many sealants available and improper application is a common mistake. An inappropriate sealant may not adhere to your building materials or could contribute to corrosion in the long term. Know what materials you are working with before heading to the

hardware or building supply store. Read product labels carefully and ask for guidance at the store. See chart for sealant types and details.

- ***Add or replace weatherstripping to windows.*** A wooden window sash may become loose and drafty overtime. An effective and low-cost way to cut air leakage through windows is to install weatherstripping. Although weatherstripping is one of the least expensive components of a window, proper installation and upkeep can increase energy performance significantly. It is also minimally visible and does not affect window and door operability. Weatherstripping is typically installed at the upper, lower, and meeting rails of windows, and around the sash and frame. The type of weatherstripping you use depends on the window; see the weatherstripping chart on page 23 for descriptions.
- ***Add or replace weatherization to doors.*** To decrease air leakage below doors, either add weatherstripping to the bottom of the door or replace your threshold or door bottoms. Thresholds are generally installed to replace those that have worn out; whereas door bottoms or sweeps are usually installed in doors with no existing threshold or door saddle to provide a positive seal against air movement. Weatherstripping should also be applied to interior doors that lead to uninsulated rooms, such as a sunroom, attic, cellar, or basement.

Weatherize other glazed building components

Weatherstripping and sealants can also be added to spaces that have storefront windows, skylights, and overhead glazing systems as well as greenhouses.

Remove paint to reclaim operable windows

Layers of paint on the sash and frame often make older windows difficult to operate over time. Scrape or strip paint layers off the window components and reapply fresh paint or sealer to return the window to operable conditions. Use non-toxic paint strippers and paints wherever possible. Old windows may have layers of lead paint, so take the necessary precautions (see section on Indoor Health, Housekeeping & Materials).

Air leaks. Older doors that have experienced daily use are likely to be worn down and dented, allowing air to leak in and out. Wooden doors like the one showed here are especially susceptible to degradation from moisture, snow and de-icing practices, and daily use; they should be maintained regularly for optimum insulating performance.

Photo © Terrapin Bright Green

Sealants for windows and doors. Using the correct sealant (caulk) for your particular application is critical. The sealants in the chart below are for filling.

SEALANT (CAULK): EXTERIORS & WINDOWS/DOORS

TYPE	USES / APPLICATIONS	COST	PERFORMANCE & COMMENTS
Silicone: Construction	Seals most dissimilar building materials such as wood and stone, metal flashing, and brick.	High	Flexible, permits joints to stretch or compress. Get guidance for proper sealant based on materials and application. Pay special attention for VOCs and instructions for products not to be used indoors.
Spray Foam: (Latex) Water-based	Around window and door frames in new construction; smaller cracks.	High	Water-based foam production does not produce greenhouse gases. Will not over expand to bend windows (new construction). Must be exposed to air to cure. Not useful for larger gaps, as curing becomes difficult. Guidance is suggested for proper sealant based on materials.
Spray Foam: Polyurethane, expandable	Expands when curing; good for larger cracks indoors or outdoors. Use in nonfriction areas, as foam becomes dry and powdery over time.	Moderate to High	Flexible. Can be applied at variable temperatures. Must be painted for exterior use to protect from ultraviolet radiation. The maufacturing process for polyurethane spray foam produces greenhouse gases.
Butyl rubber	Generally butyl rubber is not used in residential applications, and is used for example in sidewalks.	Moderate to High	Seals dissimilar materials. Toxic; follow label precautions, and do not use indoors.

Information based on DOE EERE EnergySavers.gov

Window replacement.

Inefficient historic windows replaced with aesthetically appropriate Marvin wood double hung windows.

Photos © David Cunningham Architecture Planning

OPPORTUNITIES—MODERATE COST

Install storm windows

Installing storm windows over existing windows is an effective way to improve the performance of older single pane windows. The insulating air gap created between the primary window and the storm window helps insulate against noise and drafts, prevent condensation, and save on heating costs. A 2002 study conducted by the Lawrence Berkeley National Laboratory confirmed that installing a storm window over an existing window can achieve a similar thermal performance to that of a new low-E vinyl replacement window.

Interior storm windows are easier to install than exterior storm windows and are not typically subject to regulatory approval. In addition, installing interior storm windows will not disrupt important decorative details on the outside of your building. Consult your energy audit to determine if adding storm windows will significantly improve energy efficiency.

Take care to avoid damaging historic window frames when installing storm windows. Storm window meeting rails and other divisions should match the location of the same elements of the historic windows. Paint the storm windows to match existing window frames to help diminish their visual impact.

Provide shading on windows

Adding the features outlined below to your building, especially on south-facing exposures, can help regulate the amount of hot and cold air that filters into your building.

- ***Interior window treatments.*** Interior shutters, blinds, and curtains can be used on south-facing windows to block solar heat gain in the summer. In the winter, heavy draperies will act as an additional thermal barrier from heat loss and cold drafts. For improved comfort and energy efficiency, a multipurpose window treatment strategy that allows breezes and daylight to pass through is recommended.
- ***Exterior shutters.*** Historically, exterior shutters were designed to provide security, privacy, and protection from the elements. In the summer they effectively control heat gain while allowing ventilation. Where shutters are being installed or replaced maximize your investment by making sure new or repaired shutters are operable instead of fixed and ornamental.
- ***Window awnings.*** Retractable canvas awnings over doorways and windows shield openings from rain and reduce interior heat gain by screening the sun. Awnings should be retracted in the winter to maximize heat gain. Awnings and other solar control devices may not project more than 2.5 feet from the facade (or project more than 5 feet if the device is at least 8 feet above a sidewalk), and cannot cover more than 30% of the exterior wall. Windows that are highly exposed to sun throughout the day may benefit from additional treatments. See the section on Sustainable Landscapes & Outdoor Amenities for shading opportunities with deciduous trees.
- ***Window film.*** Window films on the interior face of the window can also reduce heat gain and provide a low-e coating (see "Glass Pane Replacement" on page 23 for explanation). While these films do not function as well as new low-e windows, they are less expensive and easy to install. Films can also be tinted, but since this can drastically reduce daylighting and view to the exterior, only the lightest tints should be considered.

OPPORTUNITIES—HIGHER COST

Glass Pane Replacement

Proper glazing in a window frame, both the type of glass and how it is installed, is one of the most important factors in maintaining a comfortable indoor environment, controlling acoustics from the exterior, and managing utility bills. The aesthetic impacts should be considered whenever undertaking window replacement.

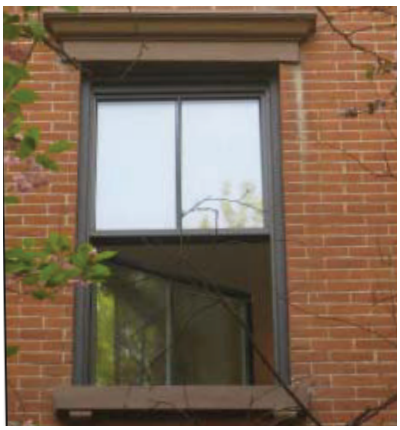
- ***Selecting an insulated glazing unit (IGU).*** Depending on your frame configuration, you may be able to alter the wood rail of the sash and replace a single-paned window with a double-glazed unit in the original frame. Another alternative is to replace the entire window sash. Compared to single glazing

Weatherstripping, or filling gaps in the building envelope, can be done in a variety of ways. Some common products are listed below.

COMMON WEATHERSTRIPPING

TYPE	WINDOW USE	DOOR USE	COST	PERFORMANCE & COMMENTS
Tension seal (V-Shape)	Inside the track of a double-hung or sliding window	Top and sides of door	Moderate; varies with material used	Durable. Effective. Can increase resistance in opening/closing doors or windows. Ease of installation varies. Not visible.
Felt	Around window frame	Around a door; fitted into a door jamb so the door presses against it	Low	Easy to install. Low durability. Not very effective in preventing airflow. Do not use where exposed to moisture or where there is friction or abrasion. Not visible.
Reinforced foam	At window stops; bottom or top of window sash	At door stops; bottom of door	Moderately Low	Closed-cell foam an effective sealer. Rigid. Can be difficult to install. Very visible. Manufacturing process produces greenhouse gas emissions.
Tape	Top and bottom of window sash; attic hatches and inoperable windows	Door frames; good for blocking corners and irregular cracks	Low	Extremely easy to install. Generally not very durable but durability varies with material used. Visibility depends on type and installation.
Magnetic	Steel windows: double-hung and sliding window channels	Steel doors, top and sides of doors	High	Relatively easy to install. Very effective air sealer. Not visible.
Reinforced silicone	On a window stop	On a doorjamb	Moderate to High	Installation may be difficult. Seals well. Not visible.
Rolled or reinforced vinyl	At window stops; bottom or top of window sash	At door stops; bottom of door (rigid strip only)	Low to Moderate	Easy installation. Visible although it comes in varying colors.
Door sweep	–	Bottom interior side of in-swinging door; bottom exterior side of out-swinging door	Moderate to High	Relatively easy to install; many types are adjustable for uneven threshold. Automatically retracting sweeps also available, which reduce drag on carpet and increase durability. Visible.
Tubular rubber or vinyl	–	Around a door	Moderate to High	Self-stick may be difficult to install. Effective air barrier. Not visible.
Door shoe	–	Seal space beneath door	Moderate to High	Installation moderately difficult. Durable. Can be used with uneven opening. Visible.
Bulb threshold	–	Door thresholds	Moderate to High	Installation moderately difficult. Combination threshold and weatherstrip. Visible.
"Frost-brake" threshold	–	Seal space beneath door	Moderate to High	Installation moderately difficult. Effective. Visible.
Interlocking metal channels	–	Around door perimeters	High	Should be installed by a professional as alignment is critical. Very effective. Visible.

Information based on DOE EERE EnergySavers.gov



Passive House windows example.

Open tilt/turn window used for superior insulation in a Brooklyn Passive House.

Photo © 475 High Performance Building Supply

(one pane of glass), a double-glazed (two panes of glass) unit with an airspace in between cuts heat loss in half due to the insulating effect of the airspace. In addition, double-glazed windows will block more noise from the exterior. Double-glazed windows can change the appearance of the window from the exterior due to a change in reflectivity of the glazing unit and/or the width of the framing unit.

- ***Upgrading to a high performance window.*** A standard IGU, with double glazing, is a typical modern window assembly. To meet current energy codes, windows integrate low-e coatings, thermal films, and gases to improve thermal performance.
  - The addition of a low-e coating to a window also offers a layer of protection for interior finishes, artwork, or textiles. Low-e coatings help cut infrared radiation losses, thereby lowering the total heat flow through the glass area of a window.
  - Reducing the conductivity of the air space between the layers of glass can further improve the thermal performance of the window. Filling the space with a less conductive gas than plain air, such as argon or krypton, minimizes the convection currents within the space, thereby reducing the overall transfer of heat between the inside and outside.
  - In addition to inert gas-filled low-e windows, suspending a thermal film between the two panes of glass will further reduce thermal conductivity and noise transmission. The film functions as an additional piece of glass, adding thermal efficiency, UV and sound protection, but without excessive cost or weight associated with triple glazing. These units are slightly thicker than standard double-glazed window units and thus may be more appropriate when replacing the entire window unit.

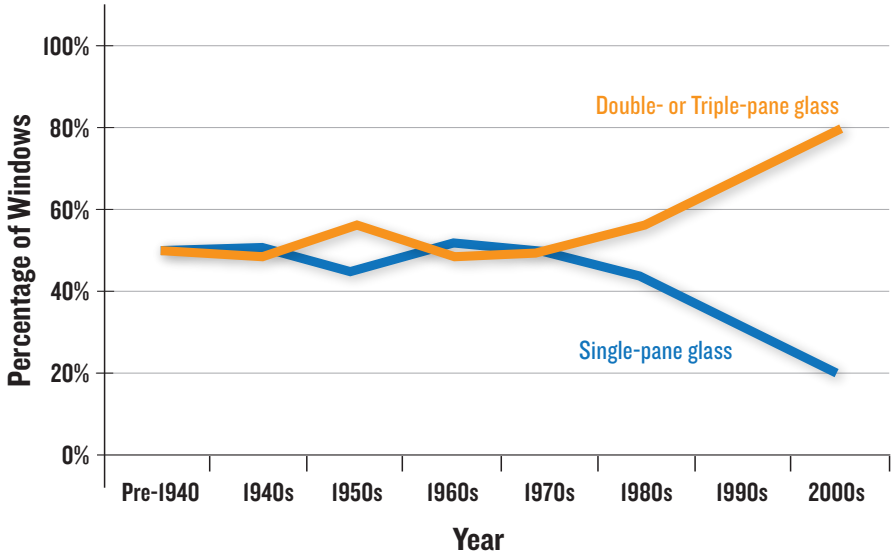
THERMAL BRIDGES AND BREAKS

The Building Science Corp defines a thermal bridge as a material with higher thermal conductivity transferring heat through an assembly with substantially lower thermal conductivity. For example, a steel stud in a wall will transfer more heat than the surrounding insulation, reducing the overall thermal control of the system. Thermal bridging is also very common in historic steel frame windows. Whenever possible, opt for products with a thermal brake: an component of low conductance (wood, rubber) placed between components of higher conductance (metals) to reduce the flow of heat.

Window Replacement

If your window is in irreparable condition and must be replaced, there are several factors to consider. If you replace particularly poorly performing windows, it may offset other upgrade costs by lowering heating and cooling loads.

- ***Window frames and casings.*** There are several issues to consider when replacing a window. The most cost-sensitive issue is typically the frame material. Windows come in several material choices, with differing cost and aesthetics: wood, aluminum clad wood, aluminum, steel, fiberglass, and vinyl. Typically, wood windows are the most appropriate for front facades of a historic rowhouse. Secondary (side or rear) facades present an opportunity to use other materials.



Trends in energy-efficient window use. Since the 1970s, the prevalence of double-pane and triple-pane windows has continued to increase, a trend that amounts to more than 80% of new windows today.

Source: US Energy Information Administration, 2009 Residential Energy Consumption Survey

When selecting a frame material, consider initial cost as well as durability, ease of repair, performance, and energy efficiency. Vinyl windows are not durable or environmentally responsible, and should be avoided. Wood frames tend to have a higher upfront cost, but last several decades and can be maintained and repaired with relative ease. Steel frame windows are durable, but traditionally do not include a thermal break and therefore conduct cold temperatures, which can lead to condensation and make them less efficient (see sidebar on Thermal Bridges & Breaks). In either case, look for frames that are thermally broken for the best performance and those that qualify for Energy Star® and tax credits (see www.efficientwindows.org).

- ***Operation.*** In historic buildings, it is most appropriate to match the original window operation. For instance, a double-hung unit should be replaced with a new double-hung unit. The homeowner should take care to look for a window unit that offers a tight seal. The tightness is highly variable based upon the manufacturing and installation quality. Typically casement windows are considered the tightest units; however, double-hung windows can also be effective when hardware is used properly and sashes are well maintained.
- ***Glazing.*** See the Glass Pane Replacement opportunity on page 23 for a discussion of possibilities. For New York City's climate double-glazed units have become the industry standard. While triple-glazed (three panes of glass) window units tend to have the highest performance in energy efficient and noise cancellation, they are also more expensive. Triple-glazed window units often use a suspended film as the third pane in order to achieve the proper thermal values necessary to meet the Passive House standards without the added weight of a third pane of glass. Passive House is a design and construction methodology that aims to drastically reduce the energy consumption of a building. See the section on Rating Systems for more information on Passive House.
- ***Sealing the window opening.*** Often overlooked, the window opening must be properly framed and prepared to insure water- and airtightness. To ensure water-tightness, properly detail and coordinate the flashing for both the window opening and the window unit. The air barrier should also be continuous in the assembly. When determining the type of sealants consider the cumulative effect of shrinkage and movement of the building components.

Door Replacement

If you replace particularly poorly performing doors it may offset other upgrade costs by allowing for smaller heating and cooling loads.

- ***Doors and door frames.*** There are several issues to consider when replacing a door. The most cost-sensitive issue is typically the door material. Doors come in several material choices with differing cost and aesthetics: wood, steel, hollow-core metal, or fiberglass. When selecting a door material, consider thermal isolative value, acoustical properties, durability, security, maintenance, up-front cost, and in some cases fire rating. Solid wood doors and frames tend to be expensive up front, but last several decades and can be maintained and repaired with relative ease. Steel doors are traditionally the most secure, but unless they are insulated do not provide an acoustical barrier or thermal insulation.
- ***Glazing.*** See the Glass Pane Replacement opportunity on page 23 for a discussion of the possibilities. This information applies to glass doors.
- ***Sealing the door opening.*** All doors should have continuous weatherstripping on the top and sides and at door sweep at the bottom. The door opening must also be properly framed and prepared to insure water- and airtightness. When determining the type of sealant to use, consider the cumulative effect of shrinkage and movement of the building components and size the caulking joints accordingly.

LOW-EMITTANCE (LOW-E) COATING

A thin, nearly invisible, metal or metallic oxide layer deposited on a window or skylight glazing surface primarily to suppress radiative heat flow. Low-E coatings reduce a window's U-factor thereby improving its insulation performance.

Sample NFRC Window Rating. The National Fenestration Rating Council (NFRC) provides reliable assessments of window and door performance. When replacing any opening in the building's envelope, compare ratings at www.nfrc.org. Select windows with the Energy Star® label may also be eligible for a tax credit (www.efficient windows.org).

LPC PERMIT EXAMPLES: WINDOWS & DOORS

No Permit Required

- Repairing (minor) original window or door materials
- Replacing or installing hardware on windows or doors
- Replacing glazing putty and broken glass
- Replacing or installing weatherstripping around windows or doors and framing
- Replacing or installing caulking around window or door framing, casings and trim
- Repairing window suspension systems or installing insulation sleeves in sash weight pockets
- Installing most interior storm windows or insulating panels with clear glass, including low-e
- Installing clear low-e films on windows or doors

Permit Required

- Repairing or replacing (extensive) original window or door materials
- Replacing or installing windows or doors
- Replacing or installing exterior storm windows or doors and some interior storm windows
- Installing tinted films (nonclear) on windows or doors
- Replacing, installing or removing exterior window shutters
- Replacing or installing window or door awnings

Source: Landmarks Preservation Commission

Other Glazed Building Component Replacement

- ***Storefronts.*** For commercial spaces that have storefront windows, thermal performance should be balanced with visual clarity of the window unit. Glazing should have a visual transmittance of at least 80%. This can be achieved with low-e argon-filled double-glazed window units. Use thermal broken frames whenever possible.
- ***Skylights/overhead glazing systems.*** Many older homes include skylights to bring natural light into central locations without windows and to provide ventilation. Older skylights benefit from regular repairs and maintenance. Adding skylights will increase daylighting and decrease lighting costs. Additionally, depending on its location, a vented skylight can increase cross-ventilation. Procure low-e, double-paned, argon filled, glass skylights whenever possible. Less expensive plastic-domed skylights are discouraged as they typically have a short usable life, tend to discolor over time, and are not as energy efficient as glass units. Research skylight systems to make sure the chosen system provides redundant waterproofing.
- ***Greenhouses.*** To function properly greenhouses need interior shading devices, proper ventilation equipment, and proper glazing. An architect should be consulted to identify the needs of your specific project. When a greenhouse-type wall and roof are open to the interior of the home, homeowners should be cautious when selecting glazing as it will significantly contribute to cooling and heating loads if not properly designed. Glazing should be of the highest performance possible and internal shades should be integrated to control glare.

REGULATORY CONSIDERATIONS

Landmarks Preservation Commission (LPC) Regulations

If your property is a City landmark or a building in a City historic district

Alterations to windows and doors may affect the character or physical integrity of your building and its site, and typically requires LPC review. For example, replacing windows and doors or installing exterior storm windows will require a LPC permit; caulking and weatherstripping around a door or window or replacing broken glass will not require a LPC permit.

Department of Buildings (DOB) Regulations

Generally, larger-scale work such as altering or adding a building opening requires a permit from the DOB. Installation of storm windows over an existing window does not require a DOB permit and is a listed exception from complying with the New York City Energy Conservation Code, but exterior storm windows will require an LPC permit; see the LPC regulation section above. Ordinary repairs and maintenance such as weatherstripping, replacing broken glass, or painting do not require DOB review or permits. If the work you are proposing requires a DOB permit, and your property is a City landmark or a building in a City historic district, an LPC permit will also be required. If you are not sure if the work you intend to do requires a permit, consult the DOB web site or call the DOB office in the borough where the property is located.

In addition, Rule 101-14 of the Rules of the New York City (RCNY) establishes categories of work that may be classified as a minor alteration or ordinary repair and therefore may be exempt from the permit requirements of the New York City construction codes. Rule 101-14 can be downloaded from the City's web site (www.nyc.gov/html/dob/downloads/rules/1_RCNY_101-14.pdf).

RESOURCES

National Fenestration Rating Council provides performance ratings for many windows and doors

www.nfrc.org

Efficient Windows Collaborative, an industry group dedicated to promoting well-insulated windows. Their web site includes information on window technologies, weatherization assistance, and replacement guidance, as well as a window selection tool and tax credits information for windows

www.efficientwindows.org

National Trust for Historic Preservation web site includes the "Window Contractor Locator" tool

www.preservationnation.org/resources/homeowners

Energy Star Doors, Windows & Skylights includes Energy Star-rated products

www.energystar.gov

US Department of Energy's Weatherization Assistance Program provides energy efficiency incentives

http://apps1.eere.energy.gov/weatherization/apply.cfm

New York State Energy Research and Development Authority (NYSERDA) offers low-interest loans and other incentives for homeowner renovations

www.nyserda

SOLAR HEAT GAIN COEFFICIENT (SHGC)

The fraction of solar radiation admitted through a window or skylight, both directly transmitted and absorbed and subsequently released inward. The SHGC is expressed as a number between 0 and 1, whereby 1 is the maximum amount of solar heat gain that can come through a window and 0 is the least amount. The lower a window's SHGC, the less solar heat it transmits, and the greater its ability to block the heat from the sun. An SHGC of 0.40, which is a recommended maximum for New York City's climate, means that 40% of the available solar heat is coming through the window.

SHGC ratings express the performance rating for the entire window, not just the glass; so two different frames with the same glass may have a different SHGC.

Glass can also be characterized by the amount of solar heat it blocks:

- *High solar gain*
- *Moderate solar gain*
- *Low solar gain*

Moderate solar gain glazing is generally preferred in New York City's climate, but it largely depends on the orientation of your building. Windows on the south or west facade may be suitable for low or moderate solar gain, whereas north-facing windows may be best suited for high solar gain.

Sources: National Fenestration Rating Council; Efficient Windows Collaborative, www.efficientwindows.org

HEATING & COOLING

For every degree you raise your AC thermostat you can cut your electricity bill by 3% or more

The City of New York, Office of the Mayor, www.nyc.gov/greenyc

Before electricity was widespread, buildings were designed with passive features to make living spaces more comfortable. Today original passive features are often underutilized, obstructed, or even eliminated to make way for more modern technologies. In some cases new active (mechanical) systems work better, but usually cost more and require more maintenance. In all likelihood, the most appropriate solution for your building is a combination of active and passive features:

- Windows, including transom windows often located above exterior and interior doors, offer natural light and airflow to enter and pass through a building.
- The intentional alignment of windows and interior doorways encourages cross-ventilation throughout the building.
- Awnings and other exterior shading devices reduce solar heat gain and reduce cooling loads. See the section on Window & Doors for more information.
- High ceilings allow for hot air to rise up and away from occupants.
- Vented skylights provide ventilation in open stairwells, allowing breezes and hot air to rise through the stairwell and out the skylight, and permitting cooler air to flow through the living spaces.
- The thermal mass of masonry buildings helps manage solar heat gain, leading to less energy use because of fewer spikes in heating and cooling requirements.

These features combined with an efficient and properly sized mechanical system should provide comfortable living conditions at reasonable cost.

TYPICAL HEATING AND COOLING SYSTEMS IN PRE-1940S BUILDINGS

If your building was originally heated by fireplace, wood stove, or coal-fired boiler, it was probably retrofitted with its current energy system sometime in the last half of the 20th century. Today historic rowhouses typically have either radiant (using steam or hot water) or electric baseboard heating systems and electricity-based window-mounted air conditioning (A/C) units. In some cases, a rowhouse may have been extensively renovated to incorporate a central heating and cooling system, typically with a heat pump.

Key issues with mechanical heating and cooling systems in historic buildings:

- ***Discomfort due to overheating.*** Design flaws and heat loss through windows or other leaks in the building envelope can contribute to overheating systems. A common solution for these problems is for building occupants to open windows or run air conditioners even in cold winter months, needlessly consuming energy.
- ***Discomfort due to underheating.*** Plug-in electric radiators are often used to compensate for spaces without enough heating due to excessive drafts or inadequate mechanical systems. These are relatively inefficient for space heating and expensive to operate.
- ***Impact of other building components.*** The exterior walls, windows, and internal heating loads (lighting, equipment, and people) alter the interior temperature and humidity of the home, factors that are often inadequately considered when selecting and sizing an HVAC system.
- ***Poor sizing of cooling systems.*** Often heating and cooling systems are improperly oversized for the building energy loads, leading to discomfort and excessive energy use.

- ***Lack of controls.*** Older building heating and cooling systems often lack appropriate controls, such as a thermostat, to monitor comfort levels and reduce energy consumption.
- ***Lack of maintenance.*** Once a heating and cooling system is installed, it is commonly left unmonitored for years. Neglect often leads to premature loss of efficiency or system failure, whereas routine maintenance and repair help ensure long-term performance.

OPPORTUNITIES—LOW/NO COST

Before addressing your building's mechanical system issues, take care of any inefficiencies found in your walls, roof, windows and doors. See sections on Walls & Roofs and Windows & Doors for information on weatherization and related opportunities.

Set your thermostat to reduce energy bills

The simplest and most cost-effective strategy to improve your current heating and cooling systems is to set your thermostat no lower than 78 degrees in the summer and no higher than 68 degrees in the winter. If you don't have a thermostat, your utility company may offer incentives for you to purchase one.

Maximize benefits of passive features and natural ventilation

- Maximize natural ventilation in the spring and fall. Opening doors and windows at night will facilitate cross-ventilation and reduce the need for air conditioning. When moving or adding interior walls or doorways or even furniture, be sure to maintain or improve upon cross-ventilation. Do not obstruct existing ventilation paths, as it could make a once airy room stuffy.
- Re-engage old openings and locate new ones to encourage cross-ventilation. Consider how air flows on each floor, as well as how open stairwells and skylights may impact whole-building airflows. Interior transom windows found in older buildings are often undervalued or forgotten or have been painted shut; utilizing these will help bring daylight and fresh air deeper into the home. Depending on historical relevance, consider adding operable transom windows to interior doors to optimize cross-ventilation and daylight.

Evaluate and adjust ventilation system

Proper moisture control and ventilation improve the effectiveness of air sealing and insulation, and vice versa. Here are some rules of thumb for proper ventilation:

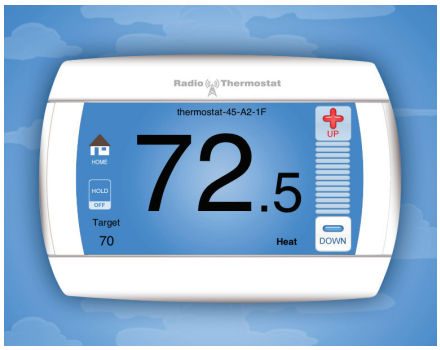
- Install exhaust vents near humidity sources in kitchens and bathrooms.
- Ventilate your attic with gables and soffit vents.
- Ensure all fuel-burning appliances have an adequate air supply and vent to the outside.

Clean or replace air conditioner filters

Filters in air conditioners are rarely replaced as often as they should be. When a filter becomes clogged the air conditioner has to work harder to achieve the same temperature, which leads to higher electricity bills, more mechanical noise, and a shorter life span. Clean or replace your filters at least once a year, at the beginning of the cooling season.

Clean chimney and install and repair dampers to reduce heat loss

Have your operable chimney cleaned regularly to minimize chances of a chimney fire. See section on Walls & Roofs for more information on reducing heat loss through your chimney.



The modern thermostat. New data technology allows greater control over heating and cooling. Consider upgrading thermostats to models that can be programmed, "learn" occupancy habits, or can be controlled remotely to allow systems to turn off when vacant and turn on before occupants arrive.

Image credit: Creative Commons, some rights reserved by Lars Ploughman

Air filter replacement. Given the degree of urban soot accumulated on this ERV supply air filter, it is being replaced routinely to maintain a high quality of indoor air.

Photos © Ken Levenson Architect

OPPORTUNITIES—MODERATE COST

Utilize a humidifier in winter to increase comfort and protect historic finishes

In New York, low outdoor humidity compounded by radiant heating systems leads to very low humidity levels inside the home. This can be damaging to historic finishes, woodwork, and human health. A humidifier can be integrated into a central heating system or installed in individual rooms to increase humidity to more comfortable levels.

Insulate and recalibrate your boiler and hot water heater

- ***Lower the high temperature range.*** For each 10°F reduction in water temperature, you can save 3%–5% in energy costs.
- ***Insulate your boiler and hot water heater.*** When boilers or water heaters are not in use they lose heat. Adding insulation to your water heater can reduce standby heat losses by 25%–45%. This can save 4%–9% in water heating costs. Install rigid insulation—a bottom board—under the tank of your electric water heater. This will help save another 4%–9% of water heating energy and is best done when installing a new water heater.

Ceiling fans. Whenever possible, rely on passive space conditioning and natural ventilation over mechanical systems. Fans can often provide sufficient air circulation to make the space feel more comfortable at a given temperature.

Photo: Public domain

Install ceiling fans to increase comfort and reduce cooling loads

Ceiling fans are found in many historic buildings and are a good option to improve air circulation. Select a fan with an efficient motor and blade design to maximize efficient air movement. See section on Appliance & Plug Loads for information on efficiency criteria for ceiling fans.

Upgrade your thermostat to respond to your needs

New, advanced thermostats are now available to help you save energy.

- ***Setback thermostats*** are designed to reduce conditioning by 3-10 degrees when rooms are unoccupied, thereby conserving energy while maintaining a high degree of comfort.
- ***"Smart" thermostats*** use fine-grained data of your activities and learn from them to predict your heating and cooling needs (e.g., NEST "smart" thermostat). Be sure to verify that the thermostat you choose is compatible with your heating and cooling system. Thermostats can also be programmed to reflect user needs in order to maximize cost savings.

Seal ductwork

In buildings with central forced-air heating and cooling systems, ducts are used to distribute conditioned air throughout the building. Typically about 20% of the air that moves through ducts is lost due to leaks. The result is higher utility bills and difficulty keeping the house comfortable, no matter how the thermostat is set. It's relatively easy to seal and insulate ducts that are accessible; however, sealing ducts concealed in walls and above ceilings may require hiring a contractor and may become costly when not part of a comprehensive renovation effort.

Install window treatments, exterior shutters and awnings

See section on Windows & Doors for benefits to heating and cooling.

Replace your window A/C units

Window and through-wall A/C units are prevalent in New York City. Window and through-wall sleeved A/C units are often left in place throughout the year. A/C units and PTAC (Packaged Terminal Air-Conditioning) units tend to leak air, averaging about six square inches of leak area, primarily attributed to the "lack

of long-term integrity in installation kits, and poor fit and sealing. . .” (Steven Winter Associates). The best way to reduce energy loss from A/C units is to improve the installation by hiring a professional installer and sealing gaps with weatherstripping or closed cell foam.

New installations of through-wall A/C units are discouraged in historic buildings as they damage the existing integrity of a building facade. There are many options for replacing a window A/C unit. Some of the options include:

- A more efficient window A/C with thermostatic controls. See section on Appliances & Plug Loads for energy efficient air conditioning units.
- A ductless A/C with a remotely located condenser with thermostatic controls.
- A central heating and air conditioning system. See page 33 for “Install a central heating and cooling system.”

For additional tips on window A/C unit installations, the DOB offers a downloadable flyer at www.nyc.gov/html/dob/downloads/pdf/install_ac.pdf.

Schedule routine equipment tune-ups and maintenance

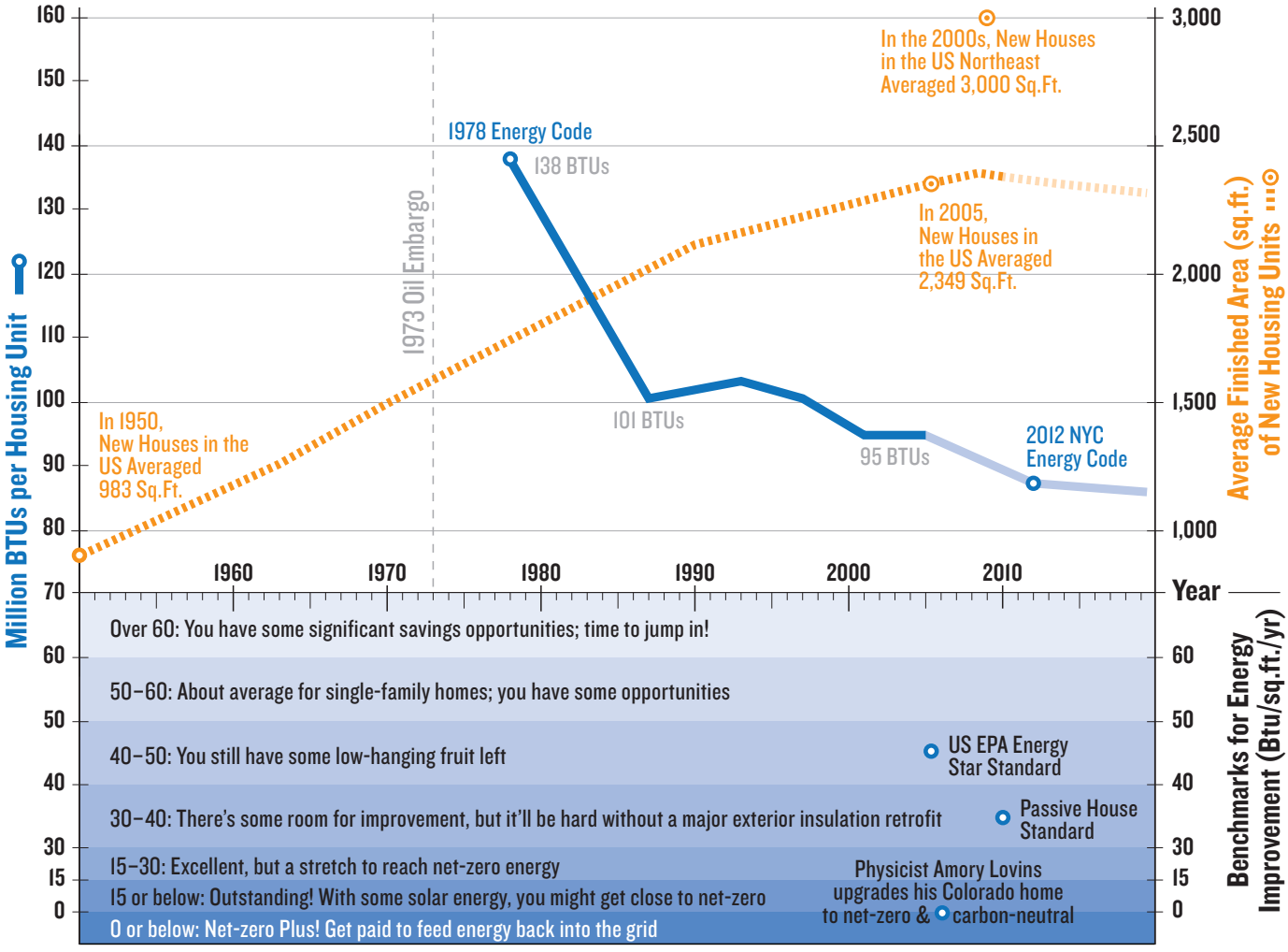
Properly maintain heating and cooling equipment, including the boiler, by scheduling annual cleaning and service checks to help ensure maximum efficiency and reduce the risk of malfunction.

Over time, radiators as well as solar heating systems can become less efficient. The reasons for this could be many things, including damaged piping, broken valves or

How does your home compare? While the graph below shows trends for newly constructed homes, you can see that those built before the 1980s are not nearly as efficient as they could be today, despite the increase in square footage. Although it is easier to maximize efficiencies in a new building, understanding the energy consumption of your historic building relative to the national trend can help put energy retrofits in perspective. Imagine what your home could achieve!

Sources: Based on data from the Energy Information Administration, 2009 RECS Housing Characteristics: Square Footage, and Environmental Building News

Graphic © Terrapin Bright Green



Window AC unit. This poorly installed air conditioner is not properly insulated and will leak air back into the building.

Photo © Terrapin Bright Green

traps, or improperly sized replacement components. Contact a reputable heating installer to balance your system. This effort should also eliminate any noises that the radiators may be making.

Upgrade your bathroom and kitchen ventilating fans

Ventilating fans remove unwanted odors and moisture when operating, but when not in use they can be an unwelcome hole. Keeping the damper and fan clean is important to fan function and avoiding unwanted air leaks. An energy auditor can test the flow of exhaust fans and determine if they meet the ventilation needs of your home.

It is important to vent fans completely to the outside, not merely into the attic, and to air seal the penetration of the exhaust duct from the fan as it passes through a wall or attic. Keep the lengths of the ducts as short as is practical with no dips that could collect condensate. Avoid condensation by insulating ductwork that passes through unheated spaces.

Turn on fans as necessary, such as in the bathroom before you start the shower and run it for five minutes after your shower ends. For simplicity, directly wire your fan into the light switch to ensure proper usage. There are many new high-quality exhaust fans on the market. Look for a unit with a sone (noise) rating of 3 sones or less.

In addition, including a central heat-recovery ventilation system, also known as an air-to-air heat exchanger, in your retrofit project will guarantee your home has the ventilation it needs without having to reheat incoming fresh air. While energy is exchanged, pollutants are not. Retrofit with a heat recovery system after your home is thoroughly air-sealed.

OPPORTUNITIES—HIGHER COST

Repair or replace your radiant heating system

A hydronic heating system, typical for detached homes in New York City, has four components: boiler, distribution piping, radiators, and controls. Proper sizing of each component is critical for efficient operation and comfort. Strategies to consider:

- If you have a steam-based heating system, replace it with a water-based radiant system, radiant floor heating, or a central system. The conversion to a hot water based system can reduce heating costs by more than 30% (US Department of Energy).
- Hire a reputable heating installer to balance your heat distribution system; replacing some piping may be necessary.
- Install thermostatically controlled radiator valves (TRVs) to modulate the boiler based upon the interior room temperature, instead of solely using the exterior temperature as a gauge.

Upgrade to a cleaner-burning fuel

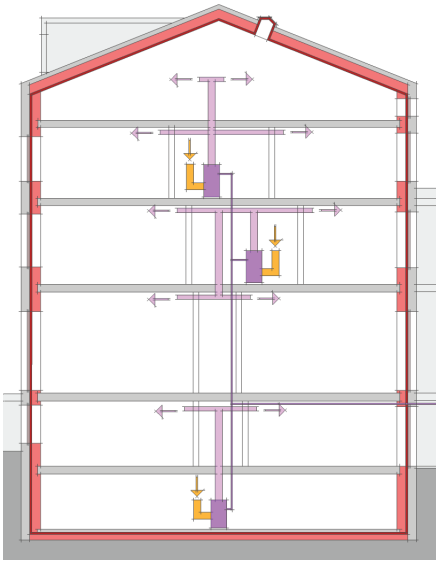
The majority of a home's fuel use is for space heating. Many boilers in New York City are fueled by No. 6 oil, which is highly polluting when burned. Replace boilers that run on No. 6 oil with boilers that use natural gas if available, since it is the cleanest option. If natural gas is not available, No. 2 fuel oil is the next best option. There are several companies in New York City that handle boiler replacement. See section on Fuel Efficiency & Renewable Energy for more information and guidance.

Install a central heating and cooling system

If you are undertaking a large-scale renovation, you should consider installing a heat pump system to provide both heating and cooling in a more energy-efficient manner than your furnace and air conditioner. Because heat pumps move heat, rather than generate heat, they can provide up to four times the amount of energy they consume. Proper installation and operation of your heat pump will save energy. Be sure not to run the indoor fan continuously and have a professional technician service your heat pump at least once per year.

Types of systems:

- ***Air-source heat pump.*** Air-source heat pumps can deliver 1.5–3 times more heat energy to a home than the electrical energy it consumes. In subfreezing temperatures, air-source heat pumps with gas heating (rather than electric resistance heaters) as a backup are able to overcome performance problems typically encountered by heat pumps with no gas heating backup.
- ***Split-system heat pump.*** Retrofit with a split system if you have low ceilings and little or no space for vertical and horizontal ductwork.
- ***Variable Refrigerant Volume (VRV).*** VRV systems are able to provide versatility among several units in a single building, whereby each indoor unit may cool or heat independently of each other.
- ***Geothermal heat pump.*** Geothermal heat pumps use the constant temperature of the earth as the exchange medium instead of the outside air temperature. They reach efficiencies two times higher than air-source heat pumps. While geothermal is an expensive investment, it pays off very quickly. Consult an engineer to determine whether your building lot is suitable for this technology.
- ***Advanced features.*** Some heat pumps come with advanced features that improve the system's efficiency and noise control. Some examples include two-speed compressors, variable-speed or dual-speed motors, heat recovery systems, scroll compressor, and backup burners. Discuss these options with your contractor to determine the most appropriate system and features for your building.



Central HVAC retrofits. A centralized heating and cooling system with a heat pump can be four times more efficient at conditioning your home.

Diagram courtesy of Ken Levenson Architect

Zone your home

Zoning your home allows you to heat and cool only the areas that you are using, while unoccupied portions of the home hover in a reduced mode to conserve energy. Keep doors to unoccupied rooms closed (especially to basements and attics) so that you are not heating or cooling more space than necessary. Zoning requires a complex system of ductwork and dampers to control the flow of air and will be most cost-effective when implemented during a whole-building renovation.

Install solar hot water heating system to reduce heating demands

See section on Fuel Efficiency & Renewable Energy.

Install photovoltaic (solar electric) system to reduce electricity demands on the utility grid

See section on Fuel Efficiency & Renewable Energy.

REGULATORY CONSIDERATIONS

Landmarks Preservation Commission (LPC) Regulations

If your property is a City landmark or a building in a City historic district

Installation or replacement of mechanical equipment may affect the character or physical integrity of your building and its site and typically requires LPC review. For example, installing condensing units or through-wall A/C units and vents

LPC PERMIT EXAMPLES: HVAC

No Permit Required

- Replacing or installing window A/C units or fans that require only opening a window sash and do not require exterior brackets
- Replacing or installing caulking around A/C units, vents, and conduits

Permit Required

- Replacing or installing window A/C units or fans that require altering or removing a window sash or require exterior brackets
- Replacing or installing central air conditioning systems that require exterior equipment
- Replacing or installing through-the-wall AC units or vents
- Replacing or installing split heating and cooling systems that require exterior equipment

Source: Landmarks Preservation Commission, LPC Tech Sheet, Chapter 4: Heating, Ventilation & Air Conditioning Equipment

will require a LPC permit; repairing existing mechanical equipment will not require a LPC permit.

Department of Buildings (DOB) Regulations

Most mechanical work, such as the installation of boilers or rooftop mechanical equipment, requires a building permit from the DOB. The DOB does not require permits for installation of common window air conditioners. If the work you are proposing requires a DOB permit, and your property is a City landmark or a building in a City historic district, an LPC permit will also be required. If you are not sure if the work you intend to do requires a permit, consult the DOB web site or call the DOB office in the borough where your property is located.

City & State Regulations

Legislation from 2010 requires all City buildings of more than 10,000 square feet to submit energy benchmarking data every year. Building renovations that involve replacing energy-using systems must comply with the Energy Conservation Code of New York State. See www.nyc.gov for more information.

RESOURCES

ConEd's My Energy Toolkit provides online calculators to estimate your savings when you "go green" and conserve energy. Calculators estimate savings for home energy, appliances, television, CFL lighting, programmable thermostat cooling and heating, and paperless billing.

www.coned.com/customercentral/calculators/EC_res.html

Energy Savers, a Department of Energy web site, has thorough explanations of energy efficiency opportunities that apply directly to particular heating and cooling systems

www.energysavers.gov

Department of Energy: Energy Efficiency & Renewable Energy includes information on hydronic heating and other building energy efficiency systems

www.eere.energy.gov

Energy Conservation Code of New York State. If you are making renovations that include replacing your HVAC system, you may be required to comply with modern energy efficiency codes

www.dos.state.ny.us/DCEA

New York State Energy Research and Development Authority (NYSERDA) offers energy efficiency resources and incentives to upgrade your HVAC system

www.nyserda.ny.gov

BuildingGreen, a web site with articles, case studies, and information about new technologies

www.buildinggreen.com

Utility Companies will usually offer a variety of incentives to upgrade systems and improve your building's energy efficiency

www.coned.com/energyefficiency/residential_HVAC_program.asp

www2.nationalgridus.com/energy/index_ny_kedny.jsp

LIGHTING & ELECTRICAL

Developing an effective lighting strategy should utilize natural daylight and efficient electric light sources and technologies to create a comfortable and safe environment. Utilizing maximum amounts of natural daylight is important to energy efficiency and has been shown to positively impact human health, well-being, and productivity. User behavior patterns should also be considered when strategizing, as this has a big impact on energy consumption.

An energy audit is a great way to learn about your lighting and electrical options. Auditors survey existing lighting fixtures and lamps, including the wattage and usage and then recommend replacement fixtures or bulbs. They can also project the expected savings after new fixtures or lamps have been installed. Many energy providers in New York offer audits and other incentives to help your make your home more efficient. Explore several opportunities before committing to a strategy that works best for you and your building.

In New York City, 27% of our electricity is used to light buildings, accounting for 12% of our overall carbon emissions

PlaNYC Update April 2011

Typical lighting systems and components

- ***Daylight:*** Recent research has shown that people experience positive physical and psychological effects when natural (free) daylight is introduced into a space.
- ***Incandescents:*** Most incandescent lightbulbs are inefficient. A typical incandescent lamp converts about 10% of the electric current into visible light, while the rest (about 90%) is released as heat. Recent federal legislation requires greater efficiency in lighting that may reduce the availability of incandescent lightbulbs.
- ***Halogens:*** Halogens can be used anywhere you would use incandescent bulbs, for about 30% less energy.
- ***Compact Fluorescent Lamps (CFL):*** CFLs last about 5 times as long as incandescent bulbs and use about 75% less energy. They are used primarily indoors and are available in a wide range of color temperatures and shapes to fit different fixtures.
- ***High-Intensity Discharge (HID):*** HIDs have good color rendition, but short lifespans.
- ***Light Emitting Diodes (LED):*** LEDs last 10 times longer than CFLs (and can last 100 times longer than incandescent bulbs) and do not contain significant amounts of mercury. They are a great noninvasive technology to use as they will not disrupt historic materials and character. LEDs can be best incorporated in accent lights, old fixtures and signage, but fluorescents are still more appropriate for space lighting.
- ***Indoor occupancy sensors:*** Occupancy sensors are a great way to save energy. They detect activity, turning on lights automatically when someone enters a room and turning them off soon after the last occupant has left. Occupancy sensors are most appropriate for closets, hallways, and other areas that are occupied for short amounts of time.
- ***Outdoor motion detectors:*** Motion sensors automatically turn on outdoor lights when they are needed (when motion is detected) and turn them off a short while later. They are very useful for outdoor security and utility lighting provided by incandescent lamps.
- ***Lighting Dimmers:*** Dimmers are devices used to vary brightness. By decreasing or increasing the mean power to the lamp, it is possible to control the intensity of the light. Multipurpose spaces often call for varying amounts of light. Dimmers are not appropriate for most types of LEDs.

JUST HOW BIG IS THE U.S. LIGHTING INDUSTRY?

There are approximately 4 billion lightbulb sockets in the US, including residential and commercial buildings.

The US purchases about 2 billion residential light bulbs a year or about 5.5 million bulbs a day.

The average US house has 45 bulbs in 30 fixtures; with 116.9 million households in the US (2006), that's more than 5.2 billion bulbs.

The average US electric rate is $0.1008/kWh, or about 10 cents (2006 data). Average US household use for lighting: 1,950 kWh per household (2002 data).

The US spends approximately $71 billion a year in electricity on lighting, which is 22% of the total US electricity bill (2006 data).

Data Sources: Department of Energy, Lawrence Berkeley National Laboratory and Philips.

HUMAN BIOLOGY & LIGHT

Regular exposure to direct and indirect sunlight minimizes eye strain and fatigue, supporting visual acuity and color rendition, and provides a connection to nature that is intuitively perceived, despite the inherent variability of daylight characteristics over time and weather. Appropriate daylighting design in a building supports our biological intuition while minimizing the use of electric lighting.

For lighting building interiors, it is often important to take into account the color temperature of the lights used. Preservationists often look for lights that match the warm color of incandescent light and daylight. The human eye naturally dilates and contracts, and registers full-spectrum light. For example, a warmer (yellow) light is typically used in areas that promote relaxation, such as a living room or library, while a cooler (white/blue) light is used to enhance concentration in offices.

Light color is also shown to impact our health, particularly conditions governed by our circadian rhythm, which manages estrogen levels. Exposure to cool light in morning and warm light in evening largely reflects natural daylight, but when we switch the colors around, such as by surfing the internet (computer screens use a blue light) for an hour before bedtime, we inadvertently throw off our circadian rhythm. In addition, studies have shown a connection to blue light exposure and breast cancer. Lighting technologies are still working to master the varying color temperatures, and more options are becoming commercially available.

For more information on human biology and light, see Stevens, RG. Light-at-night, circadian disruption and breast cancer: assessment of existing evidence. International Journal of Epidemology, *Aug 2009; 38(4):963–970*

Key issues with lighting and electrical wiring in historic buildings

- Many older buildings have outdated electrical wiring that may be insufficient for today's electrical loads and use patterns, leading to frequent blown fuses and increased potential for fire.
- Historic lighting fixtures tend to be less energy-efficient.
- User behavior directly impacts energy conservation. Leaving lights on and appliances plugged in when not in use can significantly increase a building's energy consumption.
- Daylighting features in historic buildings are often undervalued for their capacity to maintain a lighting quality that promotes health and productivity, while minimizing a building's lighting operational costs.

OPPORTUNITIES—LOW/NO COST

The most effective lighting strategy uses a variety of measures, including daylighting, electric lighting technologies, user behavior patterns, and interior finishes and treatments. Many of these opportunities can be implemented at little to no cost.

Assess user behavior

User behavior is vital to lighting efficiency. Get into a routine of turning off your lights when you leave a room and avoid turning on electric lights when there is sufficient daylight. Wash windows—especially those facing heavily trafficked streets—to maximize daylight entering your home.

Conduct a bulb survey and upgrade to more efficient bulb types

- Examine your light fixtures. Light levels decrease over time because of aging lamps and dirt on fixtures, lamps, and room surfaces. Together, these factors can reduce total illumination by 50% or more, while lights continue drawing full power.
- Examine the wattage size and type of the lightbulbs you have in your building; where appropriate, replace with bulbs that are more efficient. Your electric utility provider may offer rebates or other incentives for purchasing energy-efficient lamps.
- Incandescent lights should be turned off whenever they are not needed. Only about 10% of the electricity that incandescent lights consume results in light, and the other 90% is turned into heat. Turning lights off will keep a room cooler and save energy.
- Unlike incandescent lights, the operating life of a fluorescent light is affected by the number of times they are switched on and off. It is more cost-effective to turn off a fluorescent light if you leave a room for more than 15 minutes. In other words, if you leave the room for less than 15 minutes, it will generally be more cost-effective to leave the lights on.
- Properly recycle or dispose of lightbulbs. Some bulbs contain trace amounts of mercury and are considered a hazardous waste. CFLs and ballasts should be recycled for their glass and metals content. GrowNYC provides information on where to recycle used bulbs (www.grownyc.org/cfl). Ballasts containing PCBs should also be disposed of properly.
- Purchase "low-mercury" lamps that the EPA has categorized as non-hazardous waste and that do not have to be handled separately (www.epa.gov/osw/hazard/wastetypes/universal/lamps).

Conduct a daylighting assessment

Use a light meter to find opportunities for improved daylighting penetration into a space. A daylighting assessment can help you identify where you might position a desk or reading chair, and where you would most benefit from expanding, modifying or re-engaging existing openings.

- Maximize daylight penetration to minimize electric energy usage. Utilize direct and indirect sunlight to reduce your total building energy costs. Take advantage of existing skylights, clerestory windows, glazed transoms, dormers, false dormers, light shelves, and prisms to bring daylight deep into your building, minimizing the need for daytime electric lighting. Disengaged skylights, such as those covered to minimize maintenance or to conform to public safety blackout laws during World War II, should be re-engaged. Interior clerestory windows are often undervalued or forgotten as a strategy for bringing daylighting deeper into the home. If clerestory windows are painted opaque, try to repair the original design intent by allowing light to pass through. Operable clerestory windows also support cross-ventilation.

Use light-colored finishes and paints

Lighter colors will reflect light deep into a space and will minimize glare caused by sharp contrasts between floor and wall surfaces and sunlight or bright indoor lights. For more opportunities on using window treatments to control daylight penetration, see section on Windows & Doors.

Light meters. A daylighting assessment conducted with a light meter will reveal the spaces with the most natural daylight. This information allows you to arrange artificial lighting to focus on dim areas and install daylight-responsive lighting near windows.

Photo credit: Creative Commons, some rights reserved by Matt Biddulph

Common lighting technologies. When replacing lightbulbs, consider which technology is most appropriate for the application. Lighting varies in terms of level and quality of light, energy efficiency, and durability.

LIGHTING TECHNOLOGY	EFFICACY (LUMENS/WATT)	LIFETIME (HOURS)	COLOR RENDITION INDEX (CRI)	COLOR TEMPERATURE	APPLICATION
Incandescent & Halogen Bulbs					
Standard "A" bulb	10–17	750–2500	98–100 (excellent)	Warm	Indoors/outdoors
Energy-Saving Incandescent (or Halogen)	12–22	1,000–4,000	98–100 (excellent)	Warm to Neutral	Indoors/outdoors
Reflector	12–19	2000–3000	98–100 (excellent)	Warm	Indoors/outdoors
Fluorescent					
Straight tube	30–110	7000–24,000	50–90 (fair to good)	Warm to Cold	Indoors/outdoors
Compact fluorescent lamp (CFL)	50–70	10,000	65–88 (good)	Warm to Cold	Indoors/outdoors
Circline	40–50	12,000	62–70 (fair)	Warm to Cold	Indoors
High-Intensity Discharge (HID)					
Mercury vapor	25–60	16,000–24,000	50 (poor to fair)	Warm to Cold	Outdoors
Metal halide	70–115	5000–20,000	70 (fair)	Cold	Indoors/outdoors
High-pressure sodium	50–140	16,000–24,000	25 (poor)	Warm	Outdoors
Light-Emitting Diodes (LED)					
Cool White LEDs	60–92	25,000–50,000	70–90 (fair to good)	Cold	Indoors/outdoors
Warm White LEDs	27–54	25,000–50,000	70–90 (fair to good)	Neutral	Indoors/outdoors

Sources: US Department of Energy "Types of Lighting," National Electrical Manufacturers Association "Lighting Options for Your Home," and Rensselaer Polytechnic Institute's Lighting Research Center.

LIGHTING CONTROL STRATEGIES & POTENTIAL COST SAVINGS

Not all lighting control strategies have the same benefits; and while some strategies are stand-alone, others perform better when integrated with others. Depending on the cost of the system, the labor required to install a system, commissioning costs, the appropriateness of the application, and user behavior, considerable energy savings may be possible. Review the table (below) and chart (right) for an overview of strategies and costs, and consult with a lighting expert to determine the best strategy for you and your building.

Technology & Use	Savings
Timers	up to 40%
Dim and turn off lights when rooms are unoccupied	
Photosensors	up to 20%
Adjust electric light levels to take natural light into account	
Occupancy sensors	up to 40%
Automatic controls based on occupancy detection	
Vacancy sensors	up to 45%
Manual-on based on need; Automatic off based on vacancy detection	
Task Tuning	up to 20%
Dim lights to reduce max light levels for each space	
Personal control	up to 10%
Individuals set light levels to suit personal preferences	

Source: Adapted from "The Value of Wireless Lighting Control," Daintree Network (www.daintree.net)

OPPORTUNITY—MODERATE COST

Install electronic ballasts

Replace all magnetic ballasts with electric ones. Electronic ballasts serve up to four lamps, do not hum or flicker, and will save approximately 40% in electric lighting costs. Use long-lasting lamps in hard to reach places to keep cost and maintenance down.

Install shading devices

Utilize shading devices, curtains, and blinds to provide flexibility with lighting design. This will better regulate the level of interior light in your home, and will allow you to maximize natural daylight when it is available and minimize glare.

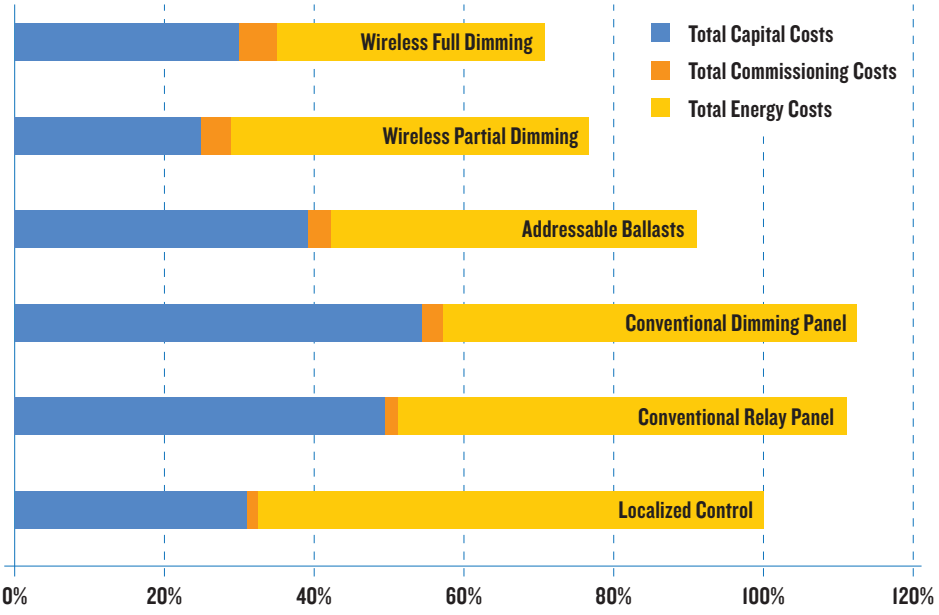
Install energy-efficient lighting fixtures

When replacing existing fixtures, consider fixture design and spacing for efficiency. Install fixtures with electronic ballasts that can be dimmed to maximize daylighting. These ballasts can dim down to about 10% of full light output. When switching to electronic ballasts, you should also switch to T5 (5/8″ tube diameter) or T8 (8/8″ or 1″ tube diameter) lamps, which deliver 80–100 lumen/watts. Choose these over the T12, which deliver 50–65 lumen/watts and use magnetic ballasts.

Install interior lighting controls

There are several lighting control devices that can be installed to improve energy efficiency. Use dimmers to manually adjust the light levels coming from a particular fixture, or use controls with set commands. Occupancy sensors use infrared, ultrasonic or microwave technology to respond to movement or surface temperatures to automatically turn off or dim the light when a room is unoccupied. Take advantage of automatic-off settings to save energy when there is

LIGHTING CONTROL STRATEGIES: PERCENTAGES OF TOTAL COST



Source: Daintree Networks

sufficient daylight. Timers can be installed to turn off lights on a set schedule when spaces are known to be unoccupied.

Use a radio-frequency (RF) wireless control technology to save energy through single-button control of lighting and plug loads, while enhancing the aesthetics of your indoor space. Integrating RF controls with occupancy and time-based controls will also save energy. First-cost savings for wireless systems are potentially significant, with higher equipment costs offset by the reduced labor for running wires.

Refer to the section on Appliances & Plug Loads for electrical efficiency monitoring opportunities. Daintree Networks also offers a series of downloadable articles on lighting controls, including a wireless control cost study for lighting retrofits (www.daintree.net/lighting/library.php).

Install energy-efficient exterior lighting and controls

Exterior lighting should help you safely and comfortably access your building, parking area, and rooftop or backyard amenities, while minimizing light pollution to preserve the purity of the night sky. Existing fixtures may be retrofitted with shields to reduce light pollution or replaced with fixtures designed to minimize light pollution. Exterior lighting should cover only the intended areas, directed downward, and installed as low to the ground as practical. Take advantage of outdoor lighting that uses solar cells (clean regularly to ensure performance levels); these fixtures are energy-efficient and low profile, and many do not require wiring. Install controls to regulate when exterior lighting is used. Because utility lights and some security lights are needed only at night and people are present, a combination of motion sensor and photosensor is often recommended. The Illuminating Engineering Society of North America (IESNA) Lighting Handbook has recommendations on luminance levels and uniformity ratios.

OPPORTUNITIES—HIGH COST

Upgrade electrical system and wiring

Worn connections in junction boxes, outlets, or circuit breaker boxes can cause points of resistance, excess heat, and hazardous conditions. Sometimes rewiring or tightening the connection in outlets will solve the problem. In other instances you can abandon your old wiring. Updating to a modern electrical panel can improve the function of your home's electrical system. If you need to upgrade the capacity of your electrical system, contact a licensed electrician. See the DOB information on page 40 for guidance on finding a licensed electrician.

- Conduct an energy audit to test the circuits and find points that need corrective work, such as rewiring, retrofitting, or a full system upgrade.
- Use a circuit analyzer to measure wire resistance in outlets during the energy audit and recheck it after repair work to ensure the wires were not affected.
- Recircuit where necessary to control large groupings of lights in correlation with daylight dimming, rather than for control in individual spaces.
- Replace old fuse boxes with modern service panels equipped with circuit breakers.
- Update to a modern electrical panel to improve efficiency and safety. Strongly consider replacing the whole system in the baseboards instead of the walls to keep the historic character of your building intact.

Use an energy management system to shed non-critical loads

In homes and apartments, there are internet-based tools to help you manage your energy usage for lighting. These energy management systems monitor lighting and

LIGHTING SENSORS: OCCUPANCY vs. VACANCY

Occupancy-based controls fall into two categories—occupancy sensors and vacancy sensors.

Occupancy sensors automatically turn the lights on as soon as you enter a room. When your presence is no longer detected, the lights turn off.

Vacancy sensors are a variation of occupancy sensors; however, instead of automatically turning on when you enter a room you must manually turn the lights on. When you leave the room the sensor detects your absence and automatically turns the lights off. The manual-on operation has several benefits and is ideal for bedrooms, bathrooms, and other applications that experience natural daylighting. The logic behind the manual-on function is that often you may need to quickly enter into your bathroom or office that is well daylit to retrieve something and not need to turn on the lights, thus saving energy. If you need the lights on, you have that option and the sensor will automatically turn the lights off once you leave.

Some sensor technologies have an option that allows you to configure them as either an occupancy or vacancy sensor. Vacancy sensors maximize energy savings and are particularly effective on applications where you are unable to install or have opted out of installing high-efficiency light sources.

UPGRADING HISTORIC LIGHT FIXTURES

Electric lighting is often used to highlight interior details such as ceiling accents and plasterwork. Existing historic fixtures may be retrofitted with compact fluorescent lamps, LEDs, high-efficiency incandescent lamps, and other sources that increase output and energy efficiency (including reducing waste heat); most upgrades can be made without affecting the appearance of the fixture.

To improve efficiencies of smaller or delicate fixtures in a manner that does not disrupt the aesthetic, use less invasive lighting technologies such as LEDs. These lights can also be placed in alcoves, sconces or on cornices to enhance the lighting aesthetic in an energy-efficient manner. See resources below for more guidance on upgrading historic light fixtures. See section on Indoor Health & Housekeeping.

appliance energy usage and can develop tools to reduce electrical consumption when these components are not in use. See section on Appliances & Plug Loads for more information.

REGULATORY CONSIDERATIONS

Landmarks Preservation Commission (LPC) Regulations

If your property is a City landmark or a building in a City historic district

In general, the material in this section is limited to the interior of the building and does not require LPC review. However, installation or replacement of exterior light fixtures may affect the character or physical integrity of your building and its site, and typically requires LPC review. For example, repairing existing light fixtures or installing energy-efficient bulbs will not require an LPC permit, but installing a light fixture at an entrance door or within an areaway will require an LPC permit.

Department of Buildings (DOB) Regulations

Most electrical work such as rewiring, electrical panel replacement, or upgrade requires a building permit from the DOB, filed by a licensed electrician. Generally, the DOB does not regulate removable electrical devices in the interior, such as plug-in light fixtures or appliances. If the work you are proposing requires a DOB permit, and your property is a City landmark or a building in a City historic district, an LPC permit will also be required.

Licensed Electricians and General Contractors: Before hiring a professional, check the DOB listing to make sure the individual has a valid license within New York City. Conduct a search for Skilled Trades Licensees or General Contractors at the DOB (site http://a810-bisweb.nyc.gov/bisweb).

City & State Energy Codes

The City requires energy benchmarking for publicly owned buildings over 10,000 sf. The City requires all buildings to install high-efficiency lighting by 2025.

RESOURCES

ConEd's My Energy Toolkit, provides online calculators to estimate your savings when you "go green" and conserve energy. Calculators estimate savings for CFL lighting.

www.coned.com/customercentral/calculators/EC_res.html

Energy Savers, a Department of Energy web site with product information and energy saving tips.

www.energysavers.gov/your_home/lighting_daylighting/index.cfm/mytopic=12030

Energy Star provides information about Energy Star–rated appliances.

www.energystar.gov; see also the Energy Star Building Upgrade Manual:

www.energystar.gov/ia/business/EPA_BUM_Full.pdf

Green Light NY, a nonprofit organization dedicated to promoting energy-efficient lighting through education, training, and design assistance:

www.greenlightny.org

General Services Administration, Guidelines for Upgrading Historic Building Lighting provides technical advice on designing a lighting strategy.

www.gsa.gov/graphics/pbs/TechnicalGuideLightingFINAL2.pdf

BuildingGreen includes articles, products, and case studies.

www.buildinggreen.com

Lighting Controls Association, an industry group that offers advice on energy-saving lighting controls.

www.lightingcontrolsassociation.org

Whole Building Design Guide, a resource for daylighting, electric lighting, electrical safety, and more.

www.wbdg.org/resources

Illuminating Engineering Society of North America (IESNA) for the most recent edition of the IESNA Lighting Handbook.

www.iesna.org

PLUMBING & WATER EFFICIENCY

New York City's wastewater treatment system handles 1.3 billion gallons of water every day.

New York City Department of Environmental Protection

While New York has a famously clean and abundant gravity-fed potable water system, the energy intensity of water is growing. Recent federal regulations have required the City to install an ultra-violet (UV) sterilization plant to protect against bioterrorism; this has resulted in a substantial increase in the energy needed in the potable water system. Incorporating efficient plumbing fixtures in your home will minimize water usage which will help reduce consumption and lower your water bills.

Key issues with plumbing and water efficiency in historic buildings

- New York City has long struggled with its combined sewer system that releases partially treated sewage into the rivers during rainfalls of more than 1/10 of an inch. Buildings with leaks, wasteful fixtures, and washing appliances are major contributors to this overflow problem.
- Lead pipes in water lines were banned in New York City buildings in 1961, and lead soldering was banned in 1987. However, the prevalence of original lead piping today is unknown, and some buildings built before 1961 may still have a lead pipe plumbing system.
- Plumbing fixtures, such as toilets and faucets that were installed before 1992 when the US government passed the Energy Policy Act, are likely to be less efficient than current legislation mandates.
- User behavior has a major impact on domestic water consumption. Operational practices can significantly impact a building's water wastage.
- Plumbing in historic buildings that has fallen into disrepair can cause significant water leaks. This is an indoor environmental health quality problem (see the section on Indoor Health, Housekeeping & Materials), as well as a structural problem caused by deterioration in ceilings, walls, and floor materials.

OPPORTUNITIES—LOW/NO COST

50-75% of residential water use occurs in the bathroom.

New York City Department of Environmental Protection

Monitor water use and associated costs

- ***Ensure faucets and fixtures are turned off.*** Eliminate dripping faucets. One faucet that drips 5 times per minute will waste more than 14 gallons of potable water each month. Use the US Geological Survey online calculator (see Resources for web site) to determine how much water your leaky faucets waste over time. If faucets are difficult to turn off completely, it may be time for a new fixture.
- ***Monitor your meter regularly.*** Ensure that water is used efficiently. By reading your water meter and your water bills, you will realize how much water is being used in the house and how much you save once you have implemented some of the opportunities mentioned here.
- ***Alter user behavior to lower water consumption.*** Run water-intensive appliances during off-peak hours, such as after 9pm. Wait until the dishwasher and clothes washer are full before running them. Avoid bathing and running appliances during a rainstorm, so as to limit impact on the sewer system.

Detect potential leaks early on

Routinely check for leaks and reapply caulk around sinks and bathroom fixtures when necessary. Look for signs of water buildup, such as staining, bubbling under paint or wallpaper, and deterioration of wall surfaces. New York City's Department of Environmental Protection (DEP) offers free water leak surveys

to most City water and sewage customers. Early detection of wet spots and examination by an experienced contractor will help minimize potential damage caused by water leaks inside the walls and ceilings, and ensure the long-term structural integrity of your home.

Maintain toilets

Reducing the amount of water consumed by bathroom toilets is a relatively simple way to conserve.

- ***Detect and stop leaks.*** Leaky toilets can waste thousands of gallons of water each month. Most hardware stores carry leak-detecting color tabs at little to no cost.
- ***Replace water flapper in toilet tank.*** The flapper is the rubber mechanism that seals water in the tank and allows it to exit the tank when you flush. Over time the flapper becomes worn and does not work effectively to stop leaks. Replace a worn-out flapper with a new one. Consider water-saving flappers that time the filling of the toilet bowl to reduce overall consumption. Flappers are simple to install and can be found at hardware stores at low cost.
- ***Reduce the volume of water in the toilet tank.*** To reduce the amount of water necessary for a toilet to function, you can insert a filled bottle, a brick, or another large, noncorrosive object to displace the water that fills the tank. This way, when toilets flush, less water is needed to fill the tank to the necessary level. Be sure your placement of the object does not interfere with the proper functioning of the water flapper.

OPPORTUNITIES—MODERATE COST

Replace inefficient toilets

- ***Select a high-efficiency toilet.*** Older toilets can use up to 7 gallons per flush. It is best to replace these inefficient toilets with more water-efficient models. Some of the more efficient models use 1.6 gallons per flush, or have dual flush capabilities that use smaller amounts of water for liquid waste than for solid waste. Look for the EPA's WaterSense label when shopping for a new fixture.

Install high-efficiency faucets

Some historic faucet fixtures do not comply with federal flow standards. Since 1999, new faucets are subject to federal flow standards and not New York State standards. There are several options to reduce water use and comply with standards:

- ***Aerators:*** Installing an aerator on the tip of your faucet spreads the water stream into many little droplets, reducing the water flow. This allows you to retain the style of the existing faucet while reducing water consumption.
- ***Fixtures:*** Federal regulation mandates that new faucets cannot flow more than 2.5 gpm at a water pressure of 80 pounds per square inch (psi). For bathroom sinks, select replacement faucets that use 1.5 gallons per minute (gpm) or less. Look for the EPA's WaterSense® label when shopping for new fixtures.
- ***Faucet sensors:*** A faucet sensor uses a motion detector to turn water on and off and is an effective way to curtail water use without any additional effort. Many sensor-controlled faucets are also low-flow varieties.

Install water-efficient showerheads

Bathing is a primary source of water consumption in the home; there is also a fair amount of energy use associated with heating water. To improve the water and energy efficiency of your shower, install higher-efficiency showerheads or aerators.

- ***Aerators:*** Installing aerators on showerheads reduces the amount of

CAULK FOR INDOOR HOUSEHOLD USE

The caulks listed below are for interior use. To select an appropriate caulking material, discuss with a hardware store its application and the materials adjacent to it in your home. If you have a joint larger than 0.25" a backer rod should be installed. See the section on Windows & Doors for exterior applications and for sealing doors and windows.

Silicone

Uses: Joints between bath and kitchen fixtures and tile. Seals metal joints in plumbing.

Cost: Moderate to High

Performance: Flexible. Allows watertight seals. Not paintable

Latex Caulk

Uses: Seals joints around tub and shower. Fills cracks in tile, plaster, glass, and plastic; fills nail holes.

Cost: Moderate

Performance: Not as durable and less elastic than some silicone or specialized sealants. Easy to use. Water resistant when dry. Can be painted. Varied durability, 2–10 years. Will not adhere to metal.

water necessary to achieve the same flow rate. This can be done whether or not the fixture is replaced. However, it should be noted that aerators in showers produce more mist, and can be linked to moisture problems if there is poor ventilation.

- ***Efficient showerheads:*** A standard showerhead uses one gallon of water in less than 20 seconds. Using low-flow showerheads of less than 2.5 gallons per minute can reduce the amount of water used in the shower by 50%.

OPPORTUNITIES—HIGHER COST

Regular showerheads take less than 20 seconds to use one gallon of water.

US DOE Ad Council

Upgrade domestic hot water system (DWH)

Waiting for the hot water to reach the showerhead wastes tens of gallons of water. Water, energy and time can be saved by using more efficient means to heat and deliver your domestic hot water. To determine which option is best for your home, consider the age and efficiency of your current system, the available space for the new options, available fuel supply, and hot water demand. A licensed plumber can help you determine the best match for your home. Hot water heating options include:

- ***Thermal control valves:*** A self-acting thermal control valve controls the temperature of your water when you specify a temperature, eliminating the need to manually mix hot and cold water until you reach a comfortable temperature. This eliminates a great deal of water waste, since the valve sets the temperature with a minimum amount of adjustment.
- ***Tankless hot water heaters:*** Tankless hot water heaters heat water only as you need it, avoiding the waste associated with storing water in tanks until it is used. Switching to an Energy Star certified tankless hot water heater can save up to 30% on water heating costs.
- ***High efficiency DHW boilers:*** Switching to a high efficiency, gas powered boiler for domestic hot water heating purposes can save you money on operating costs, and the small increase in up-front cost will generally pay itself back within two years. Energy Star certifies high-efficiency gas storage boilers, as well as gas-condensing boilers. See the sections on Appliances & Plug Loads and Heating & Cooling for more information on high efficiency boilers.

Install Energy Star-rated appliances

Energy Star certifies clothes washing machines, dishwashers, dehumidifiers, and water coolers for their level of efficiency. Energy Star–certified appliances are generally more water and energy efficient. For instance, a full-sized Energy Star clothes washer uses 14 gallons of water per load, compared to the 27 gallons used by a conventional machine. The Energy Star web site has a full list of qualified appliances (www.energystar.gov). See the section on Appliances & Plug Loads for more information on specific appliances.

Replace lead piping

If your building's plumbing system has not undergone a comprehensive renovation since 1961, there is a possibility that lead may still be present in your plumbing system. Hire a lead abatement professional to replace any lead pipes or lead soldered pipes with lead-free alternatives, such as cast iron, copper, or other code-compliant options. Avoid PVC products that use phthalate plasticizers. See the section on Indoor Health, Housekeeping & Materials for more information on occupant health impacts of building products containing lead and phthalates.

REGULATORY CONSIDERATIONS

Landmarks Preservation Commission (LPC) Regulations

If your property is a City landmark or a building in a City historic district

In general, the material in this section is limited to the interior of a building and does not require LPC review. If the work you are proposing requires a DOB permit, and your property is a City landmark or a building in a City historic district, an LPC permit will also be required.

Department of Buildings (DOB) Regulations

Any plumbing work beyond simple repairs and direct replacement of existing fixtures with a same-type fixture, like an existing faucet with a more efficient faucet, requires a plumbing permit. All work must be performed by an New York City–licensed master plumber. For work requiring a permit, the master plumber must apply for and receive a permit prior to the commencement of any work. If the work you are proposing requires a DOB permit, and your property is a City landmark or a building in a City historic district, an LPC permit will also be required.

RESOURCES

US Environmental Protection Agency WaterSense® program includes certified fixtures and appliances

www.epa.gov/WaterSense

US Environmental Protection Agency Energy Star® program includes rated appliances, including washers

www.energystar.gov

NYC Department of Environmental Protection, on lead in household plumbing for information about what to do if you suspect lead in your water supply

www.nyc.gov/html/dep/html/drinking_water/lead_faq.shtml#A4

NYC Department of Environmental Protection also offers leak detection services and other programs for City water customers

www.nyc.gov/html/dep/html/residents/index.shtml

US Department of the Interior's US Geological Survey, provides an easy calculator for determining how much water your leaking faucet wastes over time

http://ga.water.usgs.gov/edu/sc4.html

NYC Department of Buildings provides a searchable database of licensed plumbers

http://a810-bisweb.nyc.gov/bisweb/LicenseTypeServlet?vlfirst=Y

APPLIANCES & PLUG LOADS

Appliances, lamps, electronics and other gadgets that are plugged into an electrical outlet (also called plug loads) account for up to 34% of a home's electricity consumption.

EPA, EnergyStar.gov

Lamps, appliances, electronics, window air conditioners, and other gadgets that consume electricity are known collectively as the "plug load," and account for up to a third of your building's electricity consumption. It is therefore important that these items are efficient and well managed. The most efficient appliances meet or exceed a voluntary standard, such as the US EPA's Energy Star program, which far exceeds federally mandated standards. Efficient management of plug loads involves energy-conscious usage behaviors or control devices that keep your energy bills low without altering your lifestyle.

Key issues with appliances and plug loads

- ***Plug loads and peaker plants:*** Buildings that do not efficiently and effectively manage plug loads unnecessarily contribute to "peaker" plant operation. Peaker plants are turned on during the summer months when electrical demand peaks and regional power plants cannot keep up. Peaker plants provide a boost of energy to the grid, but are generally older facilities with inefficient systems that release large amounts of carbon dioxide into the atmosphere.
- ***Repair vs. replace:*** Older appliances help retain the character of a historic building; however, if manufactured before 1990 they are likely to be particularly inefficient. Repairing old appliances does not necessarily improve their efficiency. It is relatively easy to find new appliances that consume at least 20% less energy than industry standards, so it is typically better to replace inefficient large appliances, such as refrigerators and washing machines. Replacing old refrigerators is not as environmentally harmful as it used to be. It is now common practice to strip them for scrap materials and recycling, lessening the impact of disposal.
- ***Wiring:*** Wiring in older buildings may not be able to accommodate the increased energy use of modern-day electronics and appliances. Before installing major new appliances, verify the wiring and circuits can support the equipment. Inadequate wiring can damage equipment or cause electrical fires. See the section on Lighting & Electrical wiring issues and opportunities.
- ***Freon:*** Freon is a chlorofluorocarbon (CFC), a toxic chemical that was once common in refrigerants and aerosol sprays. It is known to deplete the stratospheric ozone layer and have negative impacts on the indoor environmental quality of your building. As a result of the Montreal Protocol (1987), this group of chemicals is being phased out of various industries. Nevertheless, safe and appropriate disposal of Freon is still a concern; see the section on Indoor Health, Housekeeping & Materials for more information.
- **User behavior:** A major variable in appliance-driven energy demand is user behavior. Energy conservation practices, controls, and plug load management tools can reduce the energy intensity of our buildings and our utility bills. This in turn reduces the overall demand on the electricity grid, which is especially important in August when the potential for brownouts and blackouts in New York City is at its highest.

VAMPIRE LOADS

Vampire loads, or phantom loads, represent electricity continually drawn by equipment and devices that are plugged in, but not in use. Phone chargers, televisions, computer monitors, printers, stereos and coffee makers all contribute to your vampire load when they are in standby mode or even turned off. This wasted energy adds up fast. Reducing your vampire load can cut electricity costs without sacrificing comfort or convenience.

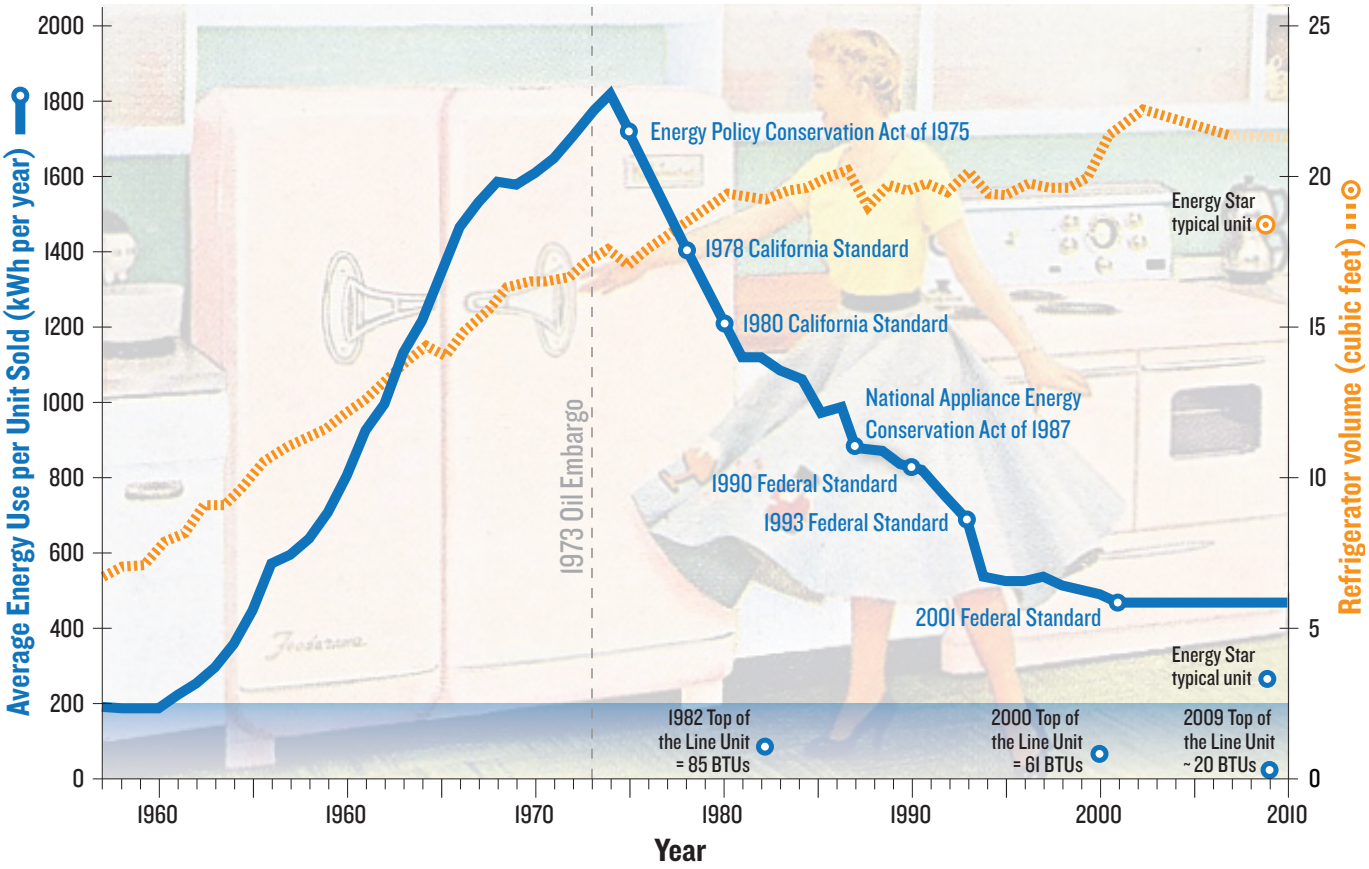
OPPORTUNITIES—LOW/NO COST

Observe your habits, change your behavior

Observe you and your family's behavior to identify operational or usage practices that could altered to increase energy savings.

- ***Small appliances and electronics:*** Use the energy-saving mode on all appliances and electronics when possible. Use items less frequently and

Refrigerator Energy Use Trends Relative to Volume, 1947–2010



during off-peak hours, such as in the late evening. Appliances and electronics that draw more than one watt, especially computers and cell phones, should be connected to power strips, making the habit of turning off these devices an easy one to develop. Small appliances not connected to a power strip should be unplugged when not in use for extended periods of time. Minimize use of plug-in radiators and electric blankets or set them on timers. Plug load management tools can also be purchased and installed around the building's interior to limit vampire loads (see sidebar on page 46).

- ***Refrigerators:*** Set refrigerator thermostats to keep frozen food at 0–5˚F and the fresh food compartments at 36–40˚F to ensure food safety. Thermostats set at lower temperatures waste energy by keeping food unnecessarily cold. Place your refrigerator away from a heat sources such as your oven or dishwasher so it doesn't have to work as hard to keep cool.
- ***Boilers:*** Reduce your boiler's hot water temperature setting and use a timer on your boiler to reduce wasteful water heating. For each 10˚F reduction in water temperature, you can save 3%–5% in energy costs.
- ***Washing machines:*** Wash in cold water, when possible. Since 90% of the energy used for washing goes to heating water, switching your temperature setting from hot to warm can reduce your energy consumption by 50%.
- ***Clothes dryers:*** Energy Star does not label clothes dryers because most clothes dryers use the same amount of energy. Limit the amount of energy used by your dryer by using the moisture sensor option, which automatically shuts off the machine when the clothes are dry. Make sure to regularly change the dryer filter and the exterior exhaust filter to ensure that extra energy is not needed to cycle air through the machine. If your clothes washer has spin options, choose a high spin speed or extended spin option to reduce the amount of remaining moisture, minimizing the drying process before putting your clothes in the dryer.

Energy efficiency standardization. Due to regulations and market forces, appliances have become dramatically more efficient in recent decades. If your refrigerator was bought in the 1970s, it is likely one of the most inefficient models ever commercially available.

Data source: Adapted from "Efficiency: Energy for the Future" by Arthur Rosenfeld; Photo source: House and Garden, *June 1955*

Though larger, today's annual kWh per refrigerator is nearly the same as it was in 1947.

Current models are up to 25 times more efficient.

Arthur Rosenfeld, "Efficiency: Energy for the Future"

Energy Star equipment. Energy Star–rated products use at least 20% less energy without sacrificing performance. Consider purchasing Energy Star–rated products in any of the categories.

COMMON EFFICIENCY METRICS

Metric	Description
Modified Energy Factor (MEF)	An industry-wide energy efficiency metric used to compare relative efficiencies of different clothes washers.
Water Factor (WF)	An industry-wide metric that evaluates water efficiency. The higher the MEF, the more efficient the clothes washer; the lower the WF, the more efficient the clothes washer.
Seasonal Energy Efficiency Ratio (SEER)	A measure of equipment energy efficiency, over the cooling season, of cooling equipment. The higher the SEER, the more energy efficient the appliance.
Energy Efficiency Ratio (EER)	A measure of the instantaneous energy efficiency of cooling equipment. The higher the EER, the more energy efficient the appliance.

Common efficiency metrics. "Energy Efficiency" can be a difficult concept to quantify because energy is used in different quantities, over different periods of time, to perform many different types of work.

ENERGY STAR EQUIPMENT

Equipment	What to do when it's time for an upgrade or replacement
Full-Size Refrigerators	Replace old refrigerators, especially if they contain Freon. Replacing a fridge from the 1980s could save $100 a year in electricity or $200 a year, if it is from the 1970s. (≥ 7.75 ft³)
Full-Size Freezers	Compared to modern, conventional freezers, Energy Star models are 10% more efficient. A freezer from the 1980s costs $70 more in energy each year than a new Energy Star model. (≥ 7.75 ft³)
Compact Refrigerators and Freezers	Compact refrigerators and freezers typically use less energy than full-size models, and can be a better choice for residential units occupied by only one or two people. (< 7.75 ft³ and ≤ 36" in height)
Top and Front-loading Clothes Washing Machines	If your washing machine is more than 10 years old, it is best to invest in a front-loading clothes washer, which is far more water-efficient than a top-loading washer. A front-loading machine uses 18 to 24 gallons per load less than the average top-loading, which uses approximately 40 gallons.
Standard-sized Dishwasher	Replacing a dishwasher purchased before 1994 could save $40 a year on energy and 10 gallons of water per cycle, when switching to a new Energy Star model. (≥ 8 place settings + 6 serving pieces, ≥ 24" in height)
Compact-sized Dishwasher	Compact models generally use less energy and water than standard-size machines, and are best suited for residential spaces occupied by only one or two people. (< 8 place settings + 6 serving pieces, 18" in height)
Air Conditioners (central)	Replace central units that are more than 12 years old with Energy Star models that are up to 30% more efficient. (size varies)
Air Conditioners (room)	Replace inefficient window units that are more than 12 years old with Energy Star models that are up to 10% more efficient. (size varies)
Dehumidifiers	If your dehumidifier requires replacement, replace it with an Energy Star–certified model, which is 15% more efficient than standard models. (size varies)
Light bulbs	Replace incandescent bulbs with compact fluorescent lightbulbs (CFL) or LEDs. These are 75% more efficient than incandescent, and can save $40 over the lifetime of each bulb. Energy Star certified lightbulbs provide a wide range of light quality and amount of light (measured in lumens).
Light fixtures	Replace inefficient or very old light fixtures with Energy Star fixtures. They use 75% less energy than conventional fixtures, distribute light more evenly, and include an above-industry standard, 3-year minimum warranty.
Computers	A computer meeting Energy Star specifications will use between 30% and 65% less energy, depending on how it is used.
Boilers	Replace inefficient boilers or ones that run on No. 6 oil with Energy Star certified gas burning models. These are 6% more efficient than standard models. If a natural gas line is not available on your street, upgrade your boiler to run on No. 2 oil.

Recycle or safely dispose of unwanted appliances

The City of New York will pick up old appliances along with your other metal recycling. To ensure that appliances containing chemicals such as Freon (e.g., refrigerators and dehumidifiers) are disposed of in a safe manner, schedule an appointment for a separate pick up. Consult New York City's "Waste Less" (www.nyc.gov/html/nycwasteless) and Energy Star's (www.energystar.gov) web sites for recycling guidance for refrigerators and freezers, clothes washers, lightbulbs, electronics and other appliances.

OPPORTUNITIES—MODERATE/HIGHER COST

Install energy efficient appliances

On average, home appliances comprise 13% of the household electricity use. Studies show that in most households, refrigerators tend to use the greatest amount of energy. To improve the energy efficiency of your appliances by 20–40% select Energy Star–labeled products. The Energy Star program certifies a number of appliances and electronics, including refrigerators, washing machines, dishwashers, air purifiers, dehumidifiers, air conditioners, televisions, computers, and battery chargers. See the Energy Star Equipment chart for more information.

Additionally, when choosing new appliances, ensure that your building's electrical wiring and plumbing can accommodate the size of your new appliance.

Install plug load management equipment and software

Using plug load monitoring systems is a good way to closely monitor your energy consumption. These systems monitor energy use at the individual plug point. The systems then feed this information into a software package that analyzes it for you. Many such products also recommend schedules whereby appliances are automatically powered off and on by the software according to your use patterns.

Plug load management devices. In the average home, 75% of the electricity used to power home electronics and appliances is consumed while the products are turned off.

There are several devices available for low cost that allow you to digitally program and monitor your plug loads. Plugging several devices into a power strip allows you to cut the power supply without unplugging each device. Other tools can monitor usage patterns and make recommendations for reducing energy consumption through changes in programming and user behavior. See EnergyStar.gov.

Photos: Think Eco (above); Creative Commons, some rights reserved by mccun934 (left)

REGULATORY CONSIDERATIONS

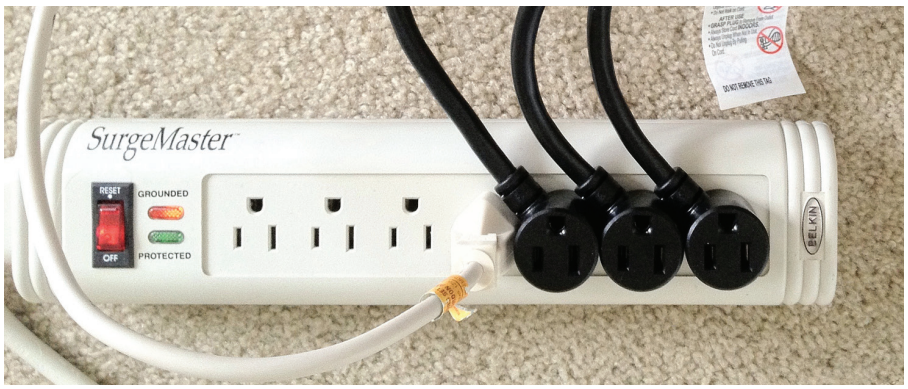
Landmarks Preservation Commission (LPC) Regulations

If your property is a City landmark or a building in a City historic district

In general, the material in this section is limited to the interior of the building and does not require LPC review. If the work you are proposing requires a DOB permit, and your property is a City landmark or a building in a City historic district, an LPC permit will also be required.

Department of Buildings (DOB) Regulations

The DOB does not require a permit for plug-in appliances; however, rewiring,



upgrading electrical panels, or other related electrical work is regulated under the Electrical Code. Hire a New York City licensed electrician to advise, file for an electrical permit, and perform this work.

RESOURCES

ConEd's My Energy Toolkit, provides online calculators to estimate your savings when you "go green" and conserve energy. Calculators estimate savings for home energy, appliances, television, CFL lighting, programmable thermostat cooling and heating, and paperless billing.

www.coned.com/customercentral/calculators/EC_res.html

Energy Savers, a Department of Energy web site with product information and energy saving tips

www.energysavers.gov

Energy Star, for efficient appliances, recycling programs and other guidance

www.energystar.gov

NYC Bureau of Waste Prevention, Reuse & Recycling

www.nyc.gov/html/nycwasteless

New York State Energy Research and Development Authority (NYSERDA) offers a variety of energy efficiency resources and incentives

www.nyserda.ny.gov

Department of Energy: Energy Efficiency & Renewable Energy includes resources and advice for reducing your energy consumption

www.eere.energy.gov

BuildingGreen, a web site with articles, case studies, and information about new technologies

www.buildinggreen.com

INDOOR HEALTH, HOUSEKEEPING & MATERIALS

A healthy indoor environment promotes physical comfort and well-being. Achieving a healthy indoor environment depends on appropriate ventilation, the selection of high-quality building and fit-out materials and proper cleaning and maintenance practices. Environmentally responsible, low-toxin, or toxin-free remodeling and housekeeping practices are the foundations of a healthy indoor environment.

The average American spends 90% of their time indoors, but the indoor environments we create are often less healthy than the urban outdoors.

Key issues with indoor health and housekeeping

High-quality indoor air, access to daylight and views, and the materials and products used to build and clean our living spaces all impact our health and well-being. However, conventional perceptions of what makes urban architecture and interior design desirable and livable have overlooked and undervalued our connection to nature and the services it provides. As a result, many older buildings have been retrofitted in a manner that disconnects inhabitants from nature, often diminishing the building's capacity to support healthy living conditions by minimizing daylight, perpetuating mold growth, and exposing us to various toxins.

Some products and materials can reduce the indoor environmental quality of your home. Typically indoor air quality deteriorates when these materials are introduced to your living spaces and emit unhealthy chemicals that are suspected or are known to be toxic to humans.

Volatile Organic Compounds (VOCs) are chemical gases emitted from solids and liquids. VOCs, some of which are proven carcinogenic, are emitted by a wide array of materials and products found throughout the home, including paints and lacquers, paint strippers, varnishes and wax, cleaning supplies, pesticides, building materials, carpeting, fabrics and furnishings, office equipment such as copiers and printers—these all contain organic solvents. Key signs or symptoms associated with concentrated exposure to VOCs include eye irritation, nose and throat discomfort, headache, allergic skin reaction, shortness of breath, nausea, vomiting, nose bleeds, fatigue, and dizziness. All of these products can release organic compounds while you are using them and, to a lesser degree, when they are stored.

Due to the age of many historic buildings, they may contain toxins that are widely acknowledged today, but were not known to cause any bodily harm at the time of installation. These particular toxins, such as lead and asbestos, are normally found in building materials rather than household cleaning supplies.

Common household toxins that impact our health

The following list covers several common household toxins that are known to be unhealthy today, but may exist in historic buildings that have not been recently renovated. It also covers toxins that can be found in more modern products. While this manual refers primarily to materials that you can find in building materials, interior finishes and consumer products, it is important to note that these chemicals can be found in many cosmetic products. For more information, see the Environmental Working Group's web site (www.ewg.org).

- ***Allergens and particulate matter*** can accumulate indoors if there is not adequate ventilation. Much of this particulate matter can be attributed to outdoor smog, while our shoes track in dirt and other contaminants.
- ***Asbestos*** was widely used from the late 1800s to the mid-1900s in fire-retardant coatings, concrete, bricks, pipes and fireplace cement, pipe insulation, ceiling insulation, fireproof drywall, flooring, and roofing. Asbestos was found to be a carcinogen in the 1970s; however, buildings that have not been heavily renovated may retain some quantity of asbestos.

- ***Bisphenol A (BPA)*** is an organic compound widely found in adhesives, protective coatings, paint, piping, epoxy resins, wire/electronic sheathing, and polycarbonate plastic products. Studies have shown that BPA can accumulate in the bodies of rats and amphibians, causing significant hormonal imbalances. Many scientists believe BPA has a similar effect on humans. The Canadian government has labeled BPA a toxic substance, and European legislation bans the use of BPA in certain consumer goods, such as baby bottles. No ban on BPA in plastic consumer goods has been issued in the US.
- ***Freon, or chlorofluorocarbon (CFC),*** is found in many older refrigerators, freezers, air conditioning units, and dehumidifiers. Outlawed by the Montreal Protocol, this ozone-depleting chemical weakens the immune system and increases the risk of skin cancer.
- ***Halogenated and brominated flame retardants*** are found in fabrics, plastics, foams, insulation, carpet backing, epoxy and resins, kitchen appliances, housing paints, and electrical devices. Incorporated for their anti-inflammatory properties, these chemicals are suspected to be carcinogens, hormone disruptors, and neurobehavioral toxins.
- ***Lead*** in paint was banned in 1999 due to its link to childhood lead poisoning, and historic buildings that have not been heavily renovated may retain some quantity of lead piping. Lead is also commonly found in flashing and roofing, radiation shielding, solder, and electrical cable jacketing.
- ***Mercury*** is a metal that was once commonly used in lamps and thermometers, and is still used in batteries and some types of lamps. It can also be found in HVAC controls, electrical components, paint, flooring, medical equipment, and switches and relays. Improper disposal of mercury can lead to human exposure. Mercury buildup in our body and prenatal exposure can result in deficits in language, attention and memory.
- ***Perfluorocarbons (PFC)*** are ozone-depleting chemicals that increase the risk of skin cancer. Studies show that PFCs accumulate in human tissue very quickly. PFCs are commonly found in stain protecting fabric treatment, fire extinguishers and refrigerants.
- ***Phthalates*** are a group of chemicals that are used as plasticizers in PVC plastics, among many others. They can be found commonly in pipes, conduits, waterproofing, roofing, siding, door and windows, resilient flooring, carpet backing, wall covering, signage, window treatments, furniture, and wire cable sheathing. In 2010, the EU partially outlawed the use of certain types of phthalates over the next three to five years. Due to suspicions that they are carcinogenic, as well as developmental and reproductive toxins, phthalates are being phased out of many products across the country.
- ***Polyvinyl chloride (PVC)*** is a type of plastic that is widely found in consumer products. The potent carcinogen dioxin is created in the production of PVC, which can cause health problems such as cancer, hormone-related disorders, birth defects, impaired childhood development, reproductive and immune system damage. PVCs are also made with phthalates (see above), a group of chemicals that aid in plasticizing PVC and other types of plastics, and which are a suspected carcinogen. PVC can be found in pipes, conduits, waterproofing, roofing, siding, door and windows, resilient flooring, carpet backing, wall covering, signage, window treatments, furniture, and wire cable sheathing.
- ***Radon*** is a colorless, odorless, radioactive gas that is formed naturally in bedrock. It can travel up through the ground to the air and into your home through cracks and holes in the foundation. In buildings with poor ventilation, radon gas can build up to levels that can be dangerous to human health. The EPA estimates that radon is responsible for 21,000 lung cancer deaths every year, second only to smoking. Radon primarily enters buildings through basements or cracks in concrete floor slabs, but also through well water or municipal water.

PRECAUTIONARY PRINCIPLE

Many definitions of the precautionary principle exist, but above all, the principle is an expression of a need to anticipate harm to humans and the environment before it occurs. The 1998 Wingspread Statement from the Science & Environmental Health Network frames the principle as follows:

"When an activity raises threats of harm to the environment or human health, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically."

The Precautionary Principle is used in public health and environmental decision making in the absence of scientific consensus that an action or policy is harmful. The term "precaution" carries the sense of foresight and preparation, and not merely "caution." Implementing the principle in the material and product selection process of your renovation project promotes transparency in industries that affect your health and the environment.

- ***Urea-formaldehyde*** is a known carcinogen and asthma trigger. It is widely found in composite wood products, insulation, furniture, and adhesives. A historic building is likely to have some urea-formaldehyde content in its materials due to age. Fortunately, there are many formaldehyde-free alternatives available on the market today that can be installed in renovations.

OPPORTUNITIES—LOW/NO COST

Use doormats to limit the introduction of dirt, allergens, and outdoor debris

Doormats are one of the easiest and lowest-cost opportunities for maintaining healthy indoor conditions. A majority of the dirt, particulates, and debris that enter your home through your main door are carried in on your shoes. Well-maintained door mats could improve indoor air quality and reduce the need for cleaning.

Doormats. Many of the common toxins found in homes are unknowingly introduced from the outside. Simple, timeless solutions like doormats limit the amount of unwanted material entering your home, and cut back on cleaning time.

Photo credit: Creative Commons, some rights reserved by F. C. Photography

Purchase products that prioritize health and environmental responsibility

Consider using the precautionary principle as a guide (see sidebar) when selecting home office supplies, cleaning products, air fresheners, toilet paper and paper towels, carpeting, furniture, food, and beverages.

- Choose products that are made of nontoxic ingredients. Make sure that cleaning products and detergents do not contain phosphates, which contaminate wastewater. Choose ammonia-free cleaners that are less toxic to humans.
- Avoid ingredients such as chlorine and glycol ethers, and air fresheners that emit toxic VOCs. Explore nontoxic, alternatives to conventional household cleaners: use vinegar in place of bleach, baking soda to scrub your tiles, and hydrogen peroxide to remove stains. When maintaining wooden floors or fixtures, use natural oils instead of abrasive chemicals.

For more information, refer to the list of chemicals above in the beginning of this section, as well as the web sites of the Environmental Working Group (www .ewg.org/chemindex), which provides a chemical index, and Perkins+Will (www .transparency.perkinswill.com), which provides good reference lists, including the Precautionary List, Asthma Triggers + Asthmagens, and Flame Retardants.

Practice environmentally responsible product disposal

- ***Electronics:*** New York City has community recycling initiatives through which you can safely dispose of unwanted electronics. New York State now requires manufacturers of covered electronic equipment to collect their products from residents and small businesses, and reuse or recycle them for free. You can also locate "SAFE" disposal events, run by the New York City Department of Sanitation and various manufacturers. The New York City Department of Sanitation is a great resource for information on additional ways you could dispose of electronics.
- ***Lamps/Lightbulbs:*** Safely dispose of fluorescent lamps, which contain toxic amounts of mercury, as well as high-intensity discharge (HID), neon, mercury vapor, high pressure sodium, and metal halide lamps, through the New York Department of Environmental Conservation. For guidance on recycling and programs available in your neighborhood, contact your local municipal solid waste agency directly. For additional information, visit the web sites of Earth911 (www.earth911.org) and the US EPA (www.epa.gov/bulbrecycling).
- ***Other hazardous household materials:*** Unwanted paints, pesticides, automotive fluids, hobby chemicals, cleaning products, thinners and strippers, batteries, acids/bases. Contact the New York Department of Environmental Conservation for instructions on how to safely dispose of these materials.
- ***Unused or expired medications:*** Disposing of expired or unused prescription drugs by putting them in the trash, flushing them down the toilet, or

pouring them down the drain can be harmful to fish and other wildlife and their habitats. Follow the guidelines set forth by the U.S. Food and Drug Administration (FDA) and the White House Office of National Drug Control Policy (ONDCP) for the proper disposal of prescription medications (see sidebar).

PROPER DISPOSAL OF PRESCRIPTION MEDICATIONS:

Follow any specific disposal instructions on the drug label or patient information that accompanies the medication. Do not flush prescription drugs down the toilet unless this information specifically instructs you to do so.

If no instructions are given, throw the drugs in the household trash, but first: Remove the drugs from their original containers and mix them with an undesirable substance, such as used coffee grounds or kitty litter. The medication will be less appealing to children and pets, and unrecognizable to people who may intentionally go through your trash.

Put the drugs (or the mixture of drugs with an undesirable substance) in a sealable bag, empty can, or other container to prevent the medication from leaking or breaking out of a garbage bag.

Take advantage of community drug take-back programs that allow the public to bring unused drugs to a central location for proper disposal. Call your city or county government's household trash and recycling service to determine if a take-back program is available in your community.

Source: FDA and ONDCP

Identify and mitigate naturally occurring pollutants

- ***Mold and mildew:*** Mold and mildew are linked to respiratory illness and if found should be removed. Check for mold and mildew in locations where water leaks are likely to occur.
- ***Radon:*** Concentrations of radon vary tremendously from building to building, and testing is the only way to know if you and your family are at risk from radon. Professional companies can conduct a radon test, or simple self-test kits are available for under $50. Because radon levels can vary inside a building seasonally, accurate results may require testing over a nine to twelve month period. If you find high radon levels (>4.0 pCi/L), install a radon detection and mitigation system (such as an efficient heat recovery ventilator); increase ventilation rates and seal cracks in the basement floor, walls and joints.

OPPORTUNITIES—MODERATE/HIGHER COST

Utilize nontoxic materials and products for all new interior finishes

- ***Interior Paint:*** Use low-VOC or no-VOC paint, dyes, stains, and finishes to provide better indoor air quality for occupants. Low-VOC and no-VOC paint options have become mainstream and are usually at the same price point as traditional paints.
- ***Furniture, upholstery and wall coverings:*** Look for textiles and products that are sustainably grown and harvested and made from renewable materials. Cotton upholstery and FSC (Forest Stewardship Council) certified wood are good options. Make sure that the materials you chose minimize your exposure to VOCs, or any of the chemicals listed in "Common household toxins that impact our health" earlier in this section.
- ***Flooring and finishes:*** Choose composite wood, agrifiber products, and laminating adhesives that contain no added urea-formaldehyde resins. These products include particleboard, medium density fiberboard (MDF), plywood, wheatboard, and strawboard. Use zero- or low-VOC adhesives and sealants to provide better indoor air quality. Choose materials that have low reflectance or are glare-resistant.

  High-VOC content is still the norm in clear wood finishes, but depending on the application you can minimize exposure while maximizing durability. Use FSC-certified wood for millwork and regularly maintain floors and millwork (especially if they are historic) with natural oils rather than abrasive chemicals. For new millwork use rapidly renewable materials where feasible.

Remove or isolate existing toxic substances

- ***Repair vs. Replace:*** Unless an indoor finishing contains a known toxin, it should be repaired instead of replaced. To restore wood finishes or flooring, use nonabrasive materials, such as natural oils.
- ***Remediation of mercury:*** Since many historic buildings, particularly those that have not been recently renovated, contain mercury in its building materials and household products (see page 51 for information on common household toxins that impact our health); replace these items with mercury-free alternatives, many of which are widely available and cost-effective.

- ***Remediation of Freon:*** If your household appliances contain Freon, you run the risk of leaks inside your home. Replace them with high-efficiency models and schedule an appointment with the New York City Department of Sanitation to remove your old model in an environmentally safe way.
- ***Abatement and removal of asbestos:*** Asbestos remediation should be a top priority for maintaining a healthy indoor environment. The Department of Buildings can provide guidance on how to safely remove asbestos insulation, but to minimize your risk of harmful exposure to asbestos and to ensure proper handling, contact a licensed professional. Asbestos abatement and removal projects are regulated by the New York State Department of Labor. For more information see their web site (www.labor.ny.gov/workerprotection/safetyhealth/DOSH_ASBESTOS.shtm).
- ***Remediation of lead paint and pipes:*** If your walls or ceilings were painted before 1970, they were most likely painted with lead-based paint. If paint cannot be safely removed, isolate with several layers of lead-free paint or wallpaper. For removal, contact your local health department to find a licensed professional who can undertake your lead paint remediation project. Pregnant women and children should absolutely not be involved in the removal of lead paint. Lead piping and soldering should be properly removed.

Select materials with a low environmental footprint

- ***Rapidly renewable materials:*** Materials like bamboo or cork, produced from rapidly-growing plants, help preserve native forests and natural resources.
- ***Repurposed or salvaged materials:*** Wood products, including doors, floor planks, and furniture can be reused in renovations. This not only keeps them out of landfills and limits resource consumption, but can reintroduce or maintain the historic character of your building.
- ***High recycled content materials:*** Wall insulation, countertops, flooring, carpeting, and even interior paint products are available with degrees of recycled content.

REGULATORY CONSIDERATIONS

Landmarks Preservation Commission (LPC) Regulations

If your property is a City landmark or a building in a City historic district

In general, the material in this section is limited to the interior of the building and does not require LPC review. If the work you are proposing requires a DOB permit, and your property is a City landmark or a building in a City historic district, an LPC permit will also be required.

Department of Buildings (DOB) Regulations

The DOB regulates the use of materials in buildings in order to protect the health of building occupants, such as banning lead and asbestos and requiring ventilation and air filtration. See the New York City Building Code for more information.

RESOURCES

BuildingGreen, for articles, case studies and news

www.buildinggreen.com

BuildingGreen Green Spec guide to products for your building

www.greenspec.buildinggreen.com

Carpet and Rug Institute for tips on installation, cleaning, and maintenance of carpets and rugs

www.carpet-rug.org

Clean: The Humble Art of Zen Cleansing, by Michael De Jong (2007) for natural and alternative cleaning methods

Environmental Working Group compiles information about potentially hazardous substances

www.ewg.org

US Environmental Protection Agency for lightbulb recycling procedures

www.epa.gov/bulbrecycling

US Environmental Protection Agency for information on radon awareness

www.epa.gov/radon

Green Seal Environmental Standard certifies environmentally sensitive cleaning products, paints and packaging

www.greenseal.org

National Trust for Historic Preservation, for tips on "Lead Safe Practices for Older and Historic Buildings"

www.preservationnation.org/resources/homeowners

NY City Department of Sanitation, for information about proper waste disposal

www.nyc.gov/nycwasteless

NY State Department of Health, for information on removing lead-based paint

www.health.ny.gov/publications/2502

NY State Department of Labor, for information about asbestos abatement and removal

www.labor.state.ny.us/workerprotection/safetyhealth/DOSH_ASBESTOS.shtm

Perkins & Will Transparency, a list of common chemicals to avoid in building products

www.transparency.perkinswill.com

SUSTAINABLE LANDSCAPES & OUTDOOR AMENITIES

A sustainable site is designed and managed to maintain or supplement the natural environment with minimal impact from the urban environment. New York City's urban infrastructure deters water infiltration and absorbs and retains heat, creating a phenomenon known as the "urban heat island effect," which causes temperatures in the city to be several degrees warmer than the surrounding suburbs. Managing your property in a sustainable manner can help decrease the heat island effect as well as reduce energy waste, minimize soil and water pollution, and maintain a more desirable living space.

75% of New York City's land area is covered by impervious surfaces.

New York City Sustainable Stormwater Management Plan

Key issues for urban landscapes

- Conventional landscaping and infrastructure practices, from the selection of materials, products, and systems, does not always adhere to the historic character of a landmarked building or community.
- Many building and landscaping materials, products, and site maintenance activities release toxins into the ground water and storm water drainage systems.
- Introducing exotic and invasive species can make landscapes unwieldy or high maintenance. It is best to select native plants, which are better suited to the local climate and will require less maintenance.
- Highly impervious and dark-colored hardscapes contribute to the heat island effect and increase the volume of rainwater runoff, erosion, and contamination. They also minimize an area's capacity for supporting biodiverse habitats.

OPPORTUNITIES—LOW/NO COST

Use cleaning products and tools that minimize waste

Use cleaning tools, such as conventional mops and brooms, and reusable hand cloths as much as possible to minimize waste. Regular use of paper towels and disposable floor sweeping tools are convenient, but contribute considerably to household waste.

Use biodegradable trash bags

Use biodegradable trash bags for kitchen and landscape waste collection and fill bags completely before disposal to minimize landfill waste.

Improve the sustainability of your landscaping practices

- ***Minimize landscape maintenance costs and water usage by xeriscaping.*** Xeriscaping (from the Greek xeros, or dry) is a systematic method of promoting water conservation in landscaped areas. Select appropriate native and adapted species and plant them in a manner that will require little irrigation. Use low-maintenance turfgrass, suited for northern climates. Avoid bluegrass turf, which requires a lot of watering. If necessary, talk to a landscape architect to help you identify the native species that will work best to meet the demands of your property and to understand the water and energy requirements of the plants you select.
- ***Compost landscaping and food waste.*** Use composted food scraps and landscape waste to enrich the soil of your garden or potted plants and reduce the need for store-bought chemical fertilizers.

Urban Rooftops. The offices at 641 Avenue of the Americas benefit from easily-maintained succulents that naturally cool the roof and provide a biophilic view.

Photo credit: Ryan Browne, for Cook+Fox Architects

- ***Encourage biodiversity.*** Provide a native habitat, either as a yard or rooftop that attracts insects, butterflies and birds. This approach will also contribute to pest management.
- ***Maintain healthy soil and water.*** Maintaining healthy soil absorbs more water and encourages deeper roots. Use topsoil and plant material that requires little fertilizer and rainwater. Using mulch keeps plant roots cool, minimizes evaporation, prevents soil from crusting, and reduces weed growth. Designate portions of your yard or rooftop garden that do not require regular mowing, cutting, cultivation, fertilization, or watering. If pest control is necessary, use biological and natural controls, including use of fungal pathogens and plant extracts as bio-pesticides.

Maintain compost

Compost organic food and landscape waste to enrich landscape soils. Rotate compost routinely to encourage decomposition and prevent pests. To find a local composting organization, visit www.nyc.gov/wasteless/compost.

Clean gutters and rain barrels

Clean gutters, drains, and rain barrels regularly to minimize buildup of organic matter. Poorly maintained gutters can lead to clogs, which support mosquitoes and algae growth, and can lead to water damage to your building.

Practice routine maintenance of large trees

Regular maintenance of trees on or near your property will help avoid potential accidents or property damage. Early detection of an overburdened limb or a disease may help prevent the tree from being removed. Large trees are hard to replace in the city. The loss of a full grown tree also means lost amenities, such as shading, rainfall management, privacy, and natural habitat.

Minimize water contamination from exterior cleaning and maintenance

- ***Practice water efficient and non-polluting car washing.*** Use captured rainwater and water-soluble, biobased, and biodegradable soaps and cleaning products to wash your car. Do not leave a hose running when not in use.
- ***Sweep sidewalks, walkways, patios and stoop.*** The use of soaps, bleach and power-washing for cleaning or clearing outdoor surfaces is an inefficient use of water, can contaminate water and soil, and damage building components and other materials.
- ***Anti-icing with sand.*** Using salt on sidewalks, stoops and pathways corrodes, cracks and degrades these surfaces, as well as your car, your shoes, and your carpet as you track it indoors. Salt also pollutes ice melt and snowmelt as it runs to the storm sewer. The most environmentally responsive way to prevent snow and ice buildup is to shovel and remove it right away. When this is not possible, use sand. While sand is not a deicer itself, it can provide traction for people and cars. An alternative approach is to anti-ice with sand soaked in a chemical de-icing liquid.
- ***De-icing with chemicals.*** Liquid products serve as preventative de-icers, whereas crystallized de-icers are applied after snow or ice has accumulated. Though less corrosive than salt, some chemical de-icers are known to pollute water. Check labels and avoid urea sodium chloride and magnesium chloride products, which are sometimes marketed as environmentally friendly. Acetate-based products, though more expensive, pollute less. Calcium magnesium acetate (CMA) is a natural acid alternative that is soluble in water and shares chemical properties with vinegar.

BIOPHILIC DESIGN

Many studies show that humans have an innate attraction to other living beings. Introducing nature into the built environment has been shown to relieve stress, improve concentration and productivity, and improve occupant's health. When designing your interiors, maximize views to the outside from all spaces, introduce potted plants, provide superior ventilation, and use non-toxic finishes with natural materials like wood or stone. The economic benefits of biophilic design are compiled in Terrapin Bright Green's The Economics of Biophilia: Why Designing with Nature in Mind Makes Financial Sense (2012). *For more ideas on design, see Kellert, Heerwagen and Mador's* Biophilic Design, *published by Wiley & Sons (2008).*

Utilize integrated pest management to reduce toxins around the home

Implement a comprehensive Integrated Pest Management (IPM) program to prevent pest issues in and around your home. An effective IPM program will include the following actions:

- Manage landscape to render it less suitable for pests and pest carriers.
- Exclude pest carriers with fencing or direct reduction.
- Control small pests by providing habitat for birds to feed and nest.
- Use host-targeted pesticide application through passive topical application devices.
- Consider biological and natural controls, including use of fungal pathogens and plant extracts.
- Minimize the application of chemical insecticides to select areas.

OPPORTUNITIES—MODERATE/HIGHER COST

Reduce heat island effect of your roof

See section on Walls & Roofs for more information on roof treatments and materials or vegetated roof opportunities.

Improve rainwater management on your property

- ***Use rain barrels and cisterns.*** With an average of four inches of rainfall per month, nonpotable water is abundant and fairly consistent in New York City. Capture and store rainwater in cisterns for graywater use such as landscape irrigation.
- ***Install permeable paving.*** For outdoor parking, patios, and walkways, install permeable systems wherever possible, to allow rainwater to infiltrate the soil instead of running off into the storm sewer or your basement. Select open grid pavement systems that are at least 50% pervious and accommodate vegetation within open cells. Open grid pavement systems are common and come in a variety of materials (brick, stone, concrete, tile, and plastics), decorative styles and levels of durability (load tolerance from usage types, e.g., cars versus trucks).
- ***Install a vegetated roof.*** Vegetated rooftops can function on more than one level. In addition to being a great way to reclaim underutilized urban spaces, support biodiversity and reduce the heat island effect, they also help minimize the amount of rainwater runoff in our city's combined sewer system. Before installing a vegetated roof system, consult a structural engineer to ensure your building can support the additional load.

Install durable gutters and downspouts

Effective gutters must be durable and watertight, and maintain good water quality. Gutters should be installed at a slight slope toward downspouts to allow them to completely drain. Standing water can shorten the life of your gutter system and attract mosquitoes.

- ***Maximize durability and minimize waste.*** Select seamless aluminum products from services that fabricate gutters on-site to the dimensions of your building; this will reduce the likelihood of leaks and eliminate product waste. Aluminum products will also last longer than galvanized products.
- ***Select nonpolluting materials and finishes.*** PVC (polyvinyl chloride) gutters contain additives that increase flexibility but also leach into rainwater and harm aquatic life downstream. Unpainted galvanized gutters leach zinc into rainwater and rust over time. Factory-applied, baked-on (often called powder-

URBAN HEAT ISLAND EFFECT

The heat island effect describes built-up areas that reach higher temperatures than unbuilt areas due to the change in the terrain and surface materials. As vegetation and permeable open land is replaced with streets, parking lots, buildings, and other infrastructure, the surface and ambient temperatures rise.

As urban dwellers, we are surrounded by heat islands, which can affect our homes by increasing summertime peak energy demand and air-conditioning costs, as well as air pollution and greenhouse gas emissions, heat-related illness and mortality, and water quality.

As a building owner, you can reduce your contribution to the urban heat island by increasing tree and vegetative cover, at the ground and roof levels; installing light-colored or reflective roofing materials; and using light colored pavements. Even inexpensive white roof coatings can reduce your rooftop temperature in summer by 40°F or more!

Permeable parking lots. Shade trees minimize the urban heat island effect, while permeable pavers allow on-site infiltration of water in parking areas, walkways, and hardscaped yards, which reduces the burden on our city's storm sewers.

Photo credit: Bill Browning

coated) finishes are more durable than sprayed finishes and create less pollution during manufacturing.

- ***Design for first flush.*** Guttered roofs make rainwater easy to direct, but be sure to design the capture system to discharge the first flush of water during a storm, which will reduce the amount of dirt and organic matter entering your rain barrels or cisterns. Also consider installing leafguard systems in existing gutters. Check and clean your gutters regularly to avoid build up and clogging.

Install water efficient irrigation systems and controls

- ***Drip Irrigation:*** A drip irrigation system is the most efficient choice to irrigate landscaping during the height of the summer. Because drip irrigation systems are designed to deliver water directly to the base of the plant through a network of valves, pipes, tubing, and emitters, they use water and fertilizer more efficiently than spray irrigation. Ideally, this system will utilize stored rainwater for all irrigation requirements. For best results, only operate system during dry periods.
- ***Soaker hoses:*** Place soaker hoses directly on top of the soil and flatten as possible to ensure an even distribution of water across the area to be irrigated, then cover them with mulch. The mulch does triple duty by disguising the hoses, preventing weeds, and helping the soil retain moisture longer.
- ***Moisture sensors and timers:*** Install a device that monitors soil moisture levels and suspends watering when levels are sufficient for plant health or if freezing temperatures occur. Handheld devices can also be used to monitor the moisture levels of your indoor and outdoor potted plants.

Gutters and downspouts. The placement of your downspout to openings in your building is key to minimizing moisture intake. The close proximity of the downspout discharge shown (above) to the window puts the basement at higher risk of flooding during heavy rainfalls. Redirect or extend your downspout to discharge away from your home, or collect the rainwater in a barrel to reuse for landscaping irrigation or for washing your car, patio, or walkway.

Photo © Terrapin Bright Green

Plant deciduous trees to provide summer shading

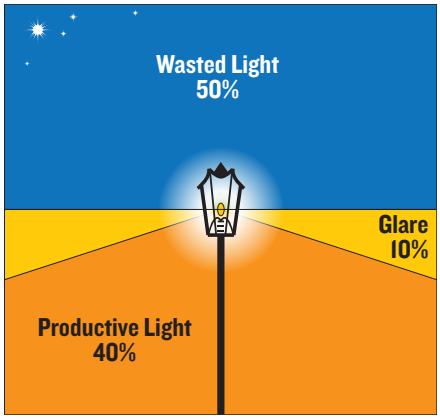
Planting native or adapted deciduous trees adjacent to your home, especially on south facades, filters daylight, managing solar heat gain by minimizing it in the summer and maximizing it in the winter. Trees also provide shade for outdoor activities and reduce the volume of rainwater that falls on your property during a storm, lessening the impact on the storm sewer system.

Improve exterior lighting design

Exterior lighting should help you safely and comfortably locate your doorway, outdoor space, or vehicle, while minimizing energy usage, respecting the historic character of the home, reducing light pollution and improving the view of the night sky.

- ***Increase energy efficiency exterior lighting.*** Design and enhance exterior lighting with low-voltage LED (light emitting diode) fixtures. LED technology is suitable for a variety of outdoor applications, including accent lighting, signage and spot lights. Where LEDs are not adequate, use metal halide high-intensity discharge (HID) lamps. Install timers and motion sensors to further improve efficiency.
- ***Install down-lighting.*** Design downward facing lighting to light pathways and other surfaces, rather than directing light toward the night sky and wasting energy. Lighting should only illuminate the intended areas. Refer to the IESNA lighting handbook for further guidance on appropriate levels of illumination (see web site in Resources on page 62).

See section on Lighting & Electrical for more information on lighting strategies.



Down-lighting. In addition to clouding the stars at night, light pollution can disrupt bird migrations. Outdoor light fixtures that direct light downward use energy more efficiently and help reduce light pollution and glare.

Graphic © Terrapin Bright Green

Minimize the environmental footprint of your structures

- ***Use recycled content in new concrete structures.*** To reduce the environmental footprint of new floor slabs or foundation walls, Portland cement used in concrete should be substituted with more environmentally responsible options. Using 20% replacement material is common in New York, but higher percentages are possible and should be discussed with your engineer and contractor. Take note that the percentage of substitute material, as well as the type of material used (e.g., fly ash or blast furnace slag), may impact the curing time for the concrete.
- ***Use recycled content in concrete amenities.*** Outdoor tables, retaining walls, and pathways made of concrete should include recycled content such as aggregates, shells, glass gravel, and sand to reduce the environmental footprint. These materials can also add a decorative element with natural textures and colors.
- ***Use nontoxic and biodegradable concrete release agents.*** Select petroleum-free, sulfur-free products that meet OSHA and EPA standards and contain the lowest VOC values. For oil-based release agents, select a vegetable or mineral oil-based product.
- ***Use sustainable wood products.*** For fencing, decks, tables, and trellis structures, use salvaged wood or products certified by the Forest Stewardship Council (FSC). See section on Rating Systems for more information on sustainable product labels.

Construct a honeybee apiary for your roof or yard

Provide a home for honeybees to pollinate plants and contribute to the biodiversity and prosperity of your plants or garden. Well-maintained beehives can serve as an educational tool for building occupants and the community, while also providing honey that you can harvest.

Before installing a hive on your property, have a solid understanding of honeybee biology and basic beekeeping methods. Correct placement of your hive is a very important consideration, as proximity to sunlight and heat, access to water, and proper ventilation are all vital to maintaining a healthy hive.

For more information, educational opportunities, best practices, New York City Health Code requirements, and other resources for beekeeping, refer to the New York City Beekeepers Association (NYCBA).

Rooftop Apiary. The presence of nonaggressive honeybees (*Apis mellifera*) is an indicator of ecological health. They pollinate plants and contribute to plant and animal biodiversity. This worldwide movement continues to rise in support of urban beekeeping. Among the most notable in the United States are the apiaries at the White House and Chicago City Hall; atop Manhattan's Waldorf-Astoria Hotel, the Natural Resources Defense Council headquarters at West 20th Street, the offices of Terrapin Bright Green and Cook+Fox Architects on 6th Avenue (above); and Brooklyn Grange farm in Long Island City, Queens.

Photo © Terrapin Bright Green

REGULATORY CONSIDERATIONS

Landmarks Preservation Commission (LPC) Regulations

If your property is a City landmark or a building in a City historic district

Alterations to yards and areaways may affect the character or physical integrity of your building and its site, and typically requires LPC review. For example, altering or replacing "hardscape" features, such as sidewalks, paths, and areaways, or installing tree pits or permanent planters will require an LPC permit; planting new lawns or shrubs in existing unpaved areas and maintaining existing lawns and shrubs will not require an LPC permit.

Department of Buildings (DOB) Regulations

Generally, larger-scale work requires a building permit from the DOB. The DOB requires permits for sidewalk alteration, large reroofing projects, and installation of green roofs. Roof drainage is regulated by the New York City Plumbing Code, and the Building Code has requirements for roof reflectance, as well as for the materials used for roof systems. If the work you are proposing requires a DOB permit and your property is a City landmark or a building in a City historic district,

LPC PERMIT EXAMPLES: YARDS/AREAWAYS

No Permit Required

- Maintaining lawns or shrubs
- Planting new lawns or shrubs in existing unpaved areas
- Placing nonpermanent planting pots, planter boxes, or window boxes

Permit Required*

- Installing pavement in yard areas previously unpaved
- Removing or replacing paving materials in yards, areaways, or sidewalks
- Installing or removing permanently installed planters
- Installing or enlarging tree pits

Source: Landmarks Preservation Commission
** LPC Tech Sheet, Chapter 6: Site Work*

an LPC permit will also be required. If you are not sure if the work you intend to do requires a permit, consult the DOB web site or call the DOB office in the borough where the property is located. DOB Rule 101-14 establishes categories of work that may be classified as a minor alteration or ordinary repair and therefore may be exempt from the permit requirements of the New York City construction codes. Rule 101-14 can be found on the City's web site (www.nyc.gov/html/dob/downloads/rules/1_RCNY_101-14.pdf).

RESOURCES

Beekeeping

NYC Public Health Entomology Unit, for information about regulations and best practices in New York City

beekeeping@health.nyc.gov

New York City Beekeepers Association (NYCBA) can provide resources from local beekeeping enthusiasts

www.nyc-bees.org

Cornell University Master Beekeeper Program teaches and certifies those who wish to become master beekeepers

www.masterbeekeeper.org

Integrated Pest Management

City Farmer, a web site with articles and tips about urban farming

www.cityfarmer.info

Association of Natural Biocontrol Producers (ANBP) is an industry group dedicated to natural, nontoxic pest control technologies

www.anbp.org

New York State Integrated Pest Management Program, run by Cornell University, provides IPM elements for a variety of crops

www.nysipm.cornell.edu

Landscaping

LPC Tech Sheet, Chapter 6: Site Work
The LCP Tech Sheet explains requirements for sidewalks, sidewalk cafes, yards, areaways, landscaping, fences, driveways, and swimming pools, as well as work affecting mature trees in the Douglaston, Riverdale, and Sunnyside Gardens historic districts.

BuildingGreen, Green Products: Sitework & Landscaping
A hub for articles, products, and case studies pertaining to site work and landscaping, including but not limited to stormwater, green walls, turf, paving, erosion protection, pest management, plantings and fencing

www.buildinggreen.com/menus

Green Roofs for Healthy Cities is a nonprofit organization focused on increasing the awareness of the economic, social, and environmental benefits of green roofs and green walls, and other forms of living architecture

www.greenroofs.org

MillionTrees NYC is part of the PlaNYC's goal of planting one million trees in New York City over a decade. This organization can help coordinate tree plantings, recommend species, and assist with tree maintenance.

www.milliontreesnyc.org

FUEL EFFICIENCY & RENEWABLE ENERGY

New York's buildings consume more heating oil annually than any other U.S. city. These building fuels create more pollution in the city than vehicles or power plants (PlaNYC, 2011). It is important to reduce building fuel use in order to decrease harmful air pollution. Integrated building systems that include some passive design (e.g., natural ventilation, daylighting), and conservation strategies tend to provide the best and lowest cost opportunities for minimizing fuel consumption.

Renewable energy technology can improve efficiencies, especially those associated with transmission losses (energy lost as it travels from the source to the grid to your home). However, implementing less expensive energy- and water-saving measures, as well as conservation strategies, remain the most cost-effective and practical first steps.

New Yorkers pay among the highest retail energy prices in the nation, collectively spending more than $15 billion each year.

PlaNYC 2030, April 2011

Types of fuels and renewable energy available to small historic buildings in New York City

Petroleum-based fuels and natural gas are the most common energy sources for heating. In New York City, our electricity is generated from low-carbon nuclear, hydroelectric, and natural gas. Renewable energy technologies are increasing in prevalence, the most common of which include biodiesel blends, solar photovoltaic and solar thermal systems, geothermal systems, wind turbines, and residential-scale fuel cells.

- ***Heating oil:*** Fossil fuels used in boilers and furnaces in New York City include No. 6, No. 4, and No. 2 heating oils. No. 6 heating oil is the most common high-pollutant heating fuel in the city today, but is being phased out by new City regulations. No. 4 is less efficient than No. 2 oil because it is mixed with unprocessed No. 6 oil. No. 2 is the cleanest type of petroleum-based oil available.
- ***Biodiesel:*** Biodiesel is a nonpetroleum, based fuel that contains no sulfur or heavy metals. Heating oil sold within New York City must contain at least 2% biodiesel. The low-sulfur blend, known as Bioheat or No. 194-A oil, caps the allowable sulfur content in fuel oil, reducing sulfur dioxide, particulate matter, and nitrogen oxide pollution and benefiting the city's air quality, water quality, and sewer infrastructure.
- ***Natural gas:*** Although increasing use of natural gas is raising concerns about the environmental implications of harvesting practices, natural gas is a commonly available and a much cleaner fuel to power boilers and furnaces. The City encourages a switch to boilers and furnaces fueled by natural gas. This information can be found in the New York City Department of Environmental Protection Rules' Chapter 15, Amendment 2.
- ***Geothermal:*** Geothermal technology involves drilling deeps wells, sometimes more than 1,000 feet below a building, to transfer heat to and from the earth. It is being used increasingly in historic buildings in New York City because it eliminates the need for unsightly cooling towers on rooftops. Prime examples of historic buildings using geothermal are the Chelsea Seminary, the South Street Seaport, and the AIA Center for Architecture. Geothermal has a low operating cost, and can provide both heating and cooling capacity, a long life-expectancy, and minimal maintenance.
- ***Solar electricity:*** Solar photovoltaic (PV) systems convert sunlight into electricity, reducing a building's reliance on the electric grid. A solar PV array will have the highest efficiency when oriented south-facing with no shadowing obstructions, which is sometimes difficult to achieve on low-rise urban buildings. Current PV technology ranges between 20–30% efficient; nevertheless, they convert solar energy into electricity without emitting harmful greenhouse gases. In June 2007 New York City was designated a

Photovoltaic (solar electrical) energy. Photovoltaic panels are most effective when installed facing south, on the rooftop or a south-facing wall, without surrounding shading objects. Check with a professional installer to identify the most suitable installment size and orientation for your rowhouse.

Photo credit: Creative Commons, some rights reserved by Demeester

Solar America City under the U.S. Department of Energy's Solar America City Initiative. The NYC Solar America City Partnership, led by Sustainable CUNY (the City University of New York), has created an online map locating existing solar PV and solar thermal installations and gives an estimate of solar PV potential for every rooftop in the city (http://nycsolarmap.com/).

- ***Solar thermal:*** Solar thermal systems use solar collectors to harvest sunlight for space conditioning and domestic water heating, including jacuzzis and pools. Solar thermal systems, for which there are several variations, provide three times the energy per square foot as PV and can provide 50–80% of a building's hot water needs. In New York City's climate, indirect active systems are the most common for heating domestic hot water.
- ***Wind:*** Wind technology uses turbines to capture kinetic energy in the wind and channel it to electricity production. Wind power makes sense on buildings that have a constant supply of wind, usually buildings located in less dense areas or on the waterfront. In order to preserve the character of historic buildings, turbines should be considered for backyard rather than rooftop installation.
- ***Fuel cells:*** Fuel cell systems utilize natural gas to power and heat your home. The natural gas is processed and converted to energy—through a chemical reaction that happens when the hydrogen is oxidized—providing on demand electric power and hot water. Fuel cells are expensive and require a constant power demand but are reliable outdoor systems that require no major renovation.

Key issues with petroleum-based fuels

Approximately 14% of local emissions of particulate matter results from the combustion of fuel used for heat and hot water (New York City Department of Environmental Protection). Today, heating systems in historic buildings are capable of running on cleaner and safer fuel alternatives than when they were initially built with; however, keeping fuel systems up to date and compliant with New York City Building Codes is an ongoing effort for building owners.

- ***Energy efficiency issues:*** Most historic buildings have infrastructure that does not meet today's efficiency criteria. Outdated boilers and hot air furnaces tend to use more fuel to generate the same amount of heat as do current Energy Star models.
- ***Heating oil issues:*** According the New York City Department of Environmental Protection, the city is one of the few places in the United States where No. 6 and No. 4 oil are still used as a heating fuel. These outdated heating fuels are dangerous to building occupant health as well as the health of the larger community. Smog created by burning petroleum-based fuels has been linked to respiratory illnesses, heart disease, and premature heart attacks. Boilers using these heavier grades of oil (No. 6 and No. 4) tend to be more difficult to operate and properly maintain, which often leads to smoke complaints and building violations.

Key issues with our energy grid

The electricity grid, built in the middle of the twentieth century, is showing its age. Anyone who remembers the New York City blackout of 2003 knows the reality of the grid's brittleness and its limits. The blackout was caused by extreme demand during a heat wave in the region, which surpassed the grid's capacity to generate power. It is critical that communities learn to manage their peak power demand to avoid brownouts and blackouts. Another issue with the grid is that it suffers from inherent inefficiencies. New York's power plants are less than 50% fuel efficient because of the inability to utilize the waste heat generated at the plants. There are additional efficiency losses in energy transmission; therefore, less than one-third of the fuel burned at a power plant ends up in our electrical outlets.

Key issues with renewable energy technologies

Renewable energy provides pollution-free energy for electricity or hot water, reducing utility bills, carbon emissions, and our dependence on fossil fuels. Some technologies are more appropriate than others for historic buildings. The adoption of renewable energy technologies in New York City is expanding rapidly, but knowing the unique characteristics and demands of one's building, as well as the renewable energy opportunities, is often a hurdle to implementing the most appropriate technologies. From a historic preservation perspective, owners should consider the aesthetic impacts of visible systems like photovoltaic panels, attachment of systems to historic structures, and structural capacity of the structure. In addition, a series of technical factors must be considered, including the type of mechanical system(s) utilized, accessibility to select utilities (e.g., not all buildings in New York City have direct access to natural gas), building orientation and location (south-facing is best for solar panels), intended end use, energy demand, and peak loads, as well as system implementation and maintenance costs.

The New York City Department of City Planning has recently revised zoning in the city to improve the ability to install renewable energy systems on buildings. Solar panels, wind turbines, and other renewable energy systems have been given specific allowances in the codes. More information can be found on the web site of the New York City Department of City Planning (www.nyc.gov/dcp).

OPPORTUNITIES—LOW/NO COST

Before switching to an alternative fuel, identify the simple modifications that can be made to improve efficiency. See section on Heating & Cooling for more information on equipment sizing.

- ***Avoid peak time usage.*** Conducting certain domestic activities such as running the dishwasher or taking a hot shower after 9pm will help keep your utility bills low.
- ***Maintain your mechanical system.*** Overuse of your mechanical system can cause unnecessary wear and reduced efficiency as the system requires more fuel to achieve the same energy output. Well-maintained systems will be more efficient over their lifetime.
- ***Maintain renewable energy systems regularly.*** Routinely clean debris (soot, pollen, leaves) and snow from solar collectors to maintain efficiency and maximize longevity.

Adjust your thermostat to a reasonable temperature

Avoid wasting fuel (and money) by setting the thermostat at temperatures beyond what is necessary, particularly when a space is unoccupied. Rather than air-conditioning your home when you are away, set controls to turn on 30 minutes before you anticipate returning home. This can be done remotely using a smart phone or other mobile devices. See section on Heating & Cooling for more guidance.

Use utility provider voluntary green power programs

Utility companies provide voluntary programs and other options for those who want to utilize renewable sources. If you decide not to install renewable energy sources in your building, you can still purchase renewable energy credits from utility provider voluntary programs. To determine your options, check with NYSERDA (nyserda.org) and your utility provider.

OPPORTUNITIES—MODERATE COST

Switch to a cleaner burning fuel

Historic buildings will most likely have boilers built to burn No. 6 oil, which is a sludgy substance that releases a large amount of soot when burnt. The DEP is gradually phasing out the use of No. 6 oil and encouraging New York City buildings to switch to much cleaner No. 2 oil instead. No. 4 oil is also available as an alternative, but it is inefficient to make, since it is a mix of energy-intensive No. 2 oil and polluting No. 6 oil. Permits for No. 6 will be eliminated by July 2015. Newly installed boilers and burners must use No. 2 or No. 4 oil, natural gas or another low-emission fuel, such as biofuel. Biofuel is a clean-burning fuel that is produced using renewable sources like soybeans or used cooking oil. It burns cleaner, is biodegradable, and is almost sulfur-free. When switching to a boiler that uses fuel more efficiently as well as cleaner fuel, look at Energy Star–certified models.

Use an energy management tool to monitor fuel consumption

Wireless measuring devices can track indoor/outdoor temperature and the consumption of fuel to improve the energy efficiency of your building. Also make sure to have your meter read regularly to ensure that you are using fuel efficiently.

OPPORTUNITIES—HIGHER COST

Solar options. Often more cost- and energy-efficient than photovoltaic panels, solar thermal can be installed on most buildings for domestic water heating. The solar thermal vacuum tubes in this photo were installed on a historic building in Brooklyn Heights. See the Sidney Place Passive House case study for more detail.

Photo © 475 High Performance Building Supply

Install solar thermal systems for water heating

If you are considering installing a solar thermal (hydronic) system in your building, have a licensed contractor handle the installation. It is important to site the solar thermal system so that it both receives enough direct sunlight to make it cost-effective and maintains the historic character of your building. You should consult a structural engineer to ensure that your building can support the additional load of the system. Also consider these tips:

- Provide space in a utility room or closet for an additional hot water storage tank. Using solar thermal in combination with a traditional hot water heater can cut water heating costs by as much as 80%.
- If your building is located in one of New York City's Solar Empowerment Zones, designated areas of the city where solar energy use is most feasible from a technical standpoint, you may qualify for a range of implementation benefits from the city government. See www.nyc.gov for more information about Solar Empowerment Zones.
- Careful calculation of building loads will help ensure your solar thermal system provides low-cost, energy-efficient hot water.
- Use the internal rate of return (IRR), or break-even time, which is the amount of time the system takes to pay for itself, to determine whether a solar system is a viable opportunity for you (www.solar-estimate.org).
- Visit the Solar Rating and Certification Corporation (www.solar-rating.org) for informative "solar facts" on types of solar collectors, performance data, ratings, durability and other issues.

Install solar photovoltaic (PV) systems to produce electricity

It is important to site the solar photovoltaic system on roofs that provide a constant stream of sunlight while being sure installation will not impact the historic character of your building. Installing on south-facing surfaces, unshaded by trees or neighboring buildings, is best.

- Use a licensed installer that will know how best to angle the panels to optimize efficiency. Choose a professional certified by the North American Board of Certified Energy Practitioners, and who is on NYSERDA's list of

approved installers. A licensed professional will take into consideration your building's energy use, as well as the roof's ability to support the system, and will also help you decide which type of solar PV system is most appropriate for your home.

- The system will need to be installed with equipment to monitor the energy produced, as well as a DC/AC power inverter to convert the collected energy to energy that can be used by the electric systems and devises in your home. Due to the toxicity of batteries, avoid installing a backup, as they are typically unnecessary when your home remains connected to the utility grid.

Install a geothermal system

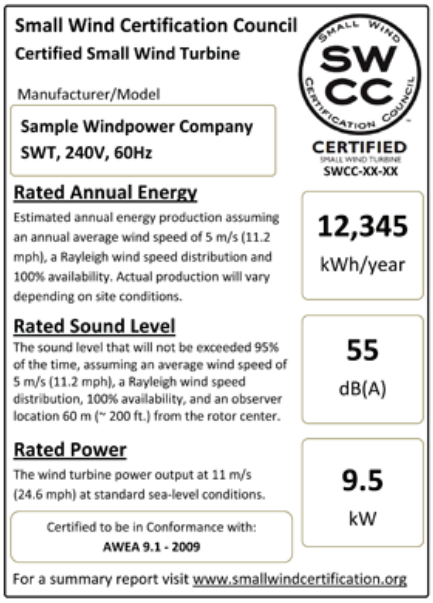
Installing a geothermal system is a major undertaking, so it is important to find a reputable contractor who will be able to guide you through the process. See the New York State Energy Research and Development (NYSERDA) web site for a list of approved contractors with experience installing geothermal systems. NYSERDA and the federal government provide financial incentives for geothermal projects. See the Incentives section for more information.

Install a wind turbine

Wind energy should be installed on roofs of buildings that have access to a constant supply of wind. However, in order to preserve the character of historic buildings, turbines should be considered for backyard rather than rooftop installation. Certain areas of Queens or the Bronx, where buildings are most likely to be a couple of stories tall and have a wind flow unencumbered by surrounding buildings, may be good candidates for a turbine.

An anemometer, a common weather station instrument, should be installed on the prospective site to measure the force and direction of the wind and to validate the cost-effectiveness of installing a wind turbine. Consistency of wind can be as important as abundance. The site must be evaluated to ensure that it has an adequate wind supply, and to make sure that wind turbines will not disturb wildlife in the area. An approved wind system installer will be able to evaluate your site for you.

Visit the DOE Wind Program (eere.energy.gov/wind) for information on wind technology, the Small Wind Certification Council (smallwindcertification.org) for certified small wind turbines, or NYSERDA (nyserda.org) to get in touch with an approved wind system installer. NYSERDA, ConEdison and other utilities offer incentives and payment programs that can make this more financially viable. See the section on Incentives and Programs for more information.



Wind energy. If carbon reduction is an important part of your building retrofit, buying certified wind power is a way to reduce carbon beyond what can be done onsite.

REGULATORY CONSIDERATIONS

Landmarks Preservation Commission (LPC) Regulations

If your property is a City landmark or a building in a City historic district

Installation of renewable energy equipment may affect the character or physical integrity of your building and its site, and typically requires LPC review. For example, installing solar thermal, photovoltaic panels, or wind turbines will require an LPC permit; maintaining existing renewable energy systems will not require an LPC permit.

LPC MYTH BUSTER

The LPC reviews proposals for solar panel installations on flat or low-slope roofs on a regular basis, most of which are approved at staff level. In some cases, the layout or configuration of solar panel installations may need to be adjusted in order to comply with LPC regulations.

Department of Buildings (DOB) Regulations

Most mechanical and electrical work related to fuel use, and conversion to renewable systems, require a permit from the DOB. DOB regulates the heating units in all buildings by issuing permits for new units and re-issuing those permits every three years. If the work you are proposing requires a DOB permit, and your property is a City landmark or a building in a City historic district, an LPC permit

will also be required. If you are not sure if the work you intend to do requires a permit, consult the DOB web site or call the DOB office in the borough where the property is located.

RESOURCES

Environmental Defense Fund, for information on clean heating fuels, and to find out what kind of fuel buildings in your neighborhood use

www.edf.org/cleanheat

www.edf.org/edf-map-dirty-heating-oil-new-york-city

National Biodiesel Board, for information about biodiesel as a heating fuel

www.nbb.org

New York State Energy Research and Development Authority (NYSERDA), Offers a variety of incentives for upgrading systems

www.nyserda.ny.gov

GreenTechMedia, for articles and developing technologies

www.greentechmedia.com

Solar Estimator
Determine your rate of return (break-even) for solar and wind technologies

www.solar-estimate.org

NYC Solar America City, a CUNY program providing a NYC Solar Map, information on Solar Empowerment Zones, and resources to navigate the solar thermal and PV installation process.

www.cuny.edu/about/resources/sustainability/solar-america.html

Solar Thermal Consortium's Roadmap for NYS shows solar thermal potential across the state

www.solarthermalworld.org/node/1030

Solar Rating & Certification Corporation, for ratings, durability, and efficiency information of different systems.

www.solar-rating.org

See the section on Incentives & Programs for state and federal government incentives that help make project financing more accessible.

RATING SYSTEMS & PERFORMANCE STANDARDS

In the 1990s, as the sustainability movement grew in the building industry, it became clear that the industry needed standards to quantitatively measure green building components. This led to a proliferation of standards for individual products, such as carpets and woods, as well as more comprehensive building and community scale certification programs. A primary objective of these rating systems has been to support market transformation by identifying the important issues in the industry and the goals for improvement. Existing building reuse has always been a valuable component of these rating systems, and as we learn more about embodied energy, the recognition of the intrinsic value of historic buildings increases.

Types of rating systems and standards

The two main categories for building rating systems and standards are building-scale and product-scale. Under these two categories, there are different focal areas, addressing issues such as energy or water (e.g., efficiency; performance; embodied resources), occupant health and comfort (e.g., materials toxicity; access to nature; user controllability of HVAC and lighting systems), and sustainable extraction of natural resources (e.g., proximity of extraction or manufacturing to project; use of renewable materials).

Key issues with rating systems and standards

The many different rating systems—some competing against each other, others complementing each other—can be overwhelming. Often the biggest challenge is knowing which rating system or performance standard to focus on. Find the best approach for your project by first identifying which issues are most important to you (e.g., health, environment, preservation, cost), and then determining which aspects of your project are impacted (e.g., scheduling, procurement, operations, cost). Not all projects are easy to categorize, but rating systems and performance standards can be a valuable guide for helping you define your project goals.

BUILDING OPPORTUNITIES

Home Performance with Energy Star®

Most New Yorkers qualify for a free or reduced-cost comprehensive home energy audit and low-cost financing through the US EPA's Home Performance with Energy Star. NYSERDA manages the program for the State of New York and uses a network of independent home improvement contractors to identify energy efficiency improvement opportunities and to test homes using a "whole-house" approach. From the initial visit to your home, to installation of energy efficiency work through to project completion, the program is designed to serve as a "one-stop shop" process. Homeowners learn where their home is wasting energy and know what to expect from their contractors and how to obtain additional information about moving forward. Details on how to participate and find a contractor near you can be accessed on the NYSERDA web site (www.nyserda.ny.gov/residential).

LEED®

LEED, or Leadership in Energy and Environmental Design, is a program of the US Green Building Council (www.usgbc.org) that provides building owners and operators with a framework for identifying and implementing practical and measurable green building design, construction, operations and maintenance solutions. The LEED program offers a series of certification paths; the following are the most common among historic and other existing small residential buildings.

LEED for New Construction & Major Renovations (LEED-NC)
LEED-NC certification relates to the environmental impact of design and construction of a new building, but also the major renovation of an existing building. LEED-NC focuses on energy performance, indoor environmental quality, water efficiency, materials and resources, and waste management.

LEED projects are certified by the Green Building Certification Institute (www .gbci.org). For more information on the type of projects eligible for LEED certification or for LEED reference guides, visit the USGBC web site (www.usgbc .org/LEED).

Passive House & EnerPHit

A Passive House is a very well insulated, virtually airtight building that is primarily heated by passive solar gain and internal gains from people, electrical equipment, and renewable energy sources. Avoiding heat gain through shading and window orientation also helps to limit cooling loads. The result targets exceptional savings in space conditioning costs and high indoor air quality. While Passive House certification of historic buildings is best suited for whole-building renovation projects, the concepts and measures, especially for windows efficiency, air sealing, and wall insulation, are also applicable to buildings not pursuing certification.

The use of Passive House components in refurbishments of existing buildings leads to extensive improvements with reference to thermal comfort, economic efficiency, absence of structural damage and climate protection. Achieving the Passive House standard in refurbishments of existing buildings is not always a realistic goal, one of the reasons being that basement walls remain as barely avoidable thermal bridges even after refurbishment. For such buildings, the Passive House Institute has developed the "EnerPHit—Quality-Approved Energy Retrofit with Passive House Components" Certificate. This has maximum heating demand requirements, or alternatively the consistent use of Passive House components in accordance with the requirements for Passive House certification of components.

See the section on Windows & Doors for details on Passive House windows. Guidelines for Passive House can be found at the Passive House Institute US (PHIUS) web site (www.passivehouse.us). The German Passive House Institute (www.passiv.de) is also a good resource. For information on EnerPHit, visit www.passiv.de/en/03_certification/02_certification_buildings/04_enerphit/04_enerphit.htm

PRODUCT-SCALE OPPORTUNITIES

There are many product-scale systems that could inform your materials and product selections. Some certified products may have a higher up-front cost compared to a similar yet uncertified products; however, their high-efficiency or positive health impact may amount to savings for you in the long-run. This short list of product rating systems should help you get started.

Carpet and Rug Institute's Green Label

The Green Label program promotes healthy indoor environmental quality by identifying rugs and carpets that have very low levels of volatile organic compound (VOC) emissions. They also provide a seal of approval for vacuum cleaners. See the section on Indoor Health, Housekeeping & Materials for more information on VOCs and other household toxicants. For information on CRI's Green Label and other approval systems, visit www.carpet-rug.org.

Cool Roof Rating Council

The Cool Roof Rating Council provides solar reflectivity index (SRI) information for most common building products. When considering adding materials to the roof or landscape of a building, SRI is an important consideration. Project sites with a high SRI help minimize urban heat island, and cost less to cool in the summer. For more information, visit the Rating Council's web site (www.coolroofs.org).

Cradle to Cradle®

The Cradle to Cradle (C2C) Certified program is a third party, multi-attribute eco-label administered by the Cradle to Cradle Products Innovation Institute (www .c2ccertified.org) that assesses a product's safety to humans and the environment for future life cycles. The materials and manufacturing practices of each product are assessed in five categories: material health, material reutilization, renewable energy use, water stewardship, and social responsibility. C2C certified products are designed to be easily reusable by humans or nature. An example would include lock-in-place wood flooring that can be easily removed for reuse elsewhere. More information is also available on the McDonough Braungart Design Chemistry (MBDC) web site (www.mbdc.com).

Energy Star®

Energy Star is an US EPA supported program that certifies appliances and other household devices for energy efficient performance. Certified products use 20–30% less energy on average than required by federal standards. Energy Star certified products include refrigerators, dishwashers, heating and air conditioning systems, televisions and other home electronics, battery chargers, lighting, computers and servers. For more information, visit the Energy Star web site (www .energystar.gov).

Environmental Product Declaration

Environmental Product Declarations (EPDs) are a standardized way of quantifying the life-cycle assessment of a product. EPDs include information on the product's consumption of raw materials, energy use, and chemical content. For more information, visit the EPD web site (www.environmentalproductdeclarations.com).

Forest Stewardship Council

Wood products certified by the nonprofit Forest Stewardship Council (FSC) are responsibly harvested by minimizing logging impact, respecting treaties and indigenous rights, maintaining critical habitats, and managing harvests to allow replenishment. For more information, visit the FSC web site (www.fsc.org).

Health Product Declaration Forum

The Health Product Declaration (HPD) Open Standard is an emerging standard for healthy building materials. The HPD Open Standard collects information on building materials, similar to the EPD (see above), and compiles it in simple, easily referenced reports. The focus of these reports is to identify hazardous or potentially hazardous chemicals in materials so that owners may make informed decisions about the chemicals to which they are exposed. This database is aimed

at reducing the research required to identify risk in using building products. For more information, visit the HPD web site (www.hpdworkinggroup.org).

National Fenestration Rating Council

The National Fenestration Rating Council (NFRC) is a nonprofit, public/private organization created by the window, door, and skylight industry. The NFRC has developed a window energy rating system based on whole product performance. The NFRC label provides a reliable way to determine the window energy properties and to compare products. The label appears on all products certified to the NFRC standards and on all window, door, and skylight products which are part of the Energy Star® program (see page 71). At this time, NFRC labels on window units give ratings for U-factor, Solar Heat Gain Coefficient (SHGC), Visible Light Transmittance (VT), and optionally Air Leakage (AL) and Condensation Resistance (CR) ratings. For more information, visit the NFRC web site (www.nfrc.org).

Solar Rating and Certification Corporation

Solar Rating and Certification Corporation (SRCC) is an independent third-party certification entity and the only national certification program established solely for solar thermal products. The SRCC currently operates two major solar programs: solar collector certification (OG-100) and complete solar water heating system certification (OG-300). For more information, visit the SRCC web site (www.solar-rating.org).

WaterSense®

WaterSense, a label proliferated by the US EPA, certifies water-using appliances use at least 20% less water than required by the Energy Policy Act of 1992, without sacrificing performance. The WaterSense program labels toilets, urinals, lavatory faucets, and showerheads. For more information, visit the WaterSense web site (www.epa.gov/watersense).

INCENTIVES & PROGRAMS

Government agencies offer a range of incentives to support the preservation of historic buildings and the improved sustainability of the nation's building stock in general. It should be noted that these incentives change often, and you should consult the agencies directly as well as your accountant to ensure your property and upgrades meet all of the qualifications necessary for these credits, abatements, and incentives.

Types of incentives available to owners of historic buildings

There are federal-, state-, and city-based incentives available to those who wish to upgrade and retrofit their historic buildings. Federal incentives are typically administered by the National Park Service, while state-based incentives are normally organized by the New York State Department of Parks, Recreation and Historic Preservation and the New York State Energy Research and Development Authority (NYSERDA). City-based incentive programs tend to be organized by the New York City Department of Buildings (DOB) and regional utility companies. A description of the major incentive plans available are listed below.

Key issues

- Federal, state and city incentive programs for energy efficiency upgrades tend to change their criteria every few years, so it is important to check for the latest version of each program's criteria and benefits when you are ready to apply.
- Most federal, state and city incentive programs tend to be categorized by technology (e.g., solar panels) or efficiency measure (e.g., home insulation), rather than the objectives of a renovation project (e.g., improved energy efficiency), so building owners need to know what they are looking for in order to find it. For example, NYSERDA, one of the largest state-level providers of retrofit incentives, offers programs for installing solar thermal systems that differ from those for installing solar photovoltaic systems, even though both approaches help improve the energy efficiency of a building. This can pose a challenge for building owners unfamiliar with the opportunities available for their building type.

OPPORTUNITIES

Rehabilitating historic buildings with energy efficiency upgrades is a practical undertaking. Although there is a high up-front cost when installing an energy-efficient boiler or appliance, these upgrades will yield lower operating costs overtime, and generally result in a payback period of just a few years.

- When organizing the installation of your program, NYSERDA's database of approved and licensed contractors is a great resource in choosing someone to carry out your retrofit or upgrade.
- Consult with your accountant and the agencies offering incentive programs early on to ensure your property and upgrade plans meet all of the qualifications requirements for the incentive.

Understand your options. A good way to begin any retrofit is to have a consultant conduct an energy audit. Often, utilities can provide an energy audit free of charge.

Photo © Clark Jones, PlaNYC

Federal Level

Federal Historic Preservation Tax Incentives

A 20% income tax credit is available for the substantial rehabilitation of historic, income-producing properties that are determined by the Secretary of the Interior, through the National Park Service, to be "certified historic structures." The work

Financing through state programs.

Images of 47 Skillman Avenue before its renovation and after. The homeowner applied for and received both the New York State Historic Homeownership Rehabilitation Tax Credit and the Residential Energy Credit.

Photos © Laura Heim Architect PLLC

performed (both interior and exterior) must meet the Secretary of the Interior's Standards for Rehabilitation and be approved by the National Park Service.

http://www.nps.gov/tps/tax-incentives.htm

State Level

New York State Tax Credit Program for Income Producing Properties

Owners of income producing properties that have been approved to receive the 20% federal rehabilitation tax credit (see page 73) automatically qualify for an additional state tax credit for 20% of the qualified rehabilitation expenditures up to $5,000,000. In order to qualify, the placed-in-service date must be after January 1, 2010, and the property must be located in an eligible census tract. There is no application form. Visit the web site for details and frequently asked questions (FAQ).

www.nysparks.com/shpo/tax-credit-programs

New York State Historic Home Ownership Rehabilitation Tax Credit

Rehabilitation work on historic residential structures may qualify for a tax incentive. Houses must be an owner-occupied residential structure and be individually listed on the State or National Register of Historic Places, or a contributing building in a historic district that is listed on the state or National Register of Historic Places. Visit the web site for details, frequently asked questions (FAQ), and application forms.

www.nysparks.com/shpo/tax-credit-programs

New York State Energy Research & Development Authority (NYSERDA)

NYSERDA organizes and runs a variety of programs that provide financial assistance to those interested in energy efficient upgrades in their homes. There are a range of incentives programs for single family, multifamily and commercial properties, as well as incentives geared towards installations of renewable energy technologies in your home.

www.nyserda.org

City Level

New York City Green Roof Property Tax Abatement

New York City Department of Buildings offers property tax abatements for building owners who wish to install green roofs.

www.nyc.gov/html/dof/html/property/property_tax_reduc_individual.shtml

New York City Solar Panel Tax Abatement

New York City's Department of Buildings runs an incentive program that can pay you up to $62,500 to install a solar electric system in your building.

www.nyc.gov/html/gbee/html/incentives/solar.shtml

NYC °CoolRoofs Program

New York City's Department of Buildings runs the NYC °CoolRoofs Program, which trains volunteers to paint the flat roofs of city buildings white, to reflect about 70% of incident solar heat. This prevents extra loads on a building's HVAC system, especially in the summertime, and saves you money on cooling in the summer.

www.nyc.gov/coolroofs

Utility-Run Incentives

Utilities like National Grid and Con Edison run a wide variety of incentive programs for tenants and building owners who wish to undertake energy

efficiency upgrades, or installation of renewable energy and clean energy technologies. Look on the utilities' web sites for more information, since these incentive programs tend to change overtime.

www.nationalgridus.com

www.coned.com/greenteam

REGULATORY CONSIDERATIONS

There are no regulations directly applicable to the Incentives & Programs section of the manual. See individual sections for regulatory information specific to the opportunity or technology.

RESOURCES

Database of State Incentives for Renewables & Efficiency (DSIRE):
See "New York State" for specific energy incentives

www.dsireusa.org/incentives

Department of Buildings, Sustainability
Tax abatements for green roofs and solar panels

www.nyc.gov/buildings

Federal Historic Preservation Tax Incentives
Program offers financial incentives for restoring historic buildings

www.nps.gov/tps/tax-incentives.htm

Preservation Directory
Compiles funding sources for historic preservation projects

www.preservationdirectory.com/PreservationGeneralResources/GrantsFundingSources.aspx

NYSERDA Renewable Energy Programs
Offer financial incentives for installing renewable energy systems

www.nyserda.ny.gov/Energy-Efficiency-and-Renewable-Programs.aspx

Rehabilitation Tax Credit & Real Estate Tax Tips

www.irs.gov/businesses/small/industries/article/0,,id=97599,00.html

State Historic Preservation Office (SHPO)
Governs historic buildings across New York State

www.nysparks.com/shpo

Tax Incentives Assistance Project (TIAP)
A nonprofit group that compiles energy-saving tax incentives

www.energytaxincentives.org

US Department of Energy's Weatherization Assistance Program provides energy efficiency incentives

http://apps1.eere.energy.gov/weatherization/apply.cfm

APPENDIX A: REGULATORY OVERVIEW

Historic preservation is a nationwide movement to maintain buildings, landmarks, and landscapes that are significant to local or national history. The National Historic Preservation Act of 1966 and the New York State Historic Preservation Act of 1980 established the National and State Registers programs. New York City's preservation agency, the Landmark Preservation Commission, is one of the country's most active preservation bodies, and was established in 1965, one year after the historic Pennsylvania Station was torn down to make way for Madison Square Garden.

What is a landmark?

The State and National Registers of Historic Places recognize buildings, structures, districts, objects, and sites that are significant in the history, architecture, archeology, engineering, and culture of New York and the nation. In New York City, a landmark is a building, property, or object that has been designated by the Landmarks Preservation Commission because it has a special character or special historical or aesthetic interest or value as part of the development, heritage, or cultural characteristics of the city, state, or nation.

In an effort to uphold the historic culture of New York City, codes and regulations manage and track environmental and cultural preservation, as well as the quality, performance, maintenance and safety of construction measures. City, state, and federal programs and agencies listed here are both regulators and resources for your renovation project.

PRESERVATION AGENCIES

National Park Service (NPS)

The federal government lists historic districts and landmarks on the National Register of Historic Places through the U.S. Department of Interior, under the auspices of the National Park Service. The NPS oversees the National Historic Landmarks program, as well as the National Register of Historic Places, established by the National Historic Preservation Act of 1966. The National Register is an official list of buildings, structures, districts, objects, and sites significant in the history and culture of the nation. Generally, properties eligible for listing in the National Register are at least 50 years old. For more information and a searchable database of National Register properties, visit the NPS web site (www.cr.nps.gov/nr/about.htm).

New York State Office of Parks, Recreation & Historic Preservation (SHPO)

In New York, the Commissioner of the New York State Office of Parks, Recreation and Historic Preservation, who is also the State Historic Preservation Officer (SHPO), administers the National Register program. In addition, the New York State Historic Preservation Act of 1980 established the New York State Register of Historic Places, because there are properties important to New York State that may not be eligible for the National Register but are still worthy of recognition and preservation.

There are no restrictions placed on private owners of federal or state registered properties. Private property owners may sell, alter or dispose of their property as they wish. However, listed properties receive some protections from the effects of federal and/or state agency-sponsored, licensed or assisted projects through a notice, review, and consultation process.

One of the key benefits of owning a registered or eligible property is access to Federal and State Historic Preservation Tax Incentives, including the New York State Rehabilitation Tax Credit for Homeowners. These incentives will be more

fully discussed in the Incentives & Programs chapter. The best way to determine if your property is listed or eligible for the State or National Register is to contact the Survey & Evaluation Unit staff member assigned to your county (www.nysparks .com/shpo/contact/). For additional information, visit the NY SHPO web site (www.nysparks.com/shpo/national-register/).

New York City Landmarks Preservation Commission (LPC)

The Landmarks Preservation Commission is the New York City agency that is responsible for identifying, designating, and regulating the City's landmarks and the buildings in the City's historic districts.

The LPC helps preserve these buildings and sites by regulating alterations to their significant features. The LPC's mission is not to prevent owners from making changes to their designated buildings. Instead, the LPC works with owners to make certain that alterations are appropriate and do not detract from the special character of the city's landmarks and historic districts.

The LPC must approve in advance any restoration, alteration, reconstruction, demolition, or new construction affecting any designated property, including buildings in historic districts. LPC approval is required for any project that will affect the exterior appearance of a designated building, even if a Department of Buildings (DOB) permit is not needed for the proposed work. If your proposed project does require a permit from the DOB, LPC approval is also needed before beginning work on your building's exterior.

LPC approval is required for changes to the interior of the building only when a permit from the Department of Buildings is required for the work, or when changes to the interior will affect the exterior of the building. Many of the opportunities presented in this manual do not affect the exterior and are therefore not subject to substantive review by LPC.

You do not need a permit from the Landmarks Commission to perform ordinary repairs or maintenance chores, and many of the suggestions presented in this manual are not subject to substantive review by LPC. Examples of types of work that do or do not require an LPC permit are included in each section. The Commission's Preservation Department staff can tell you whether a permit is needed for work you are considering. There are two avenues for LPC review, the most common being a Staff Level approval, and the other, a presentation to a full Commission at a public hearing. For more detailed information, refer to the LPC web site (www.nyc.gov/landmarks), or contact the LPC Public Information Officer for questions pertaining to the LPC application requirements and review process.

To determine if your property is a City landmark or a building in a City historic district, you can search the LPC's Historic District Maps using the LPC web site (www.nyc.gov/landmarks); or search by address using New York City's online map portal, NYCityMap (gis.nyc.gov/doitt/nycitymap//), or the New York City Buildings Department Buildings Information System (BIS) accessed through the New York City DOB web site (www.nyc.gov/buildings).

OTHER AGENCIES

New York City Department of Buildings (DOB)

The mission of the New York City Department of Buildings is to ensure the safe and lawful use of buildings and properties by enforcing the Construction Codes and the Zoning Resolution. The New York City Construction Codes include the Building Code, Plumbing Code, Fuel Gas Code, Mechanical Code, and Energy Conservation Code. Most construction in New York City requires a permit, although ordinary repairs, maintenance, and cosmetic work, such as interior painting or plaster, do not require a permit.

The DOB divides construction work into two main categories: New Buildings and Alterations. Although different types of work can be done under one application, more than one permit may be required. For example, different permits are required for plumbing and construction work, and electrical work must receive a separate permit directly from the DOB Bureau of Electrical Control. DOB Rule 101-14 establishes categories of work that may be classified as a minor alteration or ordinary repair and therefore may be exempt from the permit requirements of the New York City construction codes. Rule 101-14 can be downloaded from the City's web site (www.nyc.gov/html/dob/downloads/rules/1_RCNY_101-14.pdf).

The DOB also enforces the New York City Energy Conservation Code (NYCECC), which sets energy-efficiency standards for new construction and alterations to existing buildings in New York City. Until 2011, renovations were typically exempt from meeting the energy code, but that changed with the passage of Local Law 85-2010. All building renovations must meet the energy code regardless of scale. Historic buildings listed on the NY State Register of Historic Places or the National Register of Historic Places, either individually or as a contributing building in a historic district, and buildings that have been determined to be eligible for listing on the state or national registers, are exempt from compliance with the energy code. City designated buildings that are not also listed or eligible for listing on the state or national registers, must comply with the energy code. If an owner or applicant provides documentation to the LPC determining that a property has been listed or is eligible for listing on the state or national registers, the LPC will affirm the eligibility of the property as exempt from complying with the energy code in formal correspondence to the DOB.

Exemptions exist for certain types of work, and City and State codes and guidelines are often updated. Refer to the most recent editions before beginning a project. The Greening New York City's Historic Buildings manual provides additional DOB regulation information within each section of the manual. For more information about the DOB application and permit process, or the NYCECC, visit the DOB web site (www.nyc.gov/buildings).

New York City Department of City Planning (DCP)

The Department of City Planning promotes strategic growth, transit-oriented development, and sustainable communities in the City. It supports the City Planning Commission, which reviews more than 500 land use applications for actions such as zoning changes and special permits each year. For policy analysis and technical assistance relating to housing, transportation, community facilities, demography, waterfront, and public space, visit the DCP web site (www.nyc.gov/planning).

In early 2012, the DCP passed the Zone Green Amendment, which was designed to remove zoning impediments to the construction and retrofitting of green buildings, including exterior wall insulation, greenhouses, wind energy, sun control devices, solar energy, and other rooftop equipment. This amendment gives owners more choices for the investments they can make to save energy, save money, and improve environmental performance. Note that the provisions of this amendment do not override LPC review or regulations. For more information on Zone Green Amendment, visit the DCP web site (www.nyc.gov/planning).

Energy Conservation Construction Code of New York State (ECCCNYS)

The Energy Conservation Construction Code of New York State addresses the design and construction of energy-efficient building envelopes and the installation of energy-efficient mechanical, lighting and power systems. The emphasis of the code is on energy performance and establishes minimum requirements for buildings using prescriptive and performance-related measures. It makes possible the use of new materials and innovative techniques that conserve energy. The ECCCNYS is available for purchase from the International Code Council web site (www.iccsafe.org) or by telephone at (800) 786-4452.

A

APPENDIX B: GLOSSARY

Awning: A projecting shading device, usually of made of canvas, mounted on the outside of a door or window.

Ballast: A device (such as a fluorescent lamp) used to provide starting voltage or to stabilize the current in a circuit.

Batt: Pre-cut panels of insulation available in a variety of lengths, widths and R-values. Batt insulation is made to fit within most regular wall framing, which are usually spaced 12", 16", or 24" on center, and for either 8-ft. or 9-ft. high walls. Batt insulation is available with and without facing.

Biodiversity: The existence of a wide range of different types of organisms in a given place at a given time.

Building science: The study of the interaction between occupants, building components, systems, and the surrounding environment.

Casement: A window sash that is hinged on the side.

Cistern: An artificial reservoir (underground tank) for storing liquids, such as rainwater.

Clapboard: Wood siding composed of horizontal, overlapping boards, the lower edges of which are usually thicker than the upper.

Clerestory window: 1. The upper part of the nave, transepts, and choir of a church, containing windows.

2. An upper portion of a wall containing windows for supplying natural light to a building.

Condenser: Apparatus used to condense vapor into liquid,

Door saddle: Secured to the door sill (door sill: creates the base of the frame of a doorway, a sturdy foundation that redirects water.) The door saddle is secured to the sill to help in closing the air gap below the door. It can be used on an exterior door or an interior one.

Dormer: A vertical structure, usually housing a window, which projects from a sloping roof and is covered by a separate roof structure.

Double-hung: A type of window with two sashes, each sliding on a vertical track.

Eave: The overhanging edge of a roof.

Embodied energy: Energy used to produce a specific good or service including the energy used for extraction, manufacture, transportation of materials to site, and construction of a finished building.

Faced batts: Used in exterior walls as well as attics, finished basements, ceilings, floors, knee walls and cathedral ceilings. The facing material usually serves as a vapor retarder and makes handling and attachment easier to install.

Fascia: A horizontal, flat element often combined with a cornice and architrave.

Flashing: Strips of sheet metal bent to fit the angle between any two roof surfaces or between the roof and any projection, such as a chimney.

Gable: The upper portion of an end wall formed by the slope of a roof.

Graywater: Any household wastewater with the exception of wastewater from toilets, which is known as blackwater.

High-albedo: Very reflective roof coatings that lower the absorption of solar energy and can reduce building air-conditioning energy use.

Insulated glazing unit: Multi layered, hermetically sealed glass panes that have very dry air or inert gas between the glass panes.

Lath: A thin narrow strip of wood nailed to rafters, joists, or studding as groundwork for slates, tiles, or plaster.

Luminaires: A complete lighting unit consisting of one or more lamps, together with components of a tungsten or fluorescent light fitting.

Meeting rail: A sash rail in a double-hung window designed to interlock with an adjacent sash rail.

Multi-wythe: A multiple-wythe masonry wall may be composed of a single type of masonry unit layered to increase its thickness and structural strength, or different masonry units chosen by function, such as an economical

concrete block serving a structural purpose and a more expensive brick chosen for its appearance.

Muntin: A thin framing member that separates the panes of a window sash or glazed doors.

Rim joist: A sill (sills: the horizontal timbers of a building) which rests on the foundation, meeting the ends of the joists--(joist: is one of the set of parallel timbers beneath the floor boards that run from one side of a building to the other).

R-value: A measure of thermal resistance used in the building and construction industry.

Sash: The secondary part of a window which holds the glazing in place; may be operable or fixed; usually constructed of horizontal and vertical members; sash may be subdivided with muntins.

Sill: The horizontal member at the bottom of a window.

Sill plate: A heavy horizontal timber at the bottom of the frame of a wood structure; the timber rests directly on a foundation.

Soffit vents: 1. The exposed underside of any architectural element, especially a roof.

2. The underside of a structural component such as a beam, arch, or recessed area.

Thermal-break frames: Designed to deal with thermal bridging, which is when heat leaks through a conductive path such as metal framing. Thermal bridging can reduce thermal resistance of the wall and can cause moisture problems for the frame and internal linings. A thermal break addresses the issue of thermal bridging.

Thermostatic control: A device sue for items such as a home heating system, a refrigerator, or an air conditioner, that automatically responds to temperature changes and activates switches to control the equipment.

Threshold: The plank, stone, or piece of timber that lies under a door.

Transom: 1. A horizontal bar of wood or stone across a window.

2. The cross-bar separating a door from the window, panel, or fanlight above it. 3. the window above the transom bar of a door. 4. the glazed area above a display window or door separated from the main window area or door by a transom bar.

Unfaced batts: Pre-cut panels of insulation available in a variety of lengths, widths and R-values that does not include facing. Batt insulation is made to fit within most regular wall framing, which are usually spaced 12", 16", or 24" on center, and for either 8-ft. or 9-ft. high walls.

Vampire loads: Occur when appliances such as the TV, coffee maker and stereo draw power even when off, in standby or low power mode.

Vapor barrier: A thin layer of special plastic or composite material that prevents moisture from getting trapped inside the wall where it can cause mold growth.

Wythe: A continuous vertical section of masonry one unit in thickness. A wythe may be independent of, or interlocked with, the adjoining wythe(s). A single wythe of brick that is not structural in nature is referred to as a veneer.

APPENDIX C: CASE STUDY ON 263, 265 & 267 HENRY STREET

BUILDING OVERVIEW

Address: 263, 265 & 267 Henry Street, Manhattan, NY

Building Type: Today these three adjacent Federal style rowhouses function together as a single building. They are the office headquarters of the Henry Street Settlement, one of the nation's first settlement houses. The buildings range from four to five stories and their total floor area is 21,300 square feet. The walls are of brick construction, the roof is asphalt and the windows are single- and double-glazed.

Building History: The three buildings were originally constructed around 1830 as two-story single family residences. In the 1880s, two upper stories were added to 263 Henry Street and an additional story was added to both 265 and 267 Henry Street around the same time. After the Settlement acquired the buildings, party walls were broken down to create interior connections between all three buildings.

Historic Designations: New York City Individual landmark, State and National Historic landmark

Project Lead Architect/Consultant: Michael Kriegh, Studio MBK

Additional Architectural Assistance: Li/Saltzman Architects, P.C. is an architectural firm specializing in preservation and restoration, with a particular emphasis on historic properties in New York City.

Thornton Tomasetti is a leader in engineering design, investigation and analysis with practices in building structure, building skin, building performance, construction support services, and property loss consulting. Thornton Tomasetti addresses the full life cycle of a structure. A team of architects from Thornton Tomasetti assisted on the project team.

Consulting Engineers: Philip C. Steiner, P.E., Principal AltieriSeborWieber LLC Consulting Engineers; Jonathan Flowthow, Principal, The Steam Balancing Company

PROJECT INTENT & GOALS

The Municipal Art Society of New York has been working with the Lower East Side's Henry Street Settlement to retrofit their c. 1830s headquarter buildings, which are recognized as both local and national landmarks. The Henry Street Demonstration Project was begun as part of the MAS's Preservation and Climate Change Campaign in order to show that New York City's historic buildings can increase energy efficiency without tremendous expense. The project's goal is to show policymakers and the general public how to make energy efficiency gains and lower operating costs without compromising architectural character or impacting the building's durability. This project is supported by the J.M. Kaplan Fund, the New York Community Trust, the National Trust for Historic Preservation's Elizabeth and Robert Jeffe Preservation fund for New York City, and the National Endowment for the Arts.

BUILDING OVERVIEW SUMMARY

Address	263, 265 & 267 Henry Street, Manhattan, NY
Building Type	Federal-style Rowhouse
History	Built: circa 1830; Additional floors added: Late 19th Century
LPC District	New York City Individual landmark; State and National Historic landmark
Architect Team	Studio MBK; Li/Saltzman Architects, P.C.; Thornton Tomasetti
Engineer Team	AltieriSeborWeiber LLC Consulting Engineers; The Steam Balancing Company

Facades of 263, 265 & 267 Henry Street. The project team's holistic approach to achieving sustainable operations focused on resource use reductions in the building design, as well as building operations and user behavior.

Photo © Giles Ashford

IMPLEMENTATION METHODOLOGY

Energy audits

The energy retrofit process began with three energy audits, in order to be as thorough as possible. As a small business, the Settlement qualified for Con Edison's Small Business Direct Installation Program. Con Edison sent energy experts Comverge, Inc. to survey the buildings' existing lighting, ballasts and fixtures. The auditors evaluated the type and watts of existing fixtures and lamps; estimated kW usage of existing equipment; proposed retrofit fixtures and lamps for 80 separate locations throughout the buildings; and estimated the post retrofit kW reduction.

The second audit was conducted by the EME Consulting Engineering Group, LLC as part of the New York State Energy Research and Development Authority's (NYSERDA) Energy Audit Program. The auditors performed field surveys, had discussions with facility personnel, and reviewed historic energy usage to understand the building systems and staff use patterns. The result was an assessment of one year's energy use and costs; a survey of existing lighting conditions; and a description of HVAC, hot water, and other equipment. The NYSERDA audit offered general recommendations on lighting, boilers and information on competitive energy markets (ESCOs). The auditors also identified NYSERDA's Existing Facilities Program as a possibility for the Henry Street Settlement. This program offers strategies to obtain financial incentives for energy efficiency projects. Tier I offers eligible customers financial incentives for the purchase and installation of pre-qualified energy efficiency measures. Tier II offers eligible customers financial incentives for performance-based energy efficiency improvements based upon a technical engineering analysis.

The third and final audit was conducted by Andrew Rudin, an independent auditor with expertise in historic community facilities. Mr. Rudin's audit included a description of existing conditions, the physical characteristics of the buildings, facility usage, heating and cooling systems, lighting, and metering. He evaluated the Settlement's energy performance by installing temperature recorders, measuring temperature fluctuations for a one–week period in 10 locations throughout the facility. Rudin also conducted a lighting survey to determine locations where fluorescent tubes and ballasts should be replaced. This final audit included an assessment of the pros and cons of implementing certain upgrades.

Overall the auditors found that the Settlement exhibited problems common to many building types, such as overheating during the winter and inefficient lighting. All three audits suggested monitoring energy usage and cost; replacing inefficient lighting; purchasing efficient replacements when things break; and sealing gaps around windows, doors and air conditioners to reduce air infiltration. All the audits estimated "payback"—the length of time it would take for investments to pay for themselves in saved energy costs.

Eco-charrette

After the audits were conducted, MAS, with the help of architect Michael Kriegh held a day-long eco-charrette—a collaborative design and solutions-seeking process—at the Henry Street Settlement. An interdisciplinary group of experts volunteered to investigate the building's inefficiency issues and discuss ways to make the buildings more sustainable. The goal was to identify specific efficiency measures and to develop a phased plan for implementation to help the Settlement save both energy and money, and provide a more comfortable working environment. Mr. Kriegh is now working with Settlement staff and some of the charrette participants to implement the short-term energy efficiency measures identified at the eco-charrette.

SPECIFIC SUSTAINABILITY MEASURES

Lighting/electricity

After Con Edison contractors completed their audit at the Settlement, they installed replacements throughout the building free of charge, with the exception of the basement (this was paid for by the Settlement). Some of the upgrades included simple bulb replacement, such as replacing incandescent lamps with screw-in Compact Fluorescent Lighting (CFLs). Other upgrades included replacing fixtures, such as the incandescent EXIT signs with more efficiently hardwired LED EXIT signs, and retrofitting existing T12 lamp fixtures and electromagnetic ballasts with more high performance T8 lamps and ballasts. Altogether, the Con Edison contractors estimated that the Settlement would save approximately 60% in energy use and in turn would reduce their CO2 production by over 53,000 pounds.

Other lighting efficiency recommendations included installing indoor occupancy sensors to ensure lights are not left on unnecessarily. Participants at the eco-charrette also suggested that outdoor security lighting would benefit from energy-efficient bulbs, motion control sensors, and having fixtures closer to the ground in order to reduce the required wattage.

User behavior

There are approximately 48 employees working in the Henry Street Headquarter buildings each weekday. Their behavior has a huge impact on the amount of energy used. After a walk-through of the buildings, eco-charrette participants identified a number of ways that the Settlement could cut back on energy use simply by unplugging redundant copy machines, computers, and other appliances to avoid draining electricity when they are on standby. However, changing ingrained behavior can be difficult. A conscious effort must be made both individually and collectively to change behavior.

Some suggestions to help Henry Street employees use less energy included:

- Hold a staff charrette to solicit ideas and generate interest.
- Conduct ongoing staff education on building usage.
- Establish a dialogue among facilities staff and office staff.
- Demonstrate rapid, positive change by addressing basic measures.
- Send institutional signals (Create a HSSH specific Green Manual, signage, waste reduction guidelines).
- Turn off nonessential energy-guzzling appliances, such as rarely used refrigerators.

Heating & Cooling Systems

The NYSERDA and Rudin energy audits both suggested boiler replacement. Boiler performance is based on its Annual Fuel Utilization Efficiency (AFUE). The minimum efficiency standard for hot water boilers, as established by the U.S. Department of Energy, is 80% AFUE. The Settlement has two oil-fired boilers—one hot water and the other steam. The boilers were each found to have an efficiency rate of about 75% and, at almost 20 years old are nearing the end of their expected lives. Maintaining a boiler is a standard maintenance requirement, but it is more cost effective to replace rather than repair when it is past its useful life.

NYSERDA recommended replacing the current oil-fired boilers with gas-fired, high-efficiency condensing boilers, which can achieve seasonal efficiencies as high as 96%. New boilers are physically smaller, better insulated, use less fuel and emit fewer pollutants into the air, making them both more efficient and better for the environment.

Until the boilers at the Settlement's headquarters can be replaced with more efficient boilers, it was recommended that they be tuned and that the water temperature be reduced from 140 to 110 degrees. It was also suggested to install thermostatic radiator valves (TRVs) on existing radiators to allow individual temperature control in each room. NYSERDA also recommended insulating the steam and hot water pipes in accordance with the NYS Energy Conservation Construction Code, which will prevent heat loss and make the overall system more efficient. The Settlement is now working on acquiring a full-fledged mechanical report in order to better understand the pros, cons, and feasibility of switching to another system.

Windows

An assessment of the Henry Street windows was completed by experts from engineering firm Thornton Tomasetti. Their assessment found that some of the Settlement's historic, single-pane windows could be made more efficient. The assessment also found that some of the original windows across the rear façade had been replaced, and, in fact, these replacement windows were leaking air that caused drafts.

A detailed window analysis determined that the best way to help improve the historic window's thermal efficiency was to install interior storm windows. Interior storm windows provide a layer of insulation without interfering with the historic character of the original windows. Thornton Tomasetti studied the windows thermo-graphically with an infrared camera and analyzed the results using softwares called THERM and WINDOW, which model two-dimensional heat-transfer effects in building components to predict storm window performance.

Two of the original windows at the front of the building will be fitted with custom-made advanced energy interior storm windows. Window tests will be repeated to determine the efficiency of the new storm windows and ensure that they are an effective solution.

Water

Participants of the eco-charrette discussed several ways the Henry Street Settlement could conserve water. Short-term suggestions included installing low-flow aerators on faucets to reduce the amount of water released. Aerators are inexpensive and can cut water usage by up to 50%. Suggestions also included conducting a late-night leak investigation to find any major sources of leaks. Some medium and long-term suggestions included installing dual-flush mechanisms on existing toilets and replacing restroom faucets with sensor activated faucets on an ongoing basis. Implementing a graywater recycling system was also suggested as a way to further reduce water consumption.

FINANCIAL & ENERGY PERFORMANCE ASSESSMENTS

After the completion of the lighting retrofit and bulb replacement, Mr. Kriegh analyzed the impact of the lighting changes and found that there was a 7–10% drop in the number of kWh used after the lighting changes were made by the Con Edison contractor, estimating the energy savings at about 10,000 kWh per year.

MAS will continue to implement the short-term measures identified at the 2011 eco-charrette. As more energy efficiency improvement measures are implemented at the Henry Street Settlement, MAS will continue to evaluate and report on the results.

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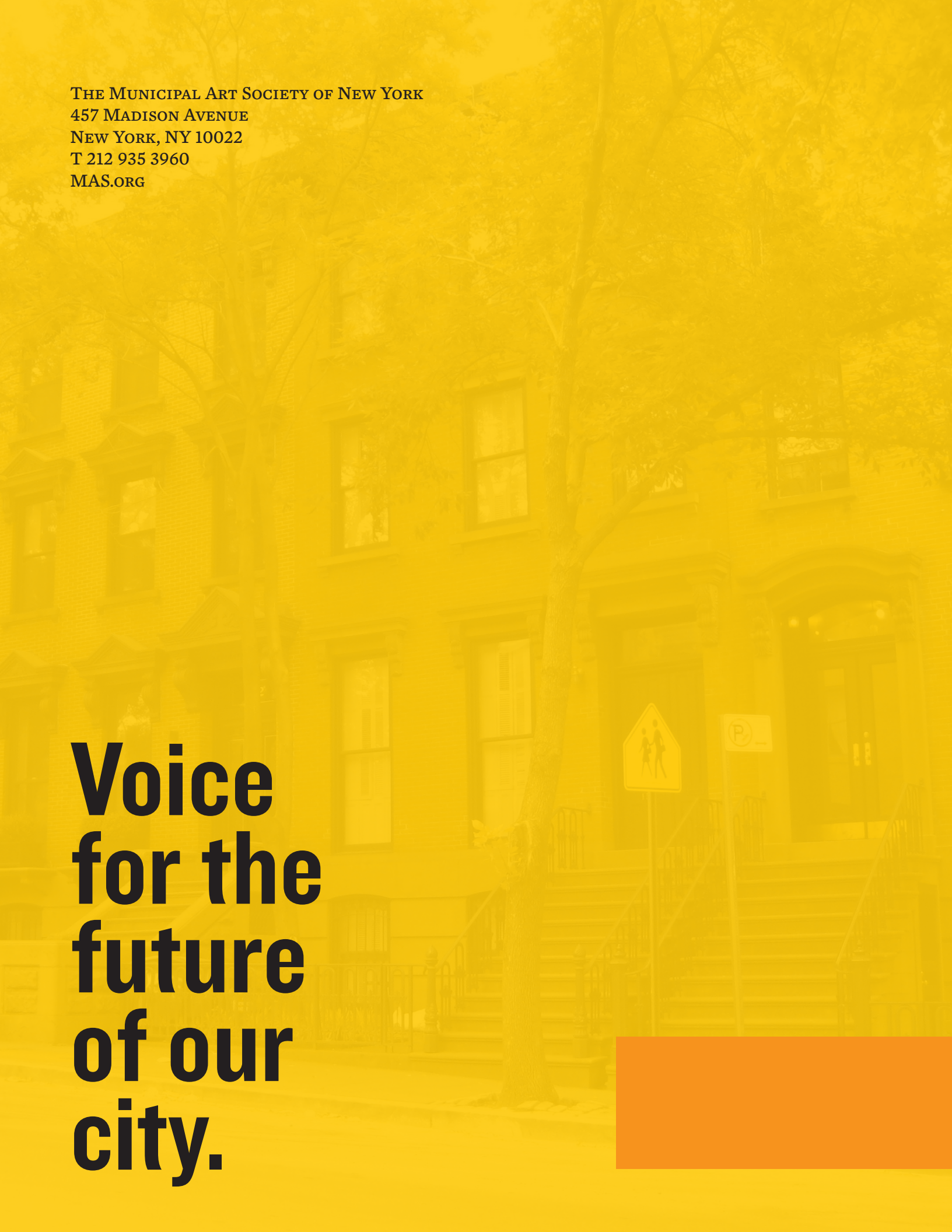

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