INTEGRATION OF HISTORIC PRESERVATION AND SUSTAINABILITY PRINCIPLES FOR LOCAL HISTORIC PRESERVATION COMMISSIONS

by

KIMBERLY L. KOOLES

(Under the Direction of John Waters)

ABSTRACT

This thesis will serve to aide historic preservation commissions through the process of integrating sustainability into local historic preservation practices. Included will be models of energy efficiency updates, green modifications, and reasons for conserving the built and natural environment.

INDEX WORDS: Historic Preservation, Historic Preservation Commissions, Design Guidelines, Sustainability, Solar Panels, Wind Turbines, Embodied Energy, Historic Districts

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KIMBERLY L. KOOLES

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KIMBERLY L. KOOLES

Major Professor: John Waters

Committee: James Reap
Alfred Vick
Jennifer Martin Lewis

Electronic Version Approved:

Maureen Grasso
Dean of the Graduate School
The University of Georgia
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DEDICATION

To the greatest blessing life has given me personally, my parents. Thank You.

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INTRODUCTION

Goals of Study

The education of historic preservation commission members and staff on contemporary preservation issues is a necessity. It is essential that these local preservationists are knowledgeable not only in design, architecture, commission decorum, and preservation principles; they must also be constantly moving past basic understanding and be proactive toward future developments. A prominent example of such developments is the introduction of green building ideologies in regard to historic properties and districts. Cases of such incorporation are found in Boulder, Colorado; Davidson, North Carolina; and Chicago, Illinois. This thesis will serve to aide historic preservation commissions through the process of integrating sustainability into local historic preservation practices.

Are historic preservation commissioners receiving the training required to review applications regarding sustainability? With none of the nationwide historic preservation organizations offering workshops on sustainability, there is a lack of training available for local commissioners regarding green building and sustainable modifications. Historic preservation is inherently a green practice, but with the current environmental concerns and rising fuel prices many homeowners are going to be looking for solutions which increase the energy efficiency of their historic homes. Answers are found in the form of retrofits such as caulking and weather-stripping or in alternative energy generation through solar panels and wind turbines

. Commissioners and staff need to be prepared across the board on solutions for energy efficiency, sustainability issues, and integrated technology.

Local historic preservation commissions need to educate themselves and their communities on the potential methods available for ‘green preservation’. Therefore the second question to address is: How can local historic preservation commissions educate themselves and their communities on the proper integration of sustainability and historic preservation? Preservation commissions can integrate sustainability ideology into many aspects of their historic preservation practices. Training programs for commissioners and staff must be implemented in order to ensure a proper working knowledge of sustainability practices and their integration into local historic preservation plans. Amendments to local design guidelines, additions to historic preservation ordinances, and new public education and outreach programs are all matters in which commission members and staff can facilitate ‘greening’ local historic preservation.

The primary methodology utilized in this thesis included research into developing green technologies; local preservation commissions integrating sustainable building terminology; the history of local preservation commissions; and, the development of the green building movement. Communities from all parts of the United States were included in the research in order to provide a diverse geographical representation. Organizations such as the National Trust for Historic Preservation, the American Institute of Architects, the Association for Preservation Technology, the United States Green Building Council, and the National Alliance of Preservation Commissions all served as valuable clearinghouses for this research.

CHAPTER 2

HISTORIC PRESERVATION COMMISSION'S ROLE

Preservation of our historic resources begins at the local level. There is a common misconception that a historic resource being listed on the National Register of Historic Places guarantees its protection from demolition or severe alteration. The fact is that a listing on the National Register holds little weight in matters that can destroy an iconic image within a community. It is local designation, as a landmark or a portion of a larger district, which insures that resources remain as elements of the cultural heritage of a community. Historic preservation commissions are integrated within the local government system, and therefore are able to influence the protection of properties of value to their community.

> Local government is still the level of government that is closest to the people and delivers the public services that are a part of people's everyday lives. Local governments are close to home. Except in the largest communities, their leaders are friends and neighbors who hold elective office on a part-time, temporary basis, serving out of a sense of civic obligation rather than career ambition….They are responsive to citizen action and opinion, and most citizens deal directly and personally with their local officials without the intervention of lobbyists or interest groups.[1]

Since the origination of historic preservation commissions in the 1930s and 1940s, volunteers and staff have been battling an assortment of threats, such as unmanaged development, neglect, and inappropriate additions in order to secure the character of historic communities for future generations. Today, one of the most effective tools in a local preservation commission's arsenal is a local preservation ordinance. It is this ordinance which places the responsibility of integrating sustainability into local historic preservation programs at the feet of

[1] Banotvetz, James M. *Managing Local Governments: Cases in Decision Making.* Washington D.C.: International City Management Association, 1990 p.10.

the preservation commission. A preservation ordinance serves as the framework for a local preservation program by formalizing a community's commitment to the preservation of their cultural and built heritage, establishing the powers and duties of the historic preservation commission, officially recognizing historical significant built and cultural resources through designation, developing a preservation plan, establishing review for additions and changes to resources and aiding in the protection of properties from demolition. Commissions have also seen repeated success with other tools including design guidelines, landmark designation, comprehensive plans, and financial incentives for proper maintenance and rehabilitation of historic resources.

The evolution of the historic preservation movement into the present state can be separated into phases depicting the primary stimulus for preserving the built and cultural environment. The earliest organized preservation efforts worked to save properties of singular significance, often the result of a noteworthy specific owner, visitor, or event. Progression in the movement saw a shift toward preservation in order maintain a sense of place during the time of urban renewal, followed by economic motivations, i.e. tax incentives, for historic preservation beginning in the 1980's. The benefits of historic preservation for contemporary society continues to build on the previous periods, however there is a need to transition towards publicizing the environmental incentives available through and within historic preservation principles.

Sustainability as a Necessity

Increased pressure for communities to be environmentally responsible has led to terminology (Appendix A) such as "green" or "sustainable" becoming increasingly prevalent in municipal dialogues (Appendix G) and policies (Appendix E). The fundamental philosophy of today's sustainability movement is to reuse rather than discard, to purchase material locally, and to design buildings which achieve their maximum performance with little damage to the environment. These ideals are intrinsic characteristics found when preserving historic resources. Similarly, preservationists teach to preserve first and to repair rather than replace, and then as replacement is warranted to utilize traditional historic building techniques and locally available materials. Historic resources illustrate an understanding of design based upon regional climate characteristics, and therefore were able to maximize the comfort of inhabitants prior to conditioned interiors. There is a natural alliance between the ideals of sustainability and historic preservation, of which professionals on both sides of the line are only beginning to recognize and broaden.

Motives to preserve local cultural resources can differ from town to town, but working to fit into the community's long term vision is a common goal. Economic development, environmental responsibility and visual reference to the evolution of an area all provide strong arguments favoring historic preservation that can be referenced by local preservation commission members when called upon to legitimize the practice of preservation. To fully understand the environmental benefits of historic preservation, green building and sustainble design need to be better understood by local preservation commission members. Commissioners and staff have to begin looking at sustainability as a necessity rather than as a luxury.

Historic preservation programs need to participate in the green movement as it is now a mainstream component of development, construction, and design. Historic preservation commission members and staff may be aware of the energetic promotion of "green" through the media, but many are not aware of the necessity to educate themselves on sustainability and its translation into "green preservation". Community members are going to expect preservation commissions to be up to date on topics of energy efficiency, sustainable building, and "green" modifications, and preservation proponents need to be able to articulate how and when modern improvements are appropriate for historic structures.

The Green Museum, by Sarah Brophy and Elizabeth Wylie discusses the need for our cultural sites, epicenters and resources to embrace sustainability measures. Brophy is a LEED-AP and an independent consultant, helping museums and other cultural institutions become environmentally and financially sustainable.[2] Elizabeth Wylie has spent 20 years in the museum field as a curator and director and now directs business development activities for Finegold Alexander + Associates, a planning and architecture firm specializing in sustainable design.[3]

> Green makes sense and it is getting easier. Any second now your audience is going to demand it of you. You should start right now if you have any chance of beating the curve. You may feel that green is a fad and you don't want to chase a fad. Well, green is becoming mainstream because of its importance, not its fashion. With a little help from early adopters, packagers, and promoters, green value is moving the market. Our culture is changing and it is shaping our economy. The shortcut economy, the economy of excess and convenience, is giving way to a more sustainable economy. Don't we want to show our supporters and guests, who recognize this change, that we follow building and operational practices that contribute to preservation while also offering fascinating educational opportunities and saving money. Of course. Many institutions in the preservation business are making clear the dollar and environmental cost of collections care…[4]

Sustainability means to meet the needs of the present without compromising the ability of future generations to meet their own needs. This basic definition has been a catalyst for a new school of architectural theory of sustainable development, also known as green building. The intense growth of this new architectural theory can largely be accredited to the United States

[2] Brophy, Sarah S. and Elizabeth Wylie. *The Green Museum.* Lanahm: AltaMira Press, 2008 p. 1
[3] Brophy, p.1
[4] Brophy, p.2

Green Building Council and their Leadership in Energy and Environmental Design (LEED) rating system, which will be discussed further in later chapters.

Sustainable development is an overarching set of principles tying in energy, urban management, ecosystem conservation, economic development, policy integration and ideas for solutions which can be achieved through interdisciplinary cooperation.[5] This melting pot of professions and policies began with many issues and concerns including, but not limited to, economics, resource allocation, social issues, environmental degradation, and population growth.[6]

Sustainability deals with the environmental impacts of population growth, development and energy usage. Growth in our global population puts a continued strain on our natural resources and the abilities of our urban areas to meet our modern needs. Urban development reduces the environmental quality of our landscape and increases pollution as our services, homes, and jobs are continuously spread out. Energy usage has risen at alarming rates, dwarfing the percentages seen in population growth. Continued inappropriate management of our conventional fuels, and delays in implementation of alternative energy sources will only compound our sustainability tribulations. Historic preservation commissions should be aware of these stresses as they relate to the built environment. Enlarged populations can possibly lead to decrease in vacant historic building within a community, while also raising the threat of demolition to make way for multifamily housing. Increased urban density can strain historic districts and property owners will eventually look for means to alleviate financial pressures of rising fuel costs.

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[5] Brophy 2008, p.3

[6] Roosa, Stephen. *A Sustainable Development Handbook.* Boca Raton: CRC Press, 2008 p.3

To bring the true scope of the sustainability movement into terms that may relate to a historic preservationist, last year the United States Green Building Council (USGBC) saw nearly a twenty-five percent increase in their member organizations from 11,187 in 2007 to 15,000 member organizations in 2008 representing over one million employees.[7] Conversely, the National Trust for Historic Preservation (NTHP) had 270,000 members in 2007 and experienced a decline in membership contributions from 2003 to 2006; 2007 numbers show that contributions rose slightly but did not reach those found pre-2003.[8] The rapid rate of growth enjoyed by the USGBC is just one statistic that denotes the escalation in interest and support for sustainable ideology and green building. The historic preservation field will need to insure that they are ahead of the learning curve regarding sustainability. Professional and non-profit preservation organizations, such as the National Alliance of Preservation Commissions, the National Council of State Historic Preservation Officers, Preservation Action and the National Trust for Historic Preservation, have initiated individual sustainability research and development programs within the last five years and joint initiatives as recent as October 2008.

There is no mistaking it – we live in a time of complexity and challenge. The decisions made today will profoundly shape the course of events for the whole population. The importance of preserving our environment, built and natural, for future generations cannot be understated. Historic preservation commissions will need to acknowledge their responsibility and act as local role models for the integration of sustainability into common historic preservation practices.

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[7] Vick, Alfred. *Green Building Intro and Background.* Available from https://webct.uga.edu/SCRIPT/land4730av/scripts/serve_home. Accessed on 9 February 2009.
[8] National Trust for Historic Preservation. *Annual Reports 2003-2007.* Available from http://www.preservationnation.org/about-us/annual-report-and-tax-returns/. Accessed on 12 February 2009.

Responsibilities

The responsibilities and powers of the local preservation commission are stated in the local preservation ordinance. A commission has only the powers specified there to base their decisions and regulations upon. A local governing body need only amend the preservation ordinance to further expand or confine the abilities of a commission.

Powers and responsibilities invested in local historic preservation commissions typically include surveying local historic resources, recommending local designations, review of application for alteration or new construction, stay of demolition, sale of air rights, and the participation in land use, urban renewal, and planning processes by the local governing body. [9]

Of these responsibilities, there are two that stand out in regards to the integration of sustainability and local historic preservation practices. Approving or disapproving applications regarding alterations to local historic landmarks or within local historic districts is a key duty of the preservation commission. This gives the local preservation commission the authority to review applications for solar panels, wind turbines, green roofs, geothermal installations, and rainwater harvesting systems within their jurisdiction. The other responsibility linking the preservation commission to the review of green modifications is their involvement in conduction of land use, urban renewal, and other planning processes by their local governing body. This ensures coordination between preservation goals and zoning, land use, growth management, and transportation and housing. Bringing together the historic preservation commission with other local review

[9] Preservation North Carolina and the State Historic Preservation Office of North Carolina. *Handbook for Historic Preservation Commissions in North Carolina.* Raleigh; North Carolina Department of Cultural Resources, 1994.

boards ensures consistency among municipal policies, including sustainability initiatives, which affect the community's historic resources.

Training

Design review is the most public action that a historic preservation commission takes, and it impacts an individual's home or business. Therefore residents, which are the majority of applicants, expect historic preservation commission members to be educated and up to date on all the inner workings and nuances of historic preservation. These community members need to feel confident with the level of expertise available from their commissioners. Local commission members are volunteers from a variety of professions and backgrounds. There typically is at least one lawyer, one architect, and one historian among the commission members who can each offer their particular expertise at meetings and hearings. This professional composition attempts to achieve a balanced body of members with varied and related experiences, but cannot ensure that any or all will have familiarity with advanced building technologies.

There is a need for commission members to take their responsibilities further than the meetings, and they should be expected to dedicate some outside time for review of upcoming agendas. This works best if every commissioner is given the proper training and tools for a successful tenure. Training for commissions should occur annually, and should be the first thing that freshman commissioners complete following their appointment. Commissioner training traditionally covers a basic history of the community, historic architecture, preservation techniques, preservation planning and a thorough break down of the purpose, powers, and responsibilities of the commission. Local preservation commission training programs are currently available on the state or national level.

Currently, there is not a set training program or formula which consistently incorporates sustainability with preservation principles; however most can be customized to fit the necessities of the community, allowing for occasional green training opportunities.

The sustainability philosophy is gaining momentum and historic preservation commissions will need to be educated about the fundamentals of this field similar to their training in architecture, preservation, and planning. Commission members and staff need to uphold the public's idea of a "panel of experts", and falling short on sustainability training will quickly negate this representation.

The following chapters will showcase basic areas of knowledge that preservation commissioners should have regarding energy efficiency, the United States Green Building Council and their LEED rating system, and energy generation modifications applicable to historic resources. This working knowledge will facilitate historic preservation commissions as they move toward the integration of sustainability into design guidelines, training programs, and preservation ordinances.

CHAPTER 3

UNITED STATES GREEN BUILDING COUNCIL AND THE LEED RATING SYSTEM

Over the years the preservation movement has worked with a wide variety of partners toward a common goal of cultural resource protection. These partnerships are essential, even if not obvious to the general public or historic preservation professionals. A new joint venture on the horizon that offers the preservation field an opportunity to reach a wider audience is with the United States Green Building Council (USGBC). Cooperative educational programs and research endeavors with the USGBC will facilitate innovative links between historic preservation and green building.

The USGBC is a non-profit organization formed in 1993 with a commitment to expand sustainable building practices and was the result of two key events of the early 1990s.[10] The first was the twentieth anniversary of Earth Day in the United States, followed by the U.N. Conference of Environment and Development, also known as the Earth Summit, in Brazil in 1992.[11] The United States Green Building Council grew from a base of 150 companies in 1998, to 7,500 companies in 2007, and now hosts over 15,000 membership organizations today.[12] The membership list reads very similar to that of an historic preservation non-profit: architects, designers, real estate agents, building owners general contractors, facility managers, government agencies and other non-profits are all listed among the active membership working to make the built environment more sustainable.

[10] United States Green Building Council. *LEED Rating System.* Available from http://www.usgbc.org. Accessed on 26 August 2008.
[11] Yudelson, Jerry. *The Green Building Revolution.* Washington: Island Press, 20008 p. 2
[12] Yudelson 2008, p.2

LEED

Preservationists may not be familiar with the United States Green Building Council, but are likely to recognize its flagship program: Leadership in Energy and Environmental Design (LEED). LEED works as a holistic approach to green building by being a "third party certification system and the nationally accepted bench mark for the design, construction, and operation of high performance green buildings".[13] Prior to the formation of LEED, most systems for evaluating a building's performance focused upon energy consumption alone, like that of the Environmental Protection Agency's Energy Star program. Programs such as this are beneficial forms of review, and help to build a platform of conscientious construction; however LEED was the first system to actually hold projects up for scrutiny from the first professional bids to the performance after completion. LEED reviews the entire construction process.

The LEED rating system has four levels of recognition - certified, silver, gold, and platinum - which focus on five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality. These key areas are examined throughout each of the LEED rating systems.

The individual LEED rating systems are:[14]

1. *New Construction (NC)*: designed to guide and distinguish high-performance commercial and institutional projects, including office buildings, high-rise residential buildings, government buildings, recreational facilities, manufacturing plants and laboratories. This is the rating system that is most commonly utilized and was the original system formulated by the USGBC in 2000.

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[13] United States Green Building Council 2008
[14] United States Green Building Council 2008

2. *Existing Buildings: Operation and Maintenance (EB):* helps building owners and operators measure operations, improvements and maintenance on a consistent scale, with the goal of maximizing operational efficiency while minimizing environmental impacts.
3. *Commercial Interiors (CI):* certifies high-performance green interiors that are healthy, productive places to work, are less costly to operate and maintain, and have a reduced environmental footprint.
4. *Core & Shell (CS):* covers base building elements such as structure, envelope and the HVAC system. LEED for Core & Shell is designed to be complementary to the LEED for Commercial Interiors rating system, as both rating systems establish green building criteria for developers, owners and tenants.
5. *Schools:* recognizes the unique nature of the design and construction of K-12 schools. Based on the LEED for New Construction rating system, it addresses issues such as classroom acoustics, master planning, mold prevention and environmental site assessment.
6. *Retail:* recognizes the unique nature of the retail environment and addresses the different types of spaces that retailers need for their distinctive product line.
7. *Healthcare:* was developed to meet the unique needs of the health care market, including inpatient care facilities, licensed outpatient care facilities, and licensed long term care facilities. LEED for Healthcare may also be used for medical offices, assisted living facilities and medical education & research centers. LEED for Healthcare addresses issues such as increased sensitivity to chemicals and pollutants, traveling distances from parking facilities, and access to natural spaces.

8. *Homes:* promotes the design and construction of high-performance green homes. A green home uses less energy, water and natural resources; creates less waste; and is healthier and more comfortable for the occupants.
9. *Neighborhood Development (ND):* integrates the principles of smart growth, urbanism and green building into the first national system for neighborhood design.

Although currently undergoing revisions, the individual systems each carry their own total points attainable, however the methodology for rewarding a projects achievement is the same. This means that a LEED certification for New Construction would be the same as a LEED certification in Core and Shell. The USGBC assures consistency through a percentage based evaluation system combined with prerequisites for each system. A certified project must score more than 40 percent of the basic, or core, points in the system; a silver level project must score over 50 percent of the core points; a gold level project must score over 60 percent of the core points; and a platinum level project must score 80 percent of the core points.[15]

This rating system has truly changed the market and how architects practice. As of May 1, 2008, more than 3.5 billion square feet of building projects (10,000+ individual projects) have registered intent to seek LEED certification, with more in development.[16] The majority of completed LEED projects have been in the LEED-NC, LEED-EB, LEED-CI, and LEED-CS categories.

Increase in the quantity of LEED registered projects such as this prompted the USGBC to create in-depth training programs for professionals working with LEED. Individuals must study,

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[15] Yudelson 2008, p.14
[16] Campagna, Barbara AIA, LEED AP. *How Changes to LEED Will Benefit Existing and Historic Buildings.* Available from http://www.aia.org/practicing/groups/kc/AIAS076321?dvid=4299465183&recspec=AIAS076321. Accessed on 12 February 2009.

complete and pass a national examination in order to earn the credentials of a LEED Accredited Professional (AP). It is a goal of the United States Green Building Council to have at least one LEED AP associated with a green building project to help it complete the LEED certification process.[17]

In the two years following the USGBC launch of the LEED 1.0 pilot program in 1998 twelve buildings had completed the LEED certification process. Throughout the pilot period of LEED 1.0, there were continuous revisions made and by 2000 LEED 2.0 was released to the public as a refined set of green building standards. The current version of the rating system is LEED 2.2. In efforts to keep up with developments in green research and technologies, the USGBC has been in a constant state of evaluation and modification with the rating system since its inception.

Immediate Future

Revisions to the LEED rating system are not uncommon. The USGBC launched a hefty effort beginning in spring of 2008 for the overhaul of LEED 2.0, making some of the most comprehensive changes to the rating system since LEED was initiated in 2000.

The newest version has been labeled as LEED v3 and is the accumulation of over seven months of multiple drafts, a public comment period, a membership review period, and a membership vote to allow adoption of this newest LEED. Historic preservation ideals and the continued use of existing buildings were reinforced as ideals of the USGBC, and even saw a slight increase in "preservation points".

[17] Yudelson 2008, p.6

Changes within the credit allocation need to be recognized for their key relationship to historic structures. Beginning with the first section, Sustainable Sites, Credits 2 and 4 will have an impact on the accreditation process of historic sites. Credit 2, Development Density & Community Connectivity increased from only 1 credit to a possible 5. In order to attain most of the five credit points allowed, the USGBC suggests that "during the site selection process, give preference to urban sites with pedestrian friendly access to a variety of services."[18] Points can be earned based on a site's location to central services such as banks, day cares, places of worship, fire stations, libraries, and many more key characteristics of historic community development. Credit 4, Alternative Transportation/Public Transportation increased from 1 to 6 credits with LEED v3. Extra points can be gained under credit 4 with a site's inclusion of bicycle storage and preferred parking spaces available for energy efficient vehicles.[6] These two increases in regard to the credit allocation will benefit the frequently compact and dense historic cores of many communities, while requiring little alteration to historic resources. While these additional credits may motivate some historic property owners to pursue LEED certification while rehabilitating their resources and following the Secretary of the Interior's Standards, preservationists know that common sense does not always prevail. Without local designation requiring review and approval by a historic preservation commission, there is no way to ensure that a LEED certified rehabilitation will maintain the resource's historic fabric and character.

The segment of the LEED scorecard evaluating the water efficiency associated with a structure or resource is an area in which many historic resources can more easily follow the

[18] United States Green Building Council. *LEED 2009 New Construction for Second Public Comment.* August 25, 2008. p.50

green guidelines. It is often possible to gain the maximum credits allowed (10). Low flow water fixtures, drought resistant plantings, and rain barrels and cisterns are all ways that historic properties can achieve more credits within this category.

Other changes to the LEED credit allocation process have mixed results regarding historic resources. The third section of accreditation is the Energy and Atmosphere portion. Here, the value of Credit 1, Optimize Energy Performance, doubles from LEED v2.2. This change will undoubtedly provide for increased demands for the historic shells to meet the modern standards of today. Option 1 of this credit awards an increasing number of credits according to the percentage of a building in renovation, maxing out at nineteen credits for a forty four percent renovation of the performance system. This credit undoubtedly will reintroduce the ever-occurring debate of historic windows versus modern "energy efficient" models. Credit 2, On-Site Renewable Energy, will increase from 3 to 7 credits in 2009. Local preservation commissions may see an increase in the number of Certificate of Appropriateness applications for changes to mechanical systems, and may need to revise their design guidelines to include appropriate modifications to mechanical systems, specifically HVAC units, within historic districts and on landmark properties.

Materials and Resources credits function as another key area where historic preservation can readily participate and gain additional credits. Credits 1.1, 1.2, and 1.3 all focus upon the percentage of building reuse a project maintains through retention of walls, floors, and roofs. Fifty five percent retention is awarded one credit, seventy five percent awarded two credits, and ninety five percent retention awarded three credit points. The ratio of retained materials to credits awarded may seem proportionally unbalanced, especially to a passionate preservationist, but recognition of value within a resource's embodied energy is a significant step toward a stronger LEED/Preservation partnership. Additional credits can be acquired in materials and resources based upon other construction choices. One credit is awarded for a property that maintains fifty percent of interior nonstructural elements, two additional credits for the percentage of construction related waste diverted from landfills, and two more credits for the reuse of ten percent of "salvaged" materials. Salvaging architectural materials and the use thereof is an established practice among preservationists and therefore should be easily applicable towards obtaining these credits.

Indoor Environmental Quality is an area of LEED allocation that received no increase in credits; it retains a maximum of fourteen possible. The pre-requisite is the regulation of tobacco smoke either through total prohibition or quarantined locations located away from main doorways and common areas. While the pre-requisite may appear to be a simplistic approach into the indoor environmental review process, the requirements for attaining some of the fourteen credits may intimidate the average property owner. Permanent monitoring systems and development of an Indoor Air Quality plan, both pre- and post-construction, are just a couple of requirements established by the USGBC. Historic structures can obtain in sections 4.1, 4.2, and 4.3 where low emitting floorings, paints, finishes, and products are awarded I credit point per each section.[8] The architecture of many historic structures makes it possible for these resources to acquire additional credits in section 8.1 from the percentage of daylight available to the interior spaces of the building. In this instance, one credit is awarded if seventy five percent of the regularly occupied space receives daylight, with an addition credit awarded if ninety percent of the space reaches this same level.

The introduction of bonus credits onto the LEED scorecard functions as additional means for historic structures to receive credits. Section 1.1 through 1.5 were designed by the USGBC to "provide design teams and projects the opportunity to be awarded points for exceptional performance above the requirements set by the LEED Green Building Rating System and/or innovative performance in Green Building categories not specifically addressed by the LEED Green Building Rating System.[19] Innovation through design can be implemented through adaptive reuse, encourage recycling on a larger scale, and would provide a means for historic structures to attain additional credits necessary for basic certification all the way to a platinum rating. The use of a LEED accredited professional allows for one more bonus credit, with four more being awarded for addressing geographically-specific environmental priorities. These credits allow certain design aspects to be prioritized based upon the location of a specific project, allowing for a wider range of site specific concerns to be incorporated.

A significant result of the 2008 review reformulates how LEED Accreditation will work with the new versions of LEED, and how project certification will change. In 2008, USGBC formed a new organization, called the Green Building Certification Institute (GBCI), to manage the professional accreditation and LEED AP testing process.[20] In January 2009, GBCI took over the certification process as well. USGBC continues to handle all the development of LEED and green building practices, and GBCI will facilitate all credentialing and certification, ensuring an independent third-party verification of the testing and certifying processes.[21]

The continued metamorphosis of the LEED rating system needs to be understood and

[19] United States Green Building Council. *LEED 2009 New Construction for Second Public Comment*. August 25, 2008. p. 79
[20] Campagna 2009
[21] Campagna 2009

monitored by local historic preservation commissions. Applications for LEED rated projects will continue to increase for historic properties, especially as an increasing number of buildings reach the benchmark of fifty years old and therefore fall under the review of historic preservation commissions. Communication between local preservation commissions, historic preservation organizations, and the sustainability professionals will help support this progression.

CHAPTER 4

GREEN COLLABORATIONS

The Sustainable Preservation Coalition

The USGBC, along with other eco-minded affiliates, and the field of historic preservation have an organic alliance that is only at the cusp of fully being recognized by the respected professionals and organizations within each discipline. Recent alliances between the USGBC and national historic preservation organizations began in 2006 with the foundation of the Sustainable Preservation Coalition by the National Trust for Historic Preservation (NTHP). NTHP soon partnered with the American Institute of Architects, Association for Preservation Technology International, National Park Service, General Services Administration and the National Council for State Historic Preservation Officers - who were working on individual versions of sustainability agendas. This new collaborative effort strives to make a significant impact on the incorporation of historic preservation with green building practices.

One of the first goals of the coalition was to meet with leaders at the USGBC to communicate the necessity for existing buildings, and the preservation of these buildings, to be considered as an important role toward sustainable stewardship of our built and natural environment.[22] Historic buildings can receive LEED Platinum ratings, and act as considerable contributions to sustainable development. The current LEED rating system notes that out of 69

[22] Campagna 2009

points, 20 are building type neutral; meaning a renovation, rehabilitation or new construction all have the ability to gain these points. Traditional preservation activities lead to another possible 10 points[23], showing that historic resource at the very least has the ability to become LEED Certified with minimal difficulty.

Historic buildings are currently achieving gold and platinum LEED ratings; however the Sustainable Preservation Coalition and many members of the USGBC, believe the rating system could be improved. Areas which could use additional review include: absence of cultural heritage within the point's allotment, ineffective consideration of the embodied energy or performance of historic materials, and the over-emphasis on future green technologies over traditional building practices. The mitigation of certain disproportioned points in regard to historic properties has occurred since the Coalition first raised these concerns with the USGBC, implying that a separate rating system for historic properties is possible in the future. The continued involvement of the Coalition with the LEED rating systems, and the sustainability movement in general, will further reconcile historic preservation fundamentals and the principles of green building.

The Pocantico Principles

In the fall of 2008, leaders in the fields of historic preservation, architecture, green buildings, landscape architecture and policy-making met in New York at the Pocantico Symposium: "Sustainability and Historic Preservation – Making Policy" to discuss the integration of preservation policy with the sustainability movement. Out of this retreat, the preservation leaders from organizations such as the National Alliance of Preservation

[23] Campagna 2009

Commissions, the Department of the Interior, and the National Council of State Historic Preservation Officers, urged policy makers to consider three key motivations, labeled "imperatives", for facing the "global crises that threaten our built and natural resources". [24] They are as follows:

1. *The Climate Change Imperative*- the environment is at grave risk due to global warming. It is imperative that we act to limit Co_2 emissions and reverse climate change patterns within a generation.
2. *The Economic Imperative* – In recent years, economic inequities between rich and poor have grown exponentially in the United States and abroad. Transformation is required to assure a just distribution of economic benefits.
3. *The Equity Imperative* – Our consumption patterns must be altered to foster social equity, cultural diversity and survival of all species. Non-renewable and natural resources must be managed in a sustainable manner.

In order to satisfy the three imperatives identified from discussions at Pocantico, the organizations present chose to advocate for six points of policy change. These are now known as the Pocantico Principles.

The first of these principles advocates for the creation of a culture of reuse, thereby maximizing the lifecycle of resources through conservation. In order to achieve this the "…

[24] Pocantico Symposium. "Sustinability and Historic Preservation – Making Policy." *Draft Proclamation on Sustainability and Historic Preservation.* 2009

preservation community will play a lead role in developing the technical understanding, policies, and professional capacity needed to guide decisions about what to save and how to save it".[25]

The second principle asks that as a culture we think and reinvest at a community scale, as focusing on individual structures alone will not produce a sustainable society. Including older neighborhoods that are inherently sustainable through their original design is a manner in which we can capitalize upon previous material and financial investments.[26]

The third principle reiterates the value of historical building techniques and practices as priceless education tools. "Traditional community and building design fostered careful siting of buildings and towns, sensitivity to local conditions, and long-term durability".[27] The fields of green building and sustainable development are strong in their ability to reduce environmental degradation due to construction and its attached waste, however much can be learned from practical solutions offered through traditional building practices.

Pocantico Principle number four is geared toward methods in which preservationists can capitalize on the potential of the green economy. With this, preservationists can offer years of experience in building economic tools which focus on a stewardship-based economy rather than a consumer-driven economy.[28] In return preservationists should consider the integration of sustainable materials and practices within our activities, as long as our core values are maintained.[29]

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[25] Pocantico Symposium 2009
[26] Pocantico Symposium 2009
[27] Pocantico Symposium 2009
[28] Pocantico Symposium 2009
[29] Pocantico Symposium 2009

The fifth principle asks that the field of historic preservation move beyond the current independent situation to that of a collaborative effort with the sustainability movement. To do this, preservationists must contribute to the "…transformation of communities and the establishment of a sustainable and equitable world by re-evaluating all current historic preservation practices…"[30].

The sixth, and final, principle urges preservation professionals and policy makers to take immediate action toward the implementation of sustainable practices. The principle goes on to stress the importance of collaborative effort in the development of proactive initiatives to address our global environment and the elements which threaten its continuance.

These six principles are the result of serious consideration and collaboration from perhaps the best minds in the contemporary historic preservation field. The participating organizations have each enacted measures to implement the principles into their respective programs. The Pocantico Principles are a benchmark in the efforts by preservation organizations to not just join the sustainability movement, but actively contribute to the success of green development and communities while ensuring our preservation values do not get misplaced in the process.

[30] Pocantico Symposium 2009

CHAPTER 5

WHAT MAKES HISTORIC PRESERVATION SUSTAINABLE?

Proper stewardship of our built environment is a sustainable philosophy that considers the conservation of our natural and built resources to be complementary subsets of a larger overall goal. The preservation of natural and built global resources is mandatory for the development of a sustainable culture. A significant amount of our built environment is underused in the United States alone, especially in cases where suburban development and urban sprawl have continued to drain our resources. The adoption of historic preservation ideals is a fundamental step toward the proper maintenance and care of our built resources, therefore providing the continued use of many properties. Longstanding ideals to repair rather than replace and salvage materials rather than discard them are only a sampling of those which make historic preservation an inherently sustainable practice. These ideals have been understood and recognized among preservation professionals for some time and need to be communicated to green building professionals. "In practice, far too often in the sustainable community, greening stops at the first use. Preservation looks further".[31]

Sustainability professionals may have overlooked the green benefits of preservation practices in their efforts to raise awareness to the threats on our natural resources. It is time for historic preservation ideals to be re-examined for their potentially considerable contribution

[31] Elefante, Carl. *Historic Preservation and Sustainable Development: Lots to Learn, Lots to Teach.* APT Bulletin Vol.36, No.4 (January 2005); p. 53

toward the green building movement. Historic preservation of a building is essentially one of the largest levels of recycling that any one person may be able to achieve, and in doing so conserves our heritage in the process.

A natural alliance between historic preservation and green buildings can occur when development pressures are focused toward our urban cores and away from our open landscapes. "The reinvigoration of inner-city and first-tier suburbs can take advantage of existing municipal service infrastructure, reduce atmospheric pollution from commuters, and provide benefits of living in a physically diverse neighborhood that has many of the features that suburban neo-traditional developments strive to achieve".[32] Rehabilitation and restoration of vacant historic properties within the developed portion of a community requires no additional infrastructure construction, minimal roadway construction, and can generate new economic growth within previously forgotten areas. Nearly every successful urban revitalization plan has included preservation of our cultural resources in the planning goals of the community.[33]

At the National Governors Association (NGA) they call this type of sustainable planning "New Community Design to the Rescue". The association established principles with which to help guide this 'rescue': tree-lined streets, community integration, efficient use of infrastructure, increased density, diverse housing, decreased land consumption, links to adjacent communities, and pedestrian friendly. These principles are all characteristics of our historic neighborhoods, yet within this publication there was no mention of the term 'historic preservation'.[34] This highlights a large disconnect between historic preservation professionals, who are aware of the intrinsic

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[32] Young, Robert A. PE, LEED AP. *Historic Preservation Technology.* Hoboken: John Wiley & Sons, 2008 p. 390
[33] Rypkema, Donovan. *Economics, Sustainability, and Historic Preservation.* Available from http://www.preservationnation.org/issues/transportation/additional-resources/rypkema-speech-sustainability-portland-10012005.pdf. Accessed on 10 February 2009, p.4
[34] Rypkema 2009, p.4

sustainability of our historic neighborhoods, and a percentage of the policy makers, architects, landscape architects, developers, and citizens who are working toward making our communities green. Local historic preservation commissioners need to have the necessary tools in order to relate to property owners, community officials, and the general public why preservation as an ideology is a sustainable practice.

Embodied Energy

Once the discussion of historic preservation principles turns to the environmental benefits provided, the topic of embodied energy must be raised. Embodied energy is the "…sum of all the energy required to extract, process, deliver and install the materials needed to construct a building".[35] In 1979, the amount of energy required to process, transport, and implement construction materials was 5% of the total energy utilized by the United States.[36] Contemporary numbers are likely to put the energy requirement for new construction related endeavors closer to 15%, and the production of waste products upwards of 25%.[37] Historic preservation professionals will benefit greatly from exploring how embodied energy equations can be utilized to produce quantitative data showcasing the environmental benefits of reusing historic buildings.

The green building industry has traditionally focused upon operational energy which is the used for heating, cooling, ventilation, lighting, equipment and appliances, rather than embodied, providing a disconnection between themselves and preservationists. "The ratio

[35] Jackson, Mike. *Embodied Energy and Historic Preservation: A Needed Reassessment.*APT Bulletin Vol.36, No.4 (January 2005); p.47
[36] Advisory Council on Historic Preservation. *Assessing the energy Conservation Benefits of Historic Preservation: Methods and Examples.*

[37] National Trust for Historic Preservation. *Sustainability by the Numbers*. Available from http://www.preservationnation.org/issues/sustainability/additional-resources/sustainability-numbers.html. Accessed on 13 February 2009

between embodied energy and operating energy varies between 5:1 and 30:1”.[38] The probability that historic properties fall within the elevated end of these ratios is high, with their large volumes of durable and irreplaceable materials. A historic building that retains over 75% of its original materials, but is slightly less efficient should be considered holistically. It would take more than three decades for operational energy savings to recoup the loss of embodied energy from an historic building that was demolished and replaced.[39]

The most thorough report done on embodied energy in relation to historic properties was conducted by the Advisory Council on Historic Preservation (ACHP) in 1979. This study, done by the ACHP, contains formulas for the measurement of energy required to restore and rehabilitate existing buildings weighted against the energy required for comparable new construction. The ACHP wanted to provide means for its members to properly review the preservation cases brought before them; whether they fell under the National Historic Preservation Act or the Public Buildings Cooperative Use Act.[40] There are some key talking points at the beginning of the study that are relevant for historic preservation commissions to reference. The first of these is that eight bricks in an historic building equal a gallon of gasoline, an easy reference point for the general public. Also, the ACHP notes that because these buildings were constructed long ago, the economic value is not adequately recognized by normal economic comparisons of preservation versus new construction.[41]

The ACHP developed tools for assessing the potential energy conservation value of preservation and rehabilitation using combinations of three measurements of energy use:

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[38] Jackson 2005, p.51
[39] Jackson 2005, p.51
[40] Advisory Council on Historic Preservation 1979, p.i
[41] Advisory Council on Historic Preservation 1979, p.7

1) Embodied energy of materials and construction for existing, rehabilitated, and new construction
2) Demolition energy for existing buildings
3) Annual operating energy for existing, rehabilitated, and new construction

This information can be determined through three models and their respective equations. The models are Building Concept Model, Building Survey model, and the Building Inventory Model; sequentially increased in level of detail and range of difficulty to formulate.[42] For general local preservation commission work, the Building Concept Model is sufficient (Appendix E). Using the formulas and equations from the ACHP study, a comparison of embodied energy and operating energy in three instances shows:[43]

1) Do nothing to the existing building and build a new building. The existing building will remain and be used by a new tenant. The new building will be designed to meet Energy Star standards.
   a. Embodied energy 1,200 MBtu.sq.ft for the new building
   b. Existing building operating energy at 70,000 Btu/sq.ft.
   c. New building operating energy at 35,000Btus/sq.ft.
   d. 34.2 years before life-cycle energy savings is achieved
2) Demolish the existing building with partial salvage. Construct new office building to meet Energy Star standards.
   a. Embodied Energy: 1,200 MBtus/sq.ft. (exisiting)
   b. Embodied Energy: 1,200 MBtus/sq.ft. (new)

[42] Advisory Council on Historic Preservation 1979, p.11
[43] Jackson 2005, p.51

c. Embodied Energy: -400 MBtus/sq.ft. (salvage)

d. Total Energy: 2,000 MBtus/sq.ft.

e. New Building Operating energy at 35,000 Btu./sq.ft

f. 57 years before life-cycle energy savings is achieved

3) Renovate existing building, improving its efficiency by 30%, but not to Energy Star standards. Construct new building to Energy Star standards.

   a. Embodied Energy: 400 MBtu (rehab)

   b. Operating Energy: 50,000 MBtu (rehab)

   c. Embodied Energy: 1,200 MBtu/sq.ft. (new)

   d. Operating Energy: 35,000 Btu/sq.ft. (new)

   e. 53.3 years before any life-cycle energy savings is achieved

While comprehensive, the information in this report is itself thirty years old and based upon data from as early as 1967. Due to this significant amount of time, there are obviously points within the ACHP assessment that are in need of review. One point specifically is the possibility that overall building statistics, i.e. mass, materials and composition, have changed since the 1960s and 1970s, and therefore misrepresent the embodied energy of older buildings.[44] Another concern about using the ACHP study is in the development of construction materials over the last thirsty years. The process in which materials are produced, shipped and utilized has changed drastically so it is only logical that the data would reflect those changes.

Embodied energy acts as an influential asset in the sustainability of historic preservation and needs to receive equal recognition in the equation of sustainable design. Measures found in

[44] Jackson 2005, p. 47

the LEED rating system for the calculation of energy consumption are currently using embodied energy in a manner which limits its potential contribution, since the results are not in "equitable quantification" for historic buildings. The LEED rating system only minimally awards credits, on a range of 1-4 possible points, for the retention of an existing building material. This is a vastly undervalued portion in the overall rating system, and of the green building industry as a whole. In 1979, the ACHP pleaded for historic preservationists to publicize the energy conservation benefits of our principles, and who better to carry this message into a continually 'greening' society in communities across the nation than local preservation commissions.

Traditional Building Design

In earlier construction periods buildings relied upon natural opportunities for sunlight and ventilation in order to provide comfort for inhabitants. These methods were perhaps insufficient for all seasons; therefore, the addition of fireplaces, stoves and fans was used to mitigate shortcomings. The design of early buildings shows a cognizance of regional climates and respective necessities. "Buildings that condition space first by passive means are more certain to work for the life of the building because passive means are not dependent upon any particular mechanical technology".[45]

Sunlight and natural sources of ventilation can be found through operable windows and overhead skylights. Historic buildings utilized passive solar heat in the winter through either the quantity or the size of window panes and orientation, while controlling this heat in summer months with louvered shutters, awnings or strategically positioned porches. Prior to the

[45] Mouzon, Stephen A. *The Original Green.* Available from http://www.traditional-building.com/Previous-Issues-08/AugustFeature08Green.html. Accessed on 20 February 2009.

evolution of framed or curtain wall systems, heavier construction materials such as stone and masonry were used in order to provide a thermal mass which tempered the outdoor temperature.[46]

Architectural form itself is a key factor in the comfort of residents living within an historic structure. Two story porticos in Charleston, South Carolina and wrap around porches in New Orleans, Louisiana are further examples of vernacular architecture with regional climate conditions under consideration. High ceilings are another common characteristic in the historic homes throughout the southeast. This building technique allowed for light to penetrate deep within a room while at the same time allowing warm air to rise above occupied space, making hot and humid climates more manageable. Other typical design techniques for this climate include deep wrap around porches, open railings, and a central hallway plan for increased air circulation. Certain properties even included belvederes or towers that would act as siphons to draw the warm air out of homes; this idea can be linked as a precursor to solar chimneys today.[47] These methods did not cool the air within the homes; however the circulation of air through all these design techniques worked to make residents more comfortable.

In colder climates, such as that of New England, there were different modifications. Ceiling levels would be lowered and spaces more compact in order to retain heat generated through multiple fireplaces or free standing wood burning stoves. Large windows, and an absence of shutters or awnings, would have enabled interior spaces to be heated through the transmittal of solar energy. A perfect example of traditional craftsmen's understanding of these methods is that of the saltbox house, with a center-chimney to retain heat, and no windows on

[46] Young 2008, p.353
[47] Young 2008, p.359

the north elevation thereby preventing the infiltration of cold air. On the interior of windows, large heavy drapery may have been installed in order to retain the heat collected during the day throughout the evening hours. Home owners also used storm windows and winter door tapestries to help conserve heat generated during the winter months.[48]

The advantages of traditional building techniques should not be underestimated. Proper design of homes and businesses relates the buildings to the environment in which they are found. Energy generation technology, such as solar panels, may be a positive way to subsidize the portion of heating, cooling or ventilation not obtained through traditional techniques, but these should not be the sole source for comfort. If technology fails or breaks down, a structure would still be able to maintain a certain level of comfort for its occupants if traditional regional building examples and techniques were utilized during the design process.

Retrofitting Historic Properties

Historic properties were designed to be maintained and not discarded, and therefore are not maintenance free but require care and attention. Most new buildings are touting their 'maintenance free' design, but one should stop and consider what that entails. There is a high probability that 'maintenance free' also means that if something breaks it cannot be repaired and must be totally replaced, such as many vinyl windows. Whereas on historic properties, many of the materials used for construction were wood, stone, glass and brick and, therefore, are able to be repaired rather than replaced. Retrofits to historic properties can often greatly increase their energy efficiency while preserving their character and providing a heightened level of comfort. Strong reasons for the retrofitting of an historic property, instead of removal, are economic

[48] Energy Notebook *Save Energy the Old-Fashioned Way.* Remodeling Ideas (Winter 1986), 37.

savings, an older building's carbon footprint, and maintaining the historic character of a property or neighborhood.

The economics of a green retrofit typically fall heavier on the front end than conventional repairs or updates may, and the owners see a gradual savings in utilities over time. One great example of this is the price of compact fluorescent light bulbs (CFLs) over traditional incandescent light bulbs. A package of traditional light bulbs may cost two dollars at a local supermarket, while CFLs can have triple that in upfront costs but save an average home over seventy dollars annually.[49] There are new economic tools in place to assist with energy efficient modifications to existing buildings, such as energy efficient mortgages, which are now being offered and qualify homeowners for extra funds to be spent on energy saving retrofits. These mortgages can result in a homeowner increasing cash flow due to decreased utility bills; often these homeowners will reinvest these savings towards the proper maintenance of their historic property.

The embodied energy, traditional building design, and retrofitting possibilities associated with historic resources collaborate to make historic preservation an inherently green practice. The ability to save and reuse historic buildings maximizes the life-cycle of the original materials, to repair rather than replace building components, and to design with passive methods for climate control are all green concepts stemming from historic resources and the preservation thereof.

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[49] City of Boulder. *Making Your Historic Building Energy Efficient: Volume 1 Principles and Approaches.* Available from http://www.bouldercolorado.gov/files/PDS/historicpres/hist_supp_vol1_energy_efficient.pdf. Accessed on 20 August 2008.

CHAPTER 6

HISTORIC RESOURCES AND GREEN MODIFICATIONS

When it comes to sustainable sources of energy generation and conservation there are familiar means, such as weather-stripping and storm window installation, and emerging green technologies like solar panels, wind turbines geothermal, rain water collection systems and green roofs. These methods of energy generation can often be retrofitted to existing buildings, even historic properties. The local preservation commission must be aware of the technological advances currently available to the homeowners of their community and provide guidance in their appropriateness.

Applications for photovoltaic cells have been coming before historic preservation commissions for some time now; however, there is still uncertainty regarding the integration of solar installations and historic properties. Even fewer commissions have experience with wind turbines, geothermal, rain harvesting systems, or green roofs. In many cases local commissions tend to deny or delay such applications based on their inability to understand the impact of such modifications on historic resources. In other instances, the local commission cannot deny the construction of a large wind turbine in the front yard of an historic property if there is nothing in the design guidelines, local preservation ordinance, or local planning ordinance giving them the authority to review such an installation. This was recently the case in the historic district of Grant Park, located in Atlanta, Georgia. The property owner was able to erect a 45 foot tall wind turbine in his front yard due to the local planning ordinance only having regulatory power over the height of ‘new construction’ and not the type of construction allowable. The importance of a local preservation commission taking proactive measures to educate members and staff, update guidelines, and review the local ordinance prior to applications for green modifications cannot be overstressed. Commission members need to have a basic knowledge of the energy efficient opportunities and green systems offered for historic properties in order to make proper rulings. Whether it is an approval or a denial, a commission needs to be able to justify their reasoning beyond aesthetics.

Energy Efficient Opportunities

Improving the energy efficiency of historic properties moves preservation past established practices and into opportunities to maximize sustainability methods. Energy upgrades can be cost effective measures that, in turn, will extend the life of an older building’s systems. There are simple measures that can be taken to improve a property’s energy consumption without jeopardizing its historic integrity. The best way to analyze how a property is performing, and what options are available to improve its performance, is to initiate an energy audit. Energy audits are offered through utility companies, state or local government’s energy or weatherization office, and numerous independent companies.[50] Professional assistance is a good idea; however, historic properties are different from the contemporary buildings these tests were designed for, so your own personal accounts of the property are very important in determining where energy is being lost.

[50] United States Department of Energy. *A Consumer’s Guide to Energy Efficiency and Renewable Energy*. Available from http://apps1.eere.energy.gov/consumer/your_home/space_heating_cooling/index.cfm/mytopic=12490. Internet; Accessed on 13 February 2009.

Heat is lost through two methods: infiltration and conduction. Infiltration is when air moves through cracks, joints, and other openings. Conduction is the transfer of heat through materials. Infiltration is one of the most common and easily manageable energy efficiency problems with historic homes. "In many houses as much as 30 percent of wintertime energy use is wasted in heating air that escapes from cracks and seams" .[51] In these cases it is common for a property owner to jump to the conclusion that insulation is the best answer. In most cases, an historic property is in need of proper sealant treatments before insulation is even considered. In the majority of instances, infiltration problems are easily corrected through fairly inexpensive strategies such as caulking or weather-stripping. The difficulty in fixing these air leaks, most of the time, is finding them.

Examination of a building from the top down will show that there are opportunities for increased efficiency at numerous locations within the property. The attic is the first area that should be addressed when attempting to conserve energy and provide for a comfortable living environment as air leakage is a common problem there. Any point which penetrates the ceiling can be a source of air leakage, some of which may not even be visible. "All gaps must be sealed with a material that takes into consideration the movement, the need for access, and fire, electrical and safety hazards".[52] This may be a difficult task for many home owners; therefore a better option may be for the focus to be on stopping leaks from the top level of the house to the attic space. Attic insulation is therefore a must. If an attic is un-floored, insulation may be easily installed in batts laid between joists and butted tightly together.[53] Attics should be properly ventilated in order to maintain the effectiveness of the insulation. Once insulation becomes saturated, due to a lack of air circulation, it will lose its effectiveness. If the attic floor is

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[51] City of Boulder
[52] City of Boulder
[53] Wallace, Andy. *Weatherizing the Old House.* The Old House Journal (September 1986).

inaccessible, consideration should be made towards the installation of insulation along roof rafters or into the ceilings immediately beneath the attic.[54]

Wall insulation is a debated topic among historic preservation professionals, and falls under the purview of local preservation commissions as it may be detrimental to a historic property. New-energy methods of insulation are not always appropriate for older homes. Home owners or contractors who simply pour insulation into the walls of an older home perhaps have good intentions, but may be causing irreversible damage to the historic building. Older homes were not designed to be tightly sealed, but to be able to breathe through a method of expansion and contraction depending on climate and materials. Consultation with a local expert familiar with old homes is highly recommended prior to the addition of wall insulation, as some insulation may trap moisture and cause rot or expand and cause cracks in the walls.

Specific areas in historic properties which need to be examined by an auditor or owner for energy efficiency are: interior chimneys and flues, electrical fixtures, electrical wires, partition walls, plumbing stacks, exhaust fans, ducts, perimeter walls, dropped ceilings, clothes chutes, dumbwaiters, built in furniture, storage closets and the attic access. These can be identified in Figure 1, which is from the Boulder Historic Preservation Department, and represents areas within an historic property where energy efficiency retrofits are possible.

[54] Smith, Bernard M. AIA. *Preservation Brief 3: Conserving Energy in Historic Buildings.* Available from www.nps.gov/history/hps/tps/briefs/brief03.htm. Accessed on 16 April 2009.

1. Staircase Ceiling
2. Recessed Lighting
3. Chimney Case
4. Electric Wiring/Box
5. Ballooned Frame Walls
6. Attic Entrance
7. Partition Wall Top Plate
8. Plumbing Vent Chase
9. Exhaust Fan
10. Dryer Vent
11. Plumbing/Utility Penetration
12. Sill Plate
13. Rim Joist
14. Bathtub Opening
15. Basement Windows/Doors
16. Block Wall Cavities
17. Water Heater/Furnace Flue
18. Dutch Work
19. Plumbing Chase
20. Leakage Between Basement and Crawl Space
21. Floor Boards
22. Windows
23. Laundry Chutes
24. Stairwells
25. Kneewall Framing
26. Built-in Dresser
27. Chimney Penetration
28. Built-in Cabinet
29. Holes in Plaster
30. Furnace Registers
31. Doors
32. Baseboards
33. Plumbing Access Panel
34. Sink Plumbing Penetrations
35. Dropped Soffit
36. Electrical Outlets
37. Electrical Fixtures
38. Porch Framing Intersection
39. Missing Siding
40. Additions/Dormers/Overhangs
41. Unused Chimney
42. Floor Joists

Figure 1 – Energy Retrofits for Historic Homes[55]

[55] City of Boulder

Recommendations

Information on energy efficient measures that can be easily taken should be made available to the residents and property owners of historic properties and within historic districts. Historic preservation commissions can develop easily distributable brochures (Appendix C) which point out the inherent energy efficiency of historic properties, i.e. design, along with simple steps that they can take to improve the energy performance of the building. It would benefit the community members and the commission members to include a list of retrofits that do not require a certificate of appropriateness or can be done through staff approval instead of coming before the commission at a hearing. Making this process as easy for the property owner as possible, while still maintaining the integrity of the historic property, will showcase a local preservation commission's dedication to preservation and support of sustainable design.

Preservation commission members should also be aware that some home owners will be retrofitting historic properties in an effort to transform them into LEED certified, silver, gold, or platinum buildings. Commissioners should recognize that the LEED rating system is optional, and therefore the historic preservation principles should be prioritized should they conflict with the LEED rating system requirements. The preservation commission may support property owners in their efforts to make their home as energy efficient as possible without compromising a portion of the community's collective cultural and built heritage.

Windows

A specific area of retrofitting that has been an issue for local preservation commissions for decades is historic wooden windows. Historic windows are a push-button topic with home owners who are looking for a 'quick fix' or are swindled by a savvy vinyl window salesman. As mentioned before, historic properties are not maintenance free. This is a good thing. In the majority of historic wooden windows, if a component of the window sash is broken, it can be repaired; if the sash is not fully operating, it can be repaired. Repair of vinyl windows is not an option. If a component of a vinyl window breaks or ceases to function, then a whole brand new window is required to correct the problem. There are ten key points highlighted by the National Trust for Historic Preservation, of which a local preservation commission should be aware of when an application for replacement windows comes before them:

1) More heating is typically lost through your roof and un-insulated wall than through your windows.
2) Replacement windows are called 'replacement' for a reason, 30% of the time a 'replacement' window will need to be replaced in 10 years.
3) Replacement windows that contain vinyl or PVC are toxic; they produce and create toxic byproducts.
4) If the wood windows are 60 years or older, chances are the wood is made from old growth and is irreplaceable.
5) A historic wood window, properly maintained, weather-stripped and with a storm widow, can be just as energy efficient as a new window.

6) It can take up to 240 years to recoup enough money in energy savings to pay back the cost of installing replacement windows.
7) Every window, historic or replacement, which goes into a landfill, is adding to the 124 million tons of debris annually accumulated from demolished buildings in the United States alone.
8) It can be easy for property owners to maintain and repair wooden windows.
9) Hiring a professional tradesman to repair wooden windows fuels the local economy, and is a sustainable practice of repair over replacement.
10) Historic wooden windows are key characteristics of older buildings.[56]

Vermont Division of Historic Preservation Window Study

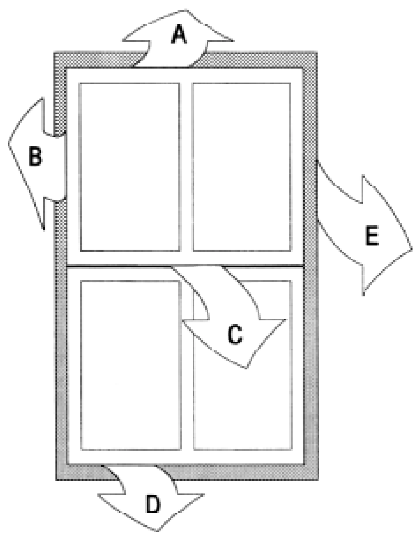
To study the assertion that replacement windows are more energy efficient than historic windows, the Vermont Division for Historic Preservation, Agency of Commerce and Community Development, commissioned a study to analyze the energy efficiency of historic windows in cold climates. This thorough study examined whole building energy losses, through windows and common retrofits such as weather-stripping, storm windows, preventing air infiltration through rough openings, as well as routine maintenance. Historic preservation commissions should familiarize themselves with the findings and relevant statistics of this study in order to temper the claim that new windows are more energy efficient than historic windows. The respective findings are as follows:

1) *Whole Building Losses*: One of the primary purposes of building renovation is to reduce energy consumption and costs via thermal losses due to air infiltration. A reduction in

[56] National Trust for Historic Preservation. *Historic Wooden Windows.* Available from www.preservationnation.org/issues/sustainability. Accessed on 26 February 2009.

building energy requirements may be accomplished by reducing air infiltration through sills, walls, basements, attics, doors, and windows. Most saving estimates fall between 30-37% of total building energy costs. [57]

2) *Window Energy Losses*: Two separate studies found the fraction of window leakage to be approximately 20% of whole house leakage. An estimated 37% of the total heat loss from a house may be due to infiltration through windows and Costs due to infiltration as a percentage of total window energy costs varied from 15% to 41 % for a two story house. [58]



A - Air infiltration through the head junction
B - Air infiltration through the sash/jamb junction
C - Air infiltration through the meeting rail
D - Air infiltration through the sill junction
E - Air infiltration through and around the jamb from the rough opening

Figure 2 – Infiltration Leaks for a Typical Double Hung Window[59]

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[57] James, p. 4
[58] James, p.4
[59] James, p.2

a) *Weather-stripping:* The intent of weather-stripping a window is to reduce the amount of air infiltrating through the sash/jamb junctions and the meeting rails. Infiltrative losses were reduced from 37% to 17% of total house thermal losses when metal rib-type weather-stripping was installed around the windows. This corresponded to an approximate 24% reduction in building energy costs.[60] Thermal energy loss is associated with poorly maintained historic windows, and occurs through either infiltration or non-infiltration. Infiltration is thermal loss due to exterior air moving through and around the sash and rough opening (Figure 2).[61] Non-infiltration loss includes convection, conduction, and radiation through the materials of a window.

b) *Storm Windows:* The installation of storm windows, either exterior or interior, presents its own range of advantages and disadvantages. In general, properly installed new storm windows in combination with existing single-glazed windows may achieve U-values comparable to insulating glass and reduce air infiltration while lowering maintenance costs and extending the life of the window. Disadvantages of exterior storm windows include visual obstruction of an historic window and its attendant details, while interior storm windows may increase condensation and cause moisture related problems to the primary sash. The negative visual effect of exterior storm windows may be reduced by using single lite storm sash. Interior storm windows have avoided the problem of condensation by incorporating vent holes and a sealed

[60] James, p.5
[61] James, Brad, Andrew Shapiro, Steve Flanders, and Dr. David Hemenway. *Testing the Energy Performance of Wood Windows in Cold Climates.* Available from http://www.ncptt.nps.gov/wp-content/uploads/1996-08.pdf. Accessed on 13 February 2009. p. 2

fit. Whole house energy consumption was reduced by 12% in a test house in England fitted with interior storm windows.[62]

c) *Single versus Double-paned Glass:* Energy losses due to direct heat transmission through a window were observed to be consistently greater than those due to air leakage, is estimated that replacing single-glazing with double-glazing reduced losses via thermal transmission such that building space heating requirements were reduced by 9%. If double-pane insulating glass is to be used and the original sash retained, there must be adequate wood thickness to accommodate the rabbeting necessary to insert thicker, double-pane glass. This presents a more complicated problem in multi-lite sash where muntins are present. Storm windows in general provide a second glazing layer, reducing non-infiltrative thermal losses. Exterior storm windows provide the additional benefit of lowering window maintenance costs as well**.** [63]

d) *Window Surrounds:* A significant source of infiltration may be the gap between the rough opening of the building and the frame of a window unit. Estimates of infiltration through window rough openings range from 12% to 39%.. An efficient and cost effective method for sealing rough openings is low expansion urethane foam. An estimated 39% of total house air leakage was from rough openings in a loose house typical of older construction. The most effective means of reducing extraneous leakage require removal of both interior and exterior trim. Trim removal provides exposure and access to the window frame/rough opening junction, allowing thorough sealing. Care must be taken when using expandable foam to prevent overfilling, which could lead to window jamb distortion.

[62] James, p.5
[63] James, p.6-7

e) *Routine Maintenance:* Significant reductions in infiltration may be accomplished by routine maintenance of an existing window while improving its integrity. Routine maintenance includes removing the glass, applying back putty, reinserting the glass, repointing and reglazing. Excess paint should be removed and any necessary sash or frame repairs done along with the installation of good quality weather-stripping. Repainting the sash, frame, and glazing will help provide a good seal against the elements.[64]

The conclusions of the Vermont report support the preservation argument that replacing an historic window does not necessarily result in a greater energy savings than 'upgrading' that same window. The study also references other benefits of renovating historic windows beyond those of energy conservation including: continuation of the historic design, appearance and value of a resource. The decision to restore or replace a historic window is based on factors other than energy efficiency and conservation. A window's historical significance, material composition, and its role in the overall character of a building are all key factors during this decision making process.

Recommendations

The local historic preservation commission should reference the Vermont study (Appendix I) and National Trust report, as well as other relevant studies, when reviewing applications for the removal of historic windows for energy efficient purposes. Preservation commissions should ask several questions when reviewing window replacement. First, are the original/historic windows capable of being repaired? If the windows can be repaired and made operable again, the local preservation commission should not approve replacement of the historic

[64] James, p.8

windows. Modifications for improving the energy efficiency of historic windows should be utilized as recommended solutions prior to approval of replacement windows. If the historic windows are not capable of being repaired, the preservation commission should evaluate the contribution to the historic integrity of said property made by the composition and configuration of the present windows. Replacement windows should be a like-for-like replacement, including true divided light rather than faux divisions. Historic windows that are removed should be salvaged when possible, mitigating their impact on local landfills.

A brochure on historic window repair and retention is a powerful education tool for a local preservation commission. This should be utilized as a proactive measure to inform a community of repair and maintenance options for historic windows, and may aide in decreasing the percentage of replacement window applications that come before a commission. Local window repair workshops are also means in which a local preservation commission may work with the community in the preservation of historic windows. These workshops should be designed to educate property owners on the proper maintenance of historic windows, appropriate repairs to window components, and energy efficient opportunities.

Solar

Solar panels are the energy source with which most people are accustomed. Development of effective solar panels has been ongoing in the United States for decades, with a large surge in their development related to the energy crisis of the 1970s. Familiarity with photovoltaics has lead to a significant increase in the number of local historic preservation commissions that have chosen to incorporate solar collection systems into their community's design guidelines in comparison with other renewable energy installations such as wind turbines or geothermal wells. At the very least, commission members and staff need to be familiar with solar energy collection and the variety of systems available for residential, commercial, and industrial usage.

Photovoltaic systems are constantly morphing and developing through advances in technology. The solar market has seen rapid development over the last decade, with developers pushing for rapid growth in all sectors. "Residential photovoltaic systems represent a potentially huge market in the United States….there are 10 million single-family homes in areas of above average sunshine."[65] With a profit driven industry, not too dissimilar from the vinyl window manufacturers, how long can local commissions assume that none of these ten million homes are within their historic districts? Evolving development requires that commission members and staff remain up to date on advancements within their areas of design concern. An annual review process is highly recommended, and should immediately precede a training workshop for commissioners.

The members of a local commission need to feel a level of comfort with photovoltaic collection systems as applicants will be looking for a level of expertise from the commission on the details of their application. Advance preparation is the best way to insure that a local commission and its members continue to make informed and unbiased rulings, negating the appearance of arbitrary decisions based upon aesthetics. Covering the basics of solar energy will familiarize commission members and staff with this source of renewable energy.

One of the first aspects to cover with commissioners are the different systems available and their main usages. Solar collectors are categorized first as stand-alone or solar-supplemented

[65] Bernstein, Paul. *Alternative Energy: Facts, Statistics, and Issues.* Westport: Oryx Press, 2001.

systems, further divided as passive or active systems, then once more by residential or industrial usage.[66] Misconceptions regarding historic preservation commissions only evaluating residential properties are common, however, historic industrial properties such as closed textile mills or other light manufacturing facilities are frequently found within historic districts nationwide.

Stand-alone systems are those in which the energy collected through solar input is the only source of energy utilized to meet the required load of a structure. These systems are often implemented in cases where the energy load requirement carries an amount of variance, meaning there is not a requirement for energy to be available at a consistent load each and every second.[67] Due to this, and their lower cost and simple operation, residential and agricultural installations tend to be the most successful stand-alone solar systems.

Thermal Systems

The more extensively used system for solar collection is the solar-supplemented system. These systems are popular among residential and industrial properties, and what many historic preservation commissions will see coming before them with increasing frequency. A supplemented system derives a portion of its energy input from solar power, with the remaining energy needed to meet its required energy load coming from an auxiliary source such as a local power company. There are two types of supplemented systems that will be examined: passive and active.

Passive solar design requires incorporation very early on in the development stages of a structure, as much depends upon the optimal orientation and configuration of a building. The

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[66] Kreith, Frank and D. Yogi Goswami. *Handbook of Energy Efficiency and Renewable Energy*. Boca Raton: CRC Press, 2007.
[67] Kreith 2007, p.20-23

dependence on design and layout necessary for passive solar systems to be successful makes retrofitting some buildings for this collection process difficult or not possible. Ideally a home or building would be aligned on axis to allow exposure to the southern elevation. There are two basic elements required for proper usage of a passive solar system; a south facing exposure of glass to gather the energy and a material to absorb and store the heat for later use.

The simplest and most historic of approaches of passive solar collection is a direct gain design. Sunlight is admitted to the space by the south facing glass and a significant portion is converted to thermal energy. The building's walls and floor are used for solar collection and thermal storage by absorbing reflected or radiated energy (Figure 3). As long as the room temperature remains high, the interior walls and floors will conduct heat to the core or center of the building. At night, when outside temperatures drop and the interior space cools, the heat flow into the walls and floors is reversed and heat is given up to the interior space in order to reach equilibrium. This re-radiation of collected daytime heat can maintain a comfortable temperature during cool nights and can extend through several cloudy days without "recharging".[68]

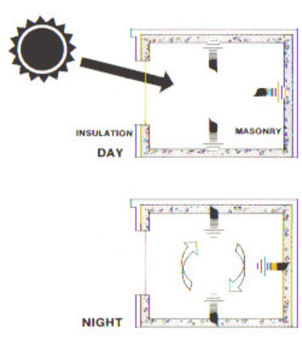

Figure 3: Direct Solar Gain[69]

[68] Arizona Solar Center. *Passive Solar Heating and Cooling.* Available from http://www.azsolarcenter.com/technology/pas-2.html Internet; accessed 13 February 2009.

[69] Arizona Solar Center

Direct gain design is simple in concept and can employ a wide variety of materials and combinations of ideas that will depend greatly upon the site and topography; building location and orientation; building shape and volume; and space use. Traditional building techniques of the eighteenth, nineteenth and early twentieth century reveal that early architects and home builders were cognizant of this proper site arrangement, often constructing buildings in order to maximize the amount of natural heating and lighting potential. This is an aspect of historic construction which commissions can refer to when attempting to translate the inherent energy efficiency found in historic properties.

Application of passive solar systems post-construction may be difficult, however it is not impossible. Designs for passive solar additions, often referred to as Sunspaces, are available from architects, engineers, and green buildings firms (Figure 3). Sunspaces are very similar to greenhouses in their configuration, materials, and purpose. Due to the fundamental principles of passive solar there is a necessity for these additions to be located upon the south elevation of a property. Local preservation commissions have experience in reviewing applications for new construction and additions for local historic landmarks and historic districts. A preservation commission should treat a Sunspace application in the same manner as they would an application for an addition or new construction project. Sunspace additions are not appropriate for all historic resources; therefore a case by case review of the applications is necessary to properly determine the impact of the Sunspace on the property. Applications should be approved by a local preservation commission if the addition is capable of being removed without damaging the original fabric, is not visible from the right of way, and does not negatively impact the historic integrity of the property.

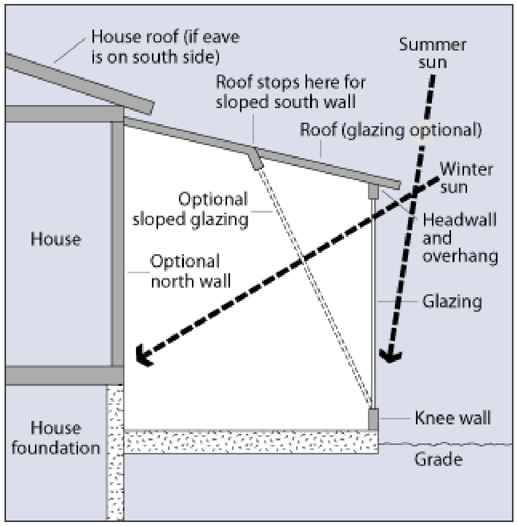

Figure 4: Sunspace Addition[70]

The second form of supplemented solar system is active solar collection, of which there are two subsets based upon what the solar collector is heating, liquid or air. Both of these systems collect and absorb solar radiation, then transfer the solar heat directly to the interior space or to storage system, from which the heat is distributed.[71]

Solar air heating systems use air as the working fluid for absorbing and transferring solar energy. Solar air collectors can directly heat individual rooms or can potentially pre-heat the air passing into a heat recovery ventilator or through the air coil of an air-source heat pump. Air collectors produce heat earlier and later in the day than liquid systems, so they may produce more usable energy over a heating season than a liquid system of the same size.[72] Also, unlike liquid systems, air systems do not freeze, and minor leaks in the collector or distribution ducts

[70] Enginnering.com. *Passive Solar Systems and Hot Water Systems.* Available from http://images.google.com/imgres?imgurl=http://www.engineering.com/portals/0/images/sunspace.gif&imgrefurl=http://www.engineering.com/SustainableEngineering/RenewableEnergyEngineering/SolarEnergyEngineering/PassiveSolarSystemsSolarHotWater/tabid/3892. Accessed 10 February 2009.

[71] U.S. Department of Energy
[72] U.S. Department of Energy

will not cause significant problems, although they will degrade performance. “Solar air collectors are often integrated into walls or roofs to hide their appearance. For instance, a tile roof could have air flow paths built into it to make use of the heat absorbed by the tiles.”[73] Integration of these air collection systems into roof material may be a best case scenario for local commissions. Collectors may have to be installed on top of a building’s roofing, therefore protruding into the roofline, or as window units.

Solar liquid collectors are most appropriate for central heating, and are the same as those used in solar domestic water heating systems (SDWH). Flat-plate collectors along rooflines are the most common, but evacuated tube and concentrating collectors are also available and become increasingly popular. In the collector, a heat transfer or "working" fluid such as water or antifreeze absorbs the solar heat. At the appropriate time, a controller operates a circulating pump to move the fluid through the collector.[74] Heating a smaller volume of liquid to a higher temperature increases heat loss from the collector and decreases the efficiency of the system. The liquid flows to either a storage tank or a heat exchanger for immediate use. Other system components include piping, pumps, valves, an expansion tank, a heat exchanger, a storage tank, and controls.[75] Once again it is the collectors with which most historic commissions will have interaction. Regulation over their visibility from the right of way and any disturbance of the historic roofline should be the major concerns of commissioners and staff.

Electrical Systems

[73] U.S. Department of Energy
[74] U.S. Department of Energy
[75] Pahl, Greg. *The Citizen-Powered Energy Handbook: Community Solutions to a Global Crisis.* White River Junction: Chelsea Green, 2007 p.41

Photovoltaic (PV) cells are the basic building block of an electric solar system. Individual cells are usually quite small, producing one to two watts of power each.[76] PV cells can be connected together to larger solar units called modules, which can be connected together to form arrays. As these solar collection units become interconnected they can produce more power, therefore a solar system should be designed around the electrical needs of a property.[77] A local preservation commission may expect a residential property to be able to accommodate its electrical demands through a few PV cells or a small module. A solar array may come under the review of a local preservation commission if it is proposed in a rural or urban context under the commission's jurisdiction.

Cells, modules, or arrays are not fully representative of an entire photovoltaic system. Structures designed to orient the solar components toward the sun must be constructed, as well as machinery to take the direct current electricity produced by modules and condition that electricity by converting it to alternative-current electricity.[78] Batteries are also necessary to the solar installation so that collected power may be stored for future usage. All these components are referred to as the "balance of system" components.[79] It is the combination of these components to cells, modules or arrays which creates an entire photovoltaic system. A 279 module photovoltaic system was installed on the Smiley Building in Durango, Colorado. This system provides for 100% of the renovated junior high school's electrical needs.[80] The contactors installed the solar panels without review by the Durango Historic Preservation Board, who holds jurisdiction over the landmarked building, the Colorado Historical Foundation, which holds an

[76] U.S. Department of Energy. *PV Systems*. Available from http://www1.eere.energy.gov/ solar/pv_systems.html. Accessed on 16 April 2009.
[77] U.S. Department of Energy, *PV Systems*
[78] U.S. Department of Energy, *PV Systems*
[79] U.S. Department of Energy, *PV Systems*
[80] Smiley Building. *Conservation Features*. Available from http://www.smileybuilding.com/solar/conservation.html. Accessed on 17 April 2009.

easement on the property, or a city building permit. The solar modules located on the original auditorium are partially visible from the right of way, while the remainders are only visible from an aerial view.

Figure 5: Smiley Building Photovoltaic System[81]

Developing solar technology has led to a collection system which converts solar energy into electricity for buildings and has resulted in a perfect match for the rooftops of historic properties. Solar shingles or tiles have been developed over the last decade by several national solar energy companies, such as Atlantis and Sunslates. These companies introduced to the market a photovoltaic cell that lies flat along a rooftop, allowing the cells to collect energy without the traditional requirement of a panel mounted at a 45 degree angle. This process is made possible by adhering silicon chips to a slat-like roof tile. These tiles can be placed along the south facing roof, and often are only noticeable by their sheen. These tiles can be installed

[81] Smiley Building

and removed from historic roofs with no damage to the original fabric. Solar shingles may be an alternative to traditional solar panels in historic districts; however they are more expensive and produce slightly less energy than tradition photovoltaics. Depending on the energy needs of a property, the solar shingles may still be able to proved 100% of the required operating energy.

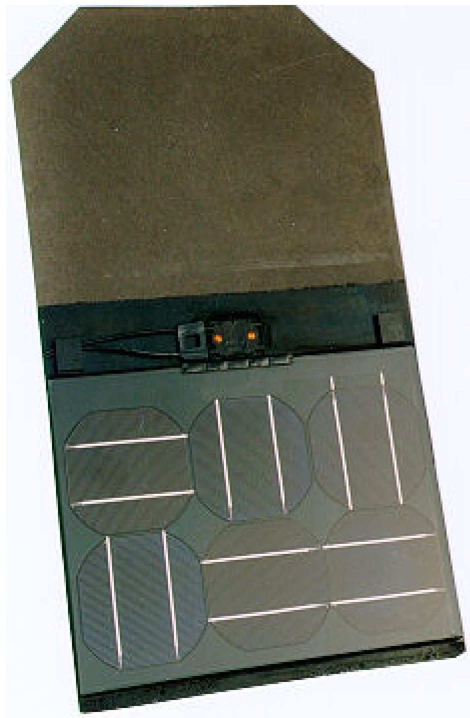

Figure 6: Solar Shingle[82]

[82] Atlantis Energy Solutions, Inc. Available from http://www.atlantisenergy.org/sunslates2.html. Accessed on 12 October 2008.

Figure 7: Solar Shingles on Historic Home[83]

Recommendations

Local historic preservation commission review of photovoltaic systems has been ongoing for some time, with many local preservation commissions integrating solar guidelines within their local design guidelines and preservation policies. Breckenridge, Colorado developed a solar ordinance (Appendix F) as a means for supporting sustainable development by streamlining appropriate installation of solar panels within the town's conservation district. The ordinance requires the panels not be placed on a character roofline or on a primary elevation, as to not be visible from the streets.[84] Solar panels are required to be set back on flat rooftops, as to not alter the historic roofline or character defining features such as dormers or chimneys.[85] The ordinance in Breckenridge reflects the primary trend in solar panels design parameters within a historic context. Preservation commissions across the nation have all denied applications for solar installations which were not in accordance with the Breckenridge ordinance, even prior to the

[83] EcoWorld. *Photovoltaic Electricity: The Ultimate Renewable Resource*. Available from http://www.ecoworld.com/features/2005/07/08/photovoltaic-electricity/. Accessed on 1 April 2009.
[84] City of Breckenridge, Colorado. *Ordinance No.26.*
[85] City of Breckenridge

ordinance's adoption. In the review of solar installation applications, local preservation commission members should first ask if the character defining features of a property are going to be compromised. Historic rooflines, dormers, chimneys, and elevations should be preserved during the design process. Solar panels should be installed in a manner which restricts their visibility from the right of way, thereby not diminishing the character of the historic property or district. Commission members should only approve solar installations which are reversible, and will not permanently infringe upon the historic resource. Review of solar applications may best be done on a case by case basis, as photovoltaics are not appropriate for every historic resource.

Wind

Wind energy has been used for centuries to drive mills and pump water, and wind turbines have come a long way from the first designs of 1891.[86] Today, larger wind turbines are able to power whole communities with no air emissions, no solid waste, and no use of water. Wind turbines come in two basic forms: horizontal-axis (propeller style) and vertical-axis (eggbeater style). The horizontal-axis turbines are by far the more common of the two choices. Turbine design includes a rotor (blades), which converts the wind's energy into rotational energy. A drive train, gearbox, generator, tower, and electronic controls are also necessary when constructing a contemporary wind turbine.

Residential wind turbines can be divided into three size categories: small, medium and large. Small turbines can be further divided into micro (4 foot diameter), mini (10 foot diameter) and household sizes (29 foot diameter).[87] In most cases, small turbines are used to generate

[86] Pahl 2007, p.21
[87] Pahl 2007, p.66

energy for a single household or as stand-alone power systems for remote sites. Ideal tower height for household size turbines is 80 feet with no trees, or 120 feet if trees are present.[88]

Incorporating one or two wind turbine generators on a site is likely to be less cost effective than a wind farm with hundreds of turbines. Wind resources in an area should be determined prior to the insulation of a turbine. Small-scale turbines often require steady wind over 20 miles per hour to maximize cost effectiveness.[89] Many historic districts are not going to see a wind consistency necessary to make small wind turbines cost effective for homeowners. The applicant who wishes to integrate a turbine into a historic property often will be doing so for reasons besides reclaiming initial investment. These homeowners are installing wind turbines because they will reduce some of the utility bills. They are more of a statement installation saying that these turbines are a way for homeowners to tell their community they are actively participating in sustainable endeavors.

Environmental benefits aside, a large portion of the population does not wish to have wind turbines in their backyard due to size and the noise generated by these devices. Mini wind turbines, with diameters of roughly 10 feet, have been tried in residential settings in an attempt to mitigate some of these concerns. In Cambridge, Massachusetts the local historic preservation commission agreed to allow a homeowner to install a mini wind turbine atop her Greek Revival property on a trial basis. In images from the property, the turbine takes up the same amount of space as a satellite dish. However, data on the amount of energy collected from the turbine and the effect of any vibrations caused by its installation is yet unknown.

[88] Pahl 2007, p.67
[89] ASHRAE GreenGuide. *The Design, Construction, and Operation of Sustainable Buildings.* Amsterdam: Elsevier, 2006 p.261.

Figure 8: Wind Turbine in Cambridge, MA[90]

Recommendations

Historic preservation commissions need to be aware of the various sizes of turbines available, and review these options according to their historic district design guidelines. If a turbine makes the exact same physical and visual impact as that of a satellite dish, and your commission staff member can approve those applications, then the denial of a mini turbine could easily place the local commission in an uncomfortable political situation. As with satellite dishes, wind turbines should not be installed on the primary elevation of a historic property.

Local preservation commissions should consider the vibrations produced by the wind turbine. In certain instances where the turbine is attached to the building, as in the Cambridge, Massachusetts example, the vibrations may by damaging to the structural integrity of the home. The reversibility of some turbine installations allow for a trial period where data can be collected regarding weight, vibration, and energy generation. If there is a negative impact to the resource during this time period the turbine must be removed. Free-standing wind turbines should be examined in the context of the individual property or collective district. A preservation

[90] Photo Courtesy of Paul Trudeau

commission needs to determine if the installation of a large turbine will detract from the historic character defining features of a property and subsequent surrounding neighborhood.

Geothermal

Geothermal energy comes from reservoirs inside the Earth from which heat can be extracted and generated into electric power. This source of energy is less expensive to remove from the Earth than conventional sources such as coal and oil.[91] Calculations show that the earth, originating from a completely molten state, would have cooled and become completely solid many thousands of years ago without an energy input in addition to that of the sun. It is believed that the ultimate source of geothermal energy is radioactive decay occurring deep within the earth.[92]

In the majority of areas throughout the United States, this heat diffuses as it rises toward the surface. It is in several deposits located mainly in western states where reservoirs have accumulated. Three temperature levels of geothermal energy determine the manner in which it is utilized. High temperature geothermal is used for electricity, and current United States geothermal power equals that produced by four nuclear power plants.[93] Moderate and low temperature geothermal can be utilized on a residential level for direct use or ground-source heat pumps.

Direct usage of geothermal can be beneficial for singular historic properties or whole districts. In Klamath Falls, Oregon, the municipality chose to install geothermal energy through

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[91] Gupta, Harsh and Sukanta Roy. *Geothermal Energy: An Alternative Resource for the 21st Century.* Amsterdam: Elsevier, 2007.

[92] Geothermal Resource Council. *What is Geothermal?* Available from http://www.geothermal.org/what.html. Accessed on 28 January 2009.

[93] Geothermal Resource Council.

direct use under sidewalks to prevent the accumulation of snow and ice in the winter months.[94] The same community uses pipes to bring in geothermal water to heat single family homes or whole residential districts. There are currently 18 districts being heated with direct use geothermal energy in the western United States, and an additional 270 cities through the nation with geothermal capabilities.[95] States beyond the western region which have the geothermal reservoirs necessary for direct usage include Texas, Oklahoma, Georgia, New York, Pennsylvania, and Tennessee.

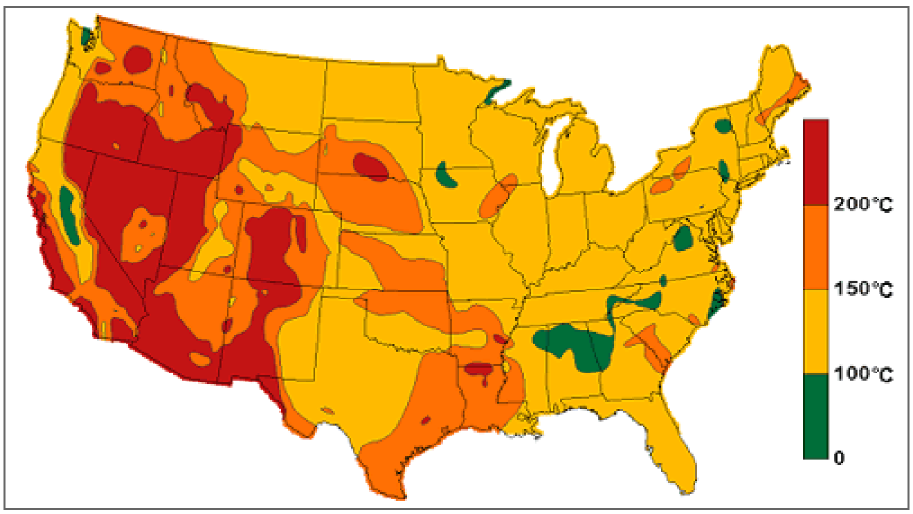

Figure 9: Geothermal Resources at 6 Kilometers[96]

Geothermal heat pumps are devices that take advantage of the relatively constant temperature of the Earth from about 10 ft to 300 ft down from the Earth's surface. These pumps can be used almost everywhere in the world, as they do not require geothermal reservoirs. By pumping fluid through loops of pipe buried underground next to a building, these systems transfer heat into buildings in winter and out of them in summer. The Environmental Protection

[94] Geothermal Education Office. *Introduction to Geothermal.* Available from http://www.geothermal.marin.org/GEOpresentation/sld088.htm. Accessed on 28 January 2009.

[95] Geothermal Education Office.
[96] Geothermal Education Office

Agency considers them to be one of the most efficient heating and cooling systems available.[97] Geothermal heat pumps can be implanted in all fifty United States.

An obvious benefit for a historic property owner who utilizes this energy source is the extremely low visibility of geothermal systems. The majority of the mechanical workings of the direct use and heat pump devices are located underground. Therefore, unless a historic landscape is present, the geothermal systems would not infringe upon the historic integrity of a property (Figure 10). What a local historic preservation commission will need to consider is the placement of the heat pump unit. For a single family household the size of this unit is typically the same as an air-conditioning unit.

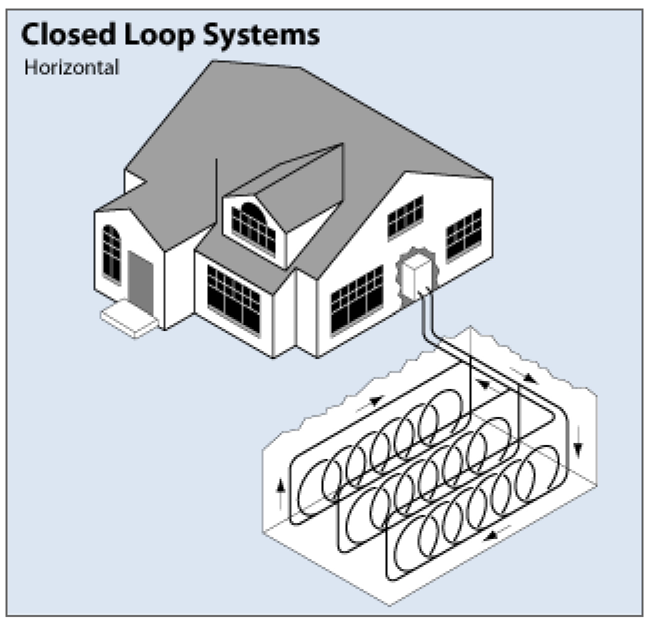

Figure 10: Geothermal Heat Pump[98]

[97] Geothermal Energy Association. Available from http://www.geo-energy.org/. Accessed on 12 January 2009.
[98] U.S. Department of Energy

Recommendations

Geothermal systems, direct usage and heat pumps, are continually growing in popularity. While limited regions in the United States provide the natural resources required for direct usage of geothermal energy, geothermal heat pump systems are available for installation nationwide. It is with this wide distribution potential that requires preservation commissions to be cognizant of their composition and installation requirements. A preservation commission has the authority to review such installations as the call into question the historic integrity of a property's landscape and gardens. If a property is historically significant for more than solely the building itself, a preservation commission needs to review the impact of the heat pump on the character defining features of the landscape. If the landscape is deemed non-significant by the preservation commission or staff, than the preservation commission should reference the provisions for HVAC units within the local design guidelines for most geothermal review. The portion of the geothermal system visible above ground should be bordered by appropriate shrubbery or constructed screen as to not detract from the integrity of the resource.

Green Roofs

A green, or vegetated, roof system is an expansion of the existing roof which involves a high quality water proofing and root repellant system, a drainage system, filter cloth, a lightweight growing medium and plants. Green roof systems may be modular, with drainage layers, filter cloth, growing media and plants already prepared in movable, interlocking grids, or, each component of the system may be installed separately. Green roof development involves the creation of "contained" green space on top of a human-made structure. This green space could be below, at or above grade, but in all cases the plants are not planted in the "ground".[99]

Green roofs are becoming increasingly popular in the United States. The city of Chicago, Illinois alone had over 200 green roofs in 2008.[100] There are two types of green roof systems: intensive and extensive. Intensive green roofs are an older, traditional-style rooftop garden, with large trees and shrubs (Figure 11). They often are accessible to the public and can include garden paths, seating, and other features that make the roof more like a park. As suggested by the name, they are labor-intensive, requiring irrigation and continuous maintenance. Intensive roofs are multi-layer constructions, typically installed over concrete roof decks. They require substantial structural capacity: approximately 8 inches to 4 feet of soil depth, and support of roof weight loads from 80-150 pounds per square foot.[101]

Figure 11: Intensive Green Roof[102]

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[99] Green Roofs for Healthy Cities. *About Green Roofs.* Available from http://www.greenroofs.org/index.php?option=com_content&task=view&id=26&Itemid=40. Accessed on 10 February 2009.

[100] Yudelson 2008, p.126

[101] Center for Sustainability as Aquinas College. *Green (or Vegetated) Roofs.* Available from http://www.centerforsustainability.org/resources.php?root=176&category=236. Accessed on 20 January 2009.

[102]Architect, Builder, Contractor, Developer. *Join the Green Revolution.* Available from http://www.abc-d.co.uk/Hot_Topics/green_revolution. Accessed on 20 February 2009.

Extensive roofs vary from intensive systems mainly by their design. These roofs systems are primarily designed for environmental benefits (Figure 12), but may also accommodate public use. They help to mitigate the effects of storm water runoff by filtering, absorbing and/or detaining rainfall. Extensive green roofs can have a soil depth of approximately 1 to 7 inches and have a weight load of 15 pounds per square foot.[103] They are constructed for a lightweight soil medium and are underlain by a drainage layer and a high quality impermeable membrane that protects the building structure.[104] Extensive green roofs can be installed during the construction of a new building or retrofitted on existing roof decks.

Figure 12: Extensive Green Roof[105]

Green roofs are becoming one of the most effective green building measures as they extend the life of the roof, keep the building cool in summer and warm in winter, provide wildlife habitat, reduce the urban heat island effect, provide a sound buffer, absorb carbon dioxide and create aesthetically pleasing green space amidst the surrounding concrete.[106]

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[103] Center for Sustainability
[104] Center for Sustainability
[105] Architect, Builder, Contractor, Developer
[106] Center for Sustainability

A structural engineer should always first inspect the structure to determine its roof weight load limitations of a roof prior to the implementation of a vegetated roof system. Historic properties across the nation have utilized this technology in efforts for increased sustainability. The Chicago City Hall, Baltimore's Montgomery Ward Building, and the Hawthorne Hostel in Portland all successfully implemented this green building technology into an historic resource.

Figure 13: Chicago, IL City Hall (Before)[107]

Figure 14: Chicago, IL City Hall (After)[108]

[107] Appendix J
[108] Appendix J

Recommendations

Local historic preservation commissions may be both excited and concerned with vegetated roofs installed on their local historic resources. Intensive green roofs are typically going to be too intrusive, in weight and visibility, to be of benefit to historic homes and therefore approval of such installations should be avoided by preservation commissions. Extensive green roofs are more likely to be integrated into the roof of a historic residence, due to their decreased soil bed and lesser weight per square foot. Prior to approval of a green roof by preservation commission, thorough research needs to be conducted regarding the structural impact of the installation on the resource. Historic properties were not designed with the concept of green roofs, and therefore even the additional 15 pounds per square foot of the extensive green roof system may be beyond the carrying capacity of the roof.

A green roof will be able to be seen on sloped roofs and should be considered when reviewing the local preservation guidelines. A flat roof resource will have minimal or no visual effects with a green roof installation and, therefore, the sole concern should be with the structural capacity of the historic roof. If the design guidelines prohibit installation of solar panels where they can be seen from the right of way, the installation of a green roof may cause similar rulings.

Rainwater Harvesting

Rainwater harvesting is a technology used for collecting and storing rainwater from rooftops, the land surface or rock catchments using simply jars and pots or more intricate techniques such as underground check dams. Stored water can be used for non-potable purposes such as irrigating lawns, washing cars, or flushing toilets. Frequently used residential rain harvesting systems are comprised of rooftop catchment systems.[109]

[109] Srinivas, Hari. *Introduction to Rainwater Harvesting.* Available from http://www.gdrc.org/uem/water/rainwater/introduction.html. Accessed on 17 April 2009.

The catchment areas are associated with either the rooftop of a building or the land surrounding it. A rooftop catchment, in a very basic form, is the collection of water through vessels located at the edge of the roof. Developed approaches on this catchment include the collection of rainwater in gutters which then drain to a collection vessel, typically a barrel or cistern, through installed down-spouts.[110] Rain water may also be taken from the gutters to containers for the process of settling particles before being utilized. If the rooftop is the catchment area, the amount and quality of rainwater collected depends heavily upon the area and type of roofing material. Reasonably pure rainwater can be collected from roofs constructed with galvanized corrugated iron, aluminum or asbestos cement sheets, or tile and slate roofs.[111] Roofs with metallic paint or other coatings are not recommended as they may impart tastes or color to the collected water.

Figure 15: Rooftop Rainwater Harvesting System

Rainwater harvesting utilizing land surface catchment areas is less complex way of collecting rainwater. It involves improving runoff capacity of the land surface through various

[110] Srinivas
[111] Srinivas

techniques including collection of runoff with drain pipes and storage of collected water.[112] Compared to rooftop catchment techniques, ground catchment techniques provide more opportunity for collecting water from a larger surface area. By retaining the flows of small creeks and streams in small storage reservoirs created by low cost dams, this technology can meet water demands during dry periods.[113] A high possibility of water loss due to infiltration into the ground, along of the often marginal quality of the water collected, results in this technique being best suited for storing water for agricultural purposes.

Some states, such as Colorado, have state laws which prohibit the collection of rainwater as such action would route water away from streams and rivers. Most areas in the United States are capable of utilizing a rainwater harvesting system. The local preservation commission should reference their state laws to determine the legality of rainwater harvesting in their community.

Recommendations

Historic preservation commissions should support the implementation of rainwater harvesting systems where permissible by the state. Harvesting systems may be installed in such a manner as to not be visible intrusive or detrimental to the integrity of a historic site. A preservation commission should work to maintain the appearance of the original gutter system, and require that all cisterns, barrels, and mechanical support be surrounded by shrubbery or constructed screens as to minimize their appearance from the right of way.

After the Fact Approval

Homeowners who are interested in installing integrative systems at a historic property or within a historic district are not always going to consider applying for permission from the local preservation commission. "Covenants, historic district regulations, and flood-plain provisions

[112] Srinivas
[113] Srinivas

can easily be overlooked”.[114] Professional installation of integrated systems is highly recommended; however the thrifty and resourceful home owner can often purchase do-it-yourself kits for their property, not apply for a building permit, and thereby illegally bypass the local historic preservation commission. Homeowners may consider applying for a building permit or zoning variance, and if the commission does not have an active dialogue with these other departments within the community, the chances of an after-the-fact review increase. Commissions have found themselves in uncomfortable public relation situations regarding after-the-fact applications, and in this instance may risk appearing to disregard the environmental benefits arbitrarily and consequently be seen in a negative light when requiring a home owner to remove an expensive installation

To prevent this circumvention around the local preservation commission, the commission must be proactive in outreach and education programs focused toward homeowners. Once a property owner is made aware of the review authority of preservation commissions, the type of changes that require a certificate of appropriateness, and the guidelines used for review, they are less likely to proceed with unauthorized construction projects.

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[114] U.S. Department of Energy

CHAPTER 7

CONCLUSION AND RECOMMENDATIONS

Interpreting the principles of historic preservation has always been the job of the local historic preservation commission, and it is these principles that make the practice of historic preservation inherently sustainable. The commission members and staff need to be properly trained in the available sustainability technology, as well as simple solutions to common energy complaints by historic home owners. A lack of training programs geared toward the incorporation of historic preservation and sustainability, and a deficiency in public outreach and education on the matter have resulted in the current state of affairs. Local preservation commissions must begin to receive proper training and education pertaining to 'green' preservation, and then pass the acquired knowledge onto members of their community.

Recommendations for the implementation of such training and outreach are:

1. Training sessions regarding preservation and sustainability should be held annually, as sustainable building technology is constantly advancing. These sessions may be conducted by the state Certified Local Government Coordinator, a national non-profit specializing in commission training, or the State Historic Preservation Office.
2. Sustainable ideas, and premises must be incorporated into an historic preservation commissioner's training packet or commission notebook to make sure information is always on hand.
3. Publish brochures on the inherent sustainability of historic preservation practices, historic window repair, and energy efficient updates for historic properties. These

4. brochures need to be distributed among property owners and residents within local historic districts.
5. Offer proactive assistance to homeowners looking to make their properties more energy efficient. This can be done through a link on the preservation commission's website for local organizations and tradesmen experienced in the sensitive process of 'greening' historic properties, by hosting public workshops, and production of educational literature on sustainability and preservation.
6. A review of the local preservation ordinance and design guidelines needs to be conducted. Sustainable information and regulations should be integrated in the appropriate context for individual communities.
7. Educational programs for green professionals explaining the benefits of historic preservation should be developed and implemented.
8. Research funding programs related to 'green' or 'sustainable' municipal programs. Financial assistance for the implementation of the above recommendations may be available from State Historic Preservation Offices, the United States Department of Energy, and the Environmental Protection Agency through grant programs or incentives.

Continued research into the study of embodied energy would be a next course of action in legitimizing and quantifying the value of historic resources. The Advisory Council for Historic Preservation study was comprehensive, however is in need of contemporary updates.

Future research should continue to monitor emerging examples of local preservation commissions that are currently acting as prototypes for the implementation of sustainable practices as applied to local historic preservation policy. Two examples are Boulder, Colorado and Davidson, North Carolina.

Prior to the implementation of any sustainability program affecting local preservation commission training and policy, proper review of a community's needs must be assessed. Communities will want to maintain the historic integrity of their local resources, while also incorporating efficient, cost-effective, and unobtrusive sustainable technologies. Preservation of local community character should be the priority throughout the development efforts for such sustainable programs into local historic preservation public policy.

The majority of local historic preservation commissions will receive training contracted through organizations outside their own community. It is not enough to simply research the prospect of sustainability within a historic context, the implantation of proper practices must begin. Nationwide organizations specializing in the training of local historic preservation commissions need be to begin offering such "green" training programs to communities. The National Alliance of Preservation Commissions, the National Trust for Historic Preservation Commissions, the National Center for Preservation Technology and Training should all be working to integrate sustainability training applications within their established training programs. Once nationwide organizations begin offering this training as standard, and not superfluous, the importance of sustainability and local preservation integration will trickle down to the smaller organizations and local governments where the need it greatest.

The ultimate responsibility over the integration of sustainability and historic preservation falls at the feet of the local historic preservation commission. It is their responsibility to maintain the historic integrity and character-defining attributes of local historic landmarks and districts, and the preservation commission should take all measures necessary to ensure proper collaboration between the principles of preservation and those of sustainable development.

REFERENCES

Advisory Council on Historic Preservation. *Assessing the Energy Conservation Benefits of Historic Preservation: Methods and Examples.*

Architect, Builder, Contractor, Developer. *Join the Green Revolution.* Available from http://www.abc-d.co.uk/Hot_Topics/green_revolution. Accessed on 20 February 2009.

Arizona Solar Center. *Passive Solar Heating and Cooling.* Available from http://www.azsolarcenter.com/technology/pas-2.html Internet; accessed 13 February 2009.

ASRAHE GreenGuide. *The Design, Construction, and Operation of Sustainable Buildings.* Amsterdam: Elsevier, 2006.

Atlantis Energy Solutions, Inc. Available from http://www.atlantisenergy.org/sunslates2.html. Accessed on 12 October 2008.

Banovetz, James M. *Managing Local Governments: Cases in Decision Making.* Washington, D.C.: International City Management Association, 1990.

Bernstein, Paul. *Alternative Energy: Facts, Statistics, and Issues.* Westport: Oryx Press, 2001.

Brophy, Sarah S. and Elizabeth Wylie. *The Green Museum.* Lanham: AltaMira Press, 2008.

Campagna, Barbara AIA, LEED AP. *How Changes to LEED will Benefit Existing and Historic Buildings.* Available from http://www.aia.org/practicing/groups/kc/AIAS076321?dvid=4294965183&recspec=AIAS076321. Accessed on 12 February 2009.

Center for Sustainability as Aquinas College. *Green (or Vegetated) Roofs.* Available from http://www.centerforsustainability.org/resources.php?root=176&category=236. Accessed on 20 January 2009.

City of Boulder. *Making Your Historic Building Energy Efficient: Volume 1 Principles and Approaches.* Available from http://www.bouldercolorado.gov/files/PDS/historicpres/hist_supp_vol1_energy_efficient.pdf. Accessed on 20 August 2008.

City of Breckenridge, Colorado. *Ordinance No.26.*

EcoWorld. *Photovoltaic Electricity: The Ultimate Renewable Resource*. Available from http://www.ecoworld.com/features/2005/07/08/photovoltaic-electricity/. Accessed on 1 April 2009.

Elefante, Carl. *Historic Preservation and Sustainable Development: Lots to Learn, Lots to Teach.* APT Bulletin Vol. 36, No. 4 (January 2005); 53.

Energy Notebook. *Save Energy the Old-Fashioned Way.* Remodeling Ideas (Winter 1986), 37.

Enginnering.com. *Passive Solar Systems and Hot Water Systems.* Available from http://images.google.com/imgres?imgurl=http://www.engineering.com/portals/0/images/sunspace.gif&imgrefurl=http://www.engineering.com/SustainableEngineering/RenewableEnergyEngineering/SolarEnergyEngineering/PassiveSolarSystemsSolarHotWater/tabid/3892/Default.aspx&usg=__3pe_PNLc1XR3_j5A8MyP8OBxhlE=&h=323&w=318&sz=13&hl=en&start=20&um=1&tbnid=Xmfe-C7XBxeoXM:&tbnh=118&tbnw=116&prev=/images%3Fq%3Dpassive%2Bsolar%2Bdesign%26ndsp%3D21%26um%3D1%26hl%3Den%26sa%3DN. Internet; Accessed 10 February 2009.

Geothermal Education Office. *Introduction to Geothermal.* Available from http://www.geothermal.marin.org/GEOpresentation/sld088.htm. Accessed on 28 January 2009.

Geothermal Energy Association. Available from http://www.geo-energy.org/. Accessed on 12 January 2009.

Geothermal Resource Council. *What is Geothermal?* Available from http://www.geothermal.org/what.html. Accessed on 28 January 2009.

Green Roofs for Healthy Cities. *About Green Roofs.* Available from http://www.greenroofs.org/index.php?option=com_content&task=view&id=26&Itemid=40. Accessed on 10 February 2009.

Gupta, Harsh and Sukanta Roy. *Geothermal Energy: An Alternative Resource for the 21st Century.* Amsterdam: Elsevier, 2007.

Jackson, Mike. *Embodied Energy and Historic Preservation: A Needed Reassessment.* APT Bulletin Vol. 36, No. 4 (January 2005); 47-52.

James, Brad, Andrew Shapiro, Steve Flanders, and Dr. David Hemenway. *Testing the Energy Performance of Wood Windows in Cold Climates.* Available from http://www.ncptt.nps.gov/wp-content/uploads/1996-08.pdf. Accessed on 13 February 2009.

Krieth, Frank and D. Yogi Goswami. *Handbook of Energy Efficiency and Renewable Energy*. Boca Raton: CRC Press, 2007.

Minnesota Office of the Revisor of Statutes. *471.193 2008 Municipal Heritage Preservation*. Available from https://www.revisor.leg.state.mn.us/statutes/?id=471.193. Accessed on 19 February 2009.

Mouzon, Stephen A. *The Original Green.* Available from http://www.traditional-building.com/Previous-Issues-08/AugustFeature08Green.html. Accessed on 20 February 2009.

National Trust for Historic Preservation. *Annual Reports 2003-2007.* Available from http://www.preservationnation.org/about-us/annual-report-and-tax-returns/. Accessed on 12 February 2009.

National Trust for Historic Preservation. *Historic Wooden Windows.* Available from www.preservationnation.org/issues/sustainability. Accessed on 26 February 2009.

National Trust for Historic Preservation. *Sustainability by the Numbers*. Available from http://www.preservationnation.org/issues/sustainability/additional-resources/sustainability-numbers.html. Accessed on 13 February 2009

Pahl, Greg. *The Citizen-Powered Energy Handbook: Community Solutions to a Global Crisis.* White River Junction: Chelsea Green, 2007.

Pocantico Symposium:"Sustainability and Historic Preservation – Making Policy. *Draft Proclamation on Sustainability and Historic Preservation* . 2009

Preservation North Carolina and the State Historic Preservation Office of North Carolina. *Handbook for Historic Preservation Commissions in North Carolina.* Raleigh; North Carolina Department of Cultural Resources, 1994.

Roosa, Stephen A. *Sustainable Development Handbook.* Boca Raton: CRC Press, 2008.

Rypkema, Donovan. *Economics, Sustainability, and Historic Preservation.* Available from http://www.preservationnation.org/issues/transportation/additional-resources/rypkema-speech-sustainability-portland-10012005.pdf. Accessed on 10 February 2009.

Smith, Bernard M. AIA. *Preservation Brief 3: Conserving Energy in Historic Buildings.* Available from www.nps.gov/history/hps/tps/briefs/brief03.htm. Accessed on 16 April 2009.

Smiley Building. *Conservation Features*. Available from http://www.smileybuilding.com/solar/conservation.html. Accessed on 17 April 2009.

Srinivas, Hari. *Introduction to Rainwater Harvesting.* Available from http://www.gdrc.org/uem/water/rainwater/introduction.html. Accessed on 17 April 2009.

United States Department of Energy. *A Consumer's Guide to Energy Efficiency and Renewable Energy*. Available from http://apps1.eere.energy.gov/consumer/your_home/space_heating_cooling/index.cfm/mytopic=12490. Internet; Accessed on 13 February 2009.

U.S. Department of Energy. *PV Systems.* Available from http://www1.eere.energy.gov/solar/pv_systems.html. Accessed on 16 April 2009.

United States Green Building Council. *LEED Rating System.* Available from http://www.usgbc.org/. Accessed on 26 August 2008.

United States Green Building Council. *LEED 2009 New Construction for Second Public Comment.* August 25, 2008.

Vick, Alfred. *Green Building Intro and Background.* Available from https://webct.uga.edu/SCRIPT/land4730av/scripts/serve_home. Accessed on 9 February 2009.

Wallace, Andy. *Weatherizing the Old House.* The Old House Journal (September 1986).

Young, Robert A. PE, LEED AP. *Historic Preservation Technology.* Hoboken; John Wiley & Sons, 2008.

Yudelson, Jerry. *The Green Building Revolution.* Washington; Island Press, 2008.

APPENDIX A

GLOSSARY OF TERMINOLOGY

Adaptive Reuse: Renovation of a building or site to include elements that allow a particular use or uses to occupy a space that originally was intended for a different use.

Aerators: Add-ons to faucets in sinks and showers that incorporate air into the water as it comes out. This reduces water consumption, while producing a wider spray with equal force.

Alternative Energy: Energy from a source other than the conventional fossil-fuel sources of oil, natural gas and coal (i.e., wind, running water, the sun). Also referred to as "alternative fuel."

ASHRAE 90.1: The American Society of Heating, Refrigerating and Air-Conditioning Engineers' guideline for evaluating the energy demands and costs of the heating, cooling, lighting, and other systems of the proposed design and comparing that to the figures for base building design that meeting ASHRAE 90.1 prescriptive requirements.

Baseline Building Performance: The annual energy cost for a building design intended for use as a baseline for rating above standard design, as defined in ASHRAE 90.1 – 2004 Informative Appendix G.

Best Management Practice (BMP): Methods that have been determined to be the most effective, practical means of preventing or reducing pollution from non-point sources

Biodegradable: Able to break down completely and naturally into safe materials for the environment.

Biofiltration: Using living materials, usually plants, to filter water.

Biomass: A collective term referring to something previously living that is being converted into something else. Most often this means agricultural waste burned for heat or converted into energy.

Bioswale: Landscaped areas capture water runoff, retaining and cleansing it of silt and pollution before it is released into the storm sewer or watershed.

Black Water: Waste water from toilets and other contaminated uses that must be treated before discharge or reuse.

Building Cooling Load: The hourly amount of heat that must be removed from a building to maintain indoor comfort (measured in British thermal units [Btu]).

Building Density: The floor area of the building divided by the total area of the site (square feet per acre)

Building Envelope: The exterior surface of a building's construction--the walls, windows, floors, roof, and floor (Also called building shell).

Carbon Footprint: Generally understood to be "a measure of the impact human activities have on the environment in terms of the amount of greenhouse gases produced, measured in units of carbon dioxide."

Certified Lumber: Shorthand term for lumber that has been certified sustainable harvest by an independent certification authority.

Chlorofluorocarbons (CFCs): A family of inert, nontoxic, and easily liquefied chemicals used in refrigeration, air conditioning, packaging, insulation, or as solvents and aerosol propellants. Because CFCs are not destroyed in the lower atmosphere they drift into the upper atmosphere where their chlorine components destroy ozone.

Cistern: Small tank or storage facility used to store water for a home or farm; often used to store rainwater.

Climate-dominated Building: A building in which the energy consumption is driven by the heat loss or gain that moves across the building's envelope. The internally generated energy requirements from machines, appliances or people are smaller than the energy requirements created by heat or cold moving through the building's envelope. This means that heating, cooling and ventilation are the building's biggest energy requirements.

CO2: Carbon dioxide

Commissioning: Building Commissioning is the systematic process of assessing the building system design and post occupancy performance compared to the design intent.

Compact Fluorescent Lighting (CFLs): Lights that can be used in traditional light fixtures, often cork screw in design, and utilize significantly less energy.

Composting: Controlled biological decomposition of organic material in the presence of air to form a humus-like material. Controlled methods of composting include mechanical mixing and aerating, ventilating the materials by dropping them through a vertical series of aerated chambers, or placing the compost in piles out in the open air and mixing it or turning it periodically.

Construction Waste Management: General term for strategies employed during construction and demolition to reduce the amount of waste and maximize reuse and recycling. Construction waste management is a sustainable building strategy in that it reduces the disposal of valuable resources, provides materials for reuse and recycling, and can promote community industries.

Cradle-to-Cradle: A term used in life-cycle analysis to describe a material or product that is recycled into a new product at the end of its defined life.

Cradle-to-Grave: A term used in life-cycle analysis to describe the entire life of a material or product up to the point of disposal. Also refers to a system that handles a product from creation through disposal.

Cubic Feet Per Minute (CFM): A measure of the volume of a substance flowing through air within a fixed period of time. With regard to indoor air, refers to the amount of air, in cubic feet, that is exchanged with outdoor air in a minute's time; i.e., the air exchange rate.

Database of States Incentives for Renewable Energy (DSIRE): An online listing, by state, of renewable energy rebates and other financial incentives.

Daylight Harvesting: Allowing daylight to penetrate into buildings to reduce the need for artificial lighting.

Daylighting: Using daylight to provide light inside a building, through windows, tubular devices, skylights, and wall placement. (Also see daylight harvesting)

Development Footprint: The area on the project site that has been impacted by any development activity. Hardscape, access roads, parking lots, non-building facilities and building structure are all included in the development footprint.

Embodied Energy: The total amount of energy used to create a product, including energy expended in raw materials extraction, processing, manufacturing and transportation. Embodied energy is often used as a rough measure of the environmental impact of a product. Energy that is used during the entire lifecycle of the commodity for manufacturing, transporting and disposing of the commodity as well as the inherent energy captured within the product itself.

Encapsulation: The treatment of asbestos-containing material with a liquid that covers the surface with a protective coating or embeds fibers in an adhesive matrix to prevent their release into the air.

Energy Audit: A review of energy uses, including rates, amounts, types, fixtures, and demand levels to create benchmarks and located areas for energy conservation or system changes.

Energy or water conservation: Using less energy or water. Conservation can imply a lifestyle change or a reduced level of service. Lowering thermostat settings or installing a shower flow restrictor are both examples of energy conservation.

Energy or water efficiency: Using less water or energy to perform the same tasks. A device is energy-efficient if it provides comparable or better quality of service while using less energy than a conventional technology. Building weatherization or high-efficiency showerheads are efficiency technologies.

Energy Star: A joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy. It is a combination of programs, tools, and the products that help individuals and businesses save energy.

Environmental Footprint: For an industrial setting, this is a company's environmental impact determined by the amount of depletable raw materials and nonrenewable resources it consumes to make its products, and the quantity of wastes and emissions that are generated in the process. Traditionally, for a company to grow, the footprint had to get larger. Today, finding ways to reduce the environmental footprint is a priority for leading companies. An environmental footprint can be determined for a building, city, or nation as well, and gives an indication of the sustainability of the unit.

Environmental Impact Statement: A document required of federal agencies by the National Environmental Policy Act for major projects or legislative proposals significantly affecting the environment. A tool for decision making, it describes the positive and negative effects of the undertaking and cites alternative actions.

Environmental Sustainability: Practices that rely on renewable or reusable materials and processes that are environmentally benign.

Extensive Green Roof: A green roof that is primarily a single shallow depth that is low maintenance, with low growing plants.

Geothermal: Existing heat inside the earth. Sometimes it comes out in hot springs, usually we access it through wells and pipes containing are or water at a nearly constant 55° Fahrenheit. In the summer this air or water is much cooler than outside air, therefore decreasing the energy required to cool indoor air temperatures. Conversely, the air or water is much warmer than outside air in the wintertime, reducing the degrees of heating required to reach a comfortable level indoors in the winter. The system can use horizontal or vertical piping, water or air, and each choice affects the type of heat exchange system required to modify air temperature in the building.

Gray Water: Waste water from sinks, not contained but nonpotable.

Green Design: A design, usually architectural, conforming to environmentally sound principles of building, material and energy use. A green building, for example, might make use of solar panels, skylights and recycled building materials.

Green Development: A sustainable approach to real estate development that incorporates such environmental issues as: efficient and appropriate use of land, energy, water, and other resources; protection of significant habitats, endangered species, archeological treasures and cultural resources; and integration of work, habitat and agriculture. Green development supports human and natural communities and cultural development while remaining economically viable for owners and tenants.

Green Globes: An environmental assessment and rating system that was developed by the Green Building Initiative.

Green Roof: A roof, flat or sloped, built and planted to capture precipitation, clean it, and slowly release it back into the air. They also have the advantage of reducing the heat island effect by acting as a buffer between the building and solar heat.

Green Wall: A planted vertical surface, either interior or exterior; may also be referred to as a living wall.

Greenwashing: Adapted from the term whitewashing, means exaggerating green properties or arbitrarily selecting the green aspects and ignoring the non-green aspects.

Harvesting: Collecting something for use or reuse.

Heat Island Effect: The buildup of heat, in urban or built areas, as the sun's heat is absorbed in dark roofs and pavement.

Heating, Ventilation, and Air Conditioning (HVAC): General term for the heating, ventilation and air conditioning system in a building. System efficiency and design impact the overall energy performance of a home and its indoor environmental quality.

Impermeable Surface: Any surface, often a roof or traffic area, which does not allow water to filter through.

Indigenous Planting: Landscaping strategy that uses native plants. Provided the natives are placed in the proper growing conditions; such plantings can have low, or zero supplemental water needs. Indoor Adhesive, Sealant and/or Sealant Primer Product: Defined as an adhesive or sealant product applied on-site, inside of the building's weatherproofing system.

Integrated Design: A holistic process that considers the many disparate parts of a building project, and examines the interaction between design, construction, and operations to optimize the energy and environmental performance of the project

Intensive Green Roof: Built with deeper growing medium, and holding more substantial plants and trees, often requiring more maintenance.

Leadership in Energy and Environmental Design (LEED): The LEED rating system was introduced by the United States Green Building Council as a technically specific ranking methodology that evaluates the levels of sustainability in buildings and operations.

LEED AP: A voluntary professional certification earned by examination through the United State Green Building Council.

LEED-EB: LEED rating system for existing buildings.

LEED-NC: LEED rating system for new construction.

Life Cycle Analysis: The assessment of a product's full environmental costs, from raw material to final disposal, in terms of consumption of resources, energy and waste.

Montreal Protocol: Treaty, signed in 1987, governs stratospheric ozone protection and research, and the production and use of ozone-depleting substances. It

Nonrenewable Energy: Energy derived from depletable fuels (oil, gas, coal) created through lengthy geological processes and existing in limited quantities on the earth.

Nonrenewable Resource: A resource that cannot be replaced in the environment (e.g., fossil fuels) because it forms at a rate far slower than its consumption.

Payback: The point where the cost savings or income generated from an item or system equals the cost to purchase and install the item or system.

Permeable Surface: Any surface, often landscaping that allows for the absorption of water.

Photovoltaics: Devices that convert sunlight to electricity. Most often found as solar panels, but also available as roofing shingles, and increasingly associated with portable and remote electrical appliances.

Radiant Heat: Heat transferred in the form of light energy (including non-visible spectra). Distinct from conductive heat, occurring with the direct contact between two materials.

Rain Barrel: Barrels placed at the end of downspouts and rain chains, or other areas where rainwater runs off a roof, that catch and hold the water for reuse later in gardens.

Rain Chain: A chain placed where a downspout would be, to direct the roof runoff to the ground or rain barrel and distribute it in a way that reduces erosion force when it reaches the ground.

Rain Garden: Gardens designed and placed to capture and the absorb rainwater runoff.

Recycled Content: The content in a material or product derived from recycled materials versus virgin materials.

Recycling: Process by which materials that would otherwise become solid waste are collected, separated or processed and returned to the economic mainstream to be reused in the form of raw materials or finished goods.

Renewable Energy: Energy from sources that do not deplete natural resources, but use natural resources that are renewed or replaced rapidly, such as wind, sun, biomass, or geothermal.

Smart Lighting: Lighting systems that shut off when a room is unoccupied, or dim when daylight is available, to reduce energy consumption.

Solar Array: A series of solar panels installed to capture sunlight for conversion into electricity or to heat hot water.

Solar Heat Gain: Heat collected from the sun.

Stormwater Runoff: The water from a rain event that does not immediately absorb into the ground but runs off in quantity.

Sustainability: Practices that would ensure the continued viability of a product or practice well into the future.

Sustainable Development: An approach to progress that meets the needs of the present without compromising the ability of future generations to meet their needs.

Sustainability: Meeting the needs of the present without compromising the ability of future generations to meet their own needs.

Thermal Mass: Any material that has the capacity to store heat. How thermal mass is used n building construction depends on the climate.

Triple Bottom Line (TBL): Calculating success based on three indicators: people, planet and profit.

United State Green Building Council: A nonprofit organization that was founded in 1993 by a group of architects, engineers, and construction experts to transform the way buildings are designed, built, and operated.

Variable Frequency Drive (VFD): These drives save energy because the machines operate at the specific required demand of the system and cycles less frequently if the demand is lower.

Volatile Organic Compounds (VOCs): An organic compound that evaporates at room temperature and contributes to poor indoor air quality.

Watts per Square Foot: A shorthand measure of the energy use of a building, often applied to indoor lighting. Energy codes often limit the watts per square foot based on building type and function.

Wind Power: Systems that convert air movement into mechanical or electrical energy. Driven by the wind, turbine blades turn a generator or power a mechanical pump.

Wind Turbine: Device for generating electricity from wind; windmill

APPENDIX B

ABBREVIATIONS

APT: Association of Preservation Technology

ASHRAE: American Society of Heating, Refrigeration, and Air-Conditioning Engineers

ASTC: Association of Science and Technology Center

DOE: Department of Energy

DSIRE: Database of States Incentives for Renewable Energy

EPA: Environmental Protection Agency

GBI: Green Building Initiative

GG: Green Globes

ICLEI: International Council for Local Environmental Initiatives

LCA: Life Cycle Analysis

LCC: Life Cycle Cost

LEED: Leadership in Energy and Environmental Design

NPS: National Parks Service

PV: Photovoltaics

ROI: Return on Investment

SDWH: Solar Domestic Water Heating System

TBL: Triple Bottom Line

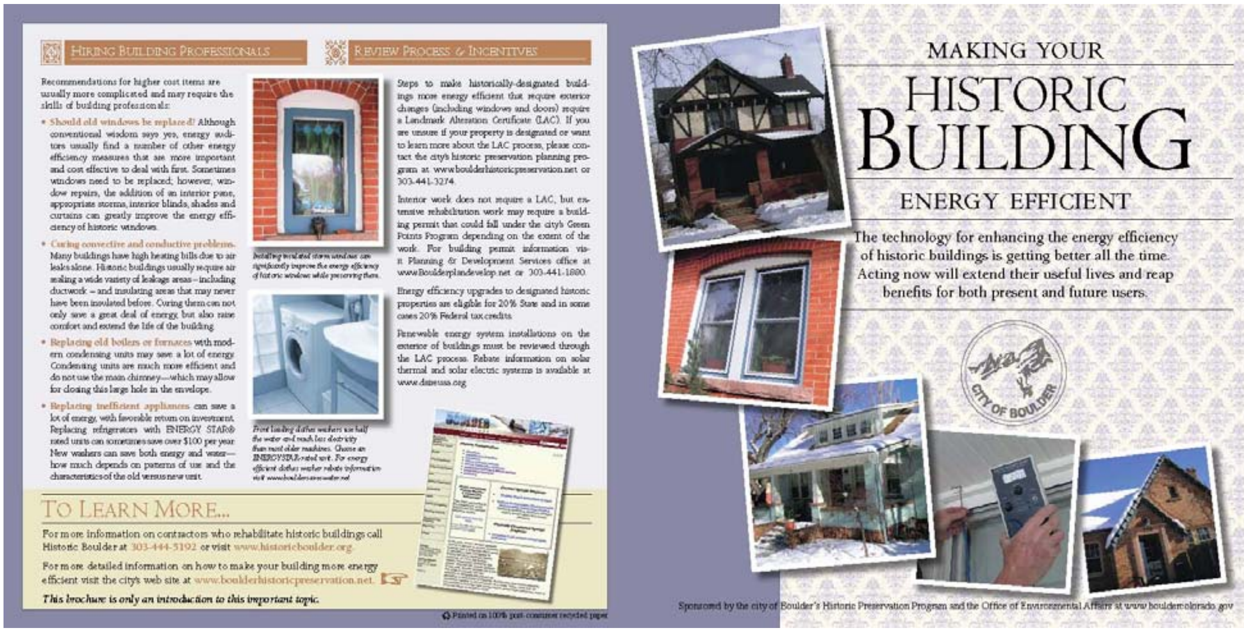
USGBC: United States Green Building Council

VOC: Volatile Organic Compound

APPENDIX C

HISTORIC BUILDING ENERGY EFFICIENT BROCHURE

BOULDER, COLORADO



Hiring Building Professionals

Recommendations for higher cost items are usually more complicated and may require the skills of building professionals:

- **Should old windows be replaced?** Although conventional wisdom says yes, energy auditors usually find a number of other energy efficiency measures that are more important and cost effective to deal with first. Sometimes windows need to be replaced; however, window repairs, the addition of an interior pane, appropriate storms, interior blinds, shades and curtains can greatly improve the energy efficiency of historic windows.
- **Curing convective and conductive problems.** Many buildings have high heating bills due to air leaks alone. Historic buildings usually require air sealing a wide variety of leakage areas – including ductwork – and insulating areas that may never have been insulated before. Curing them can not only save a great deal of energy, but also raise comfort and extend the life of the building.
- **Replacing old boilers or furnaces** with modern condensing units may save a lot of energy. Condensing units are much more efficient and do not use the main chimney—which may allow for closing this large hole in the envelope.
- **Replacing inefficient appliances** can save a lot of energy, with favorable return on investment. Replacing refrigerators with ENERGY STAR® rated units can sometimes save over $100 per year. New washers can save both energy and water—how much depends on patterns of use and the characteristics of the old versus new unit.

Installing insulated storm windows can significantly improve the energy efficiency of historic windows while preserving them.

Front loading clothes washers use half the water and much less electricity than most older machines. Choose an ENERGYSTAR-rated unit. For energy efficient clothes washer rebate information visit www.boulderwater.net

Review Process & Incentives

Steps to make historically-designated buildings more energy efficient that require exterior changes (including windows and doors) require a Landmark Alteration Certificate (LAC). If you are unsure if your property is designated or want to learn more about the LAC process, please contact the city's historic preservation planning program at www.boulderhistoricpreservation.net or 303-441-3274.

Interior work does not require a LAC, but extensive rehabilitation work may require a building permit that could fall under the city's Green Points Program depending on the extent of the work. For building permit information visit Planning & Development Services office at www.Boulderplandevelop.net or 303-441-1880.

Energy efficiency upgrades to designated historic properties are eligible for 20% State and in some cases 20% Federal tax credits.

Renewable energy system installations on the exterior of buildings must be reviewed through the LAC process. Rebate information on solar thermal and solar electric systems is available at www.dsireusa.org.

To Learn More...

For more information on contractors who rehabilitate historic buildings call Historic Boulder at 303-444-5192 or visit www.historicboulder.org.

For more detailed information on how to make your building more energy efficient visit the city's web site at www.boulderhistoricpreservation.net.

This brochure is only an introduction to this important topic.

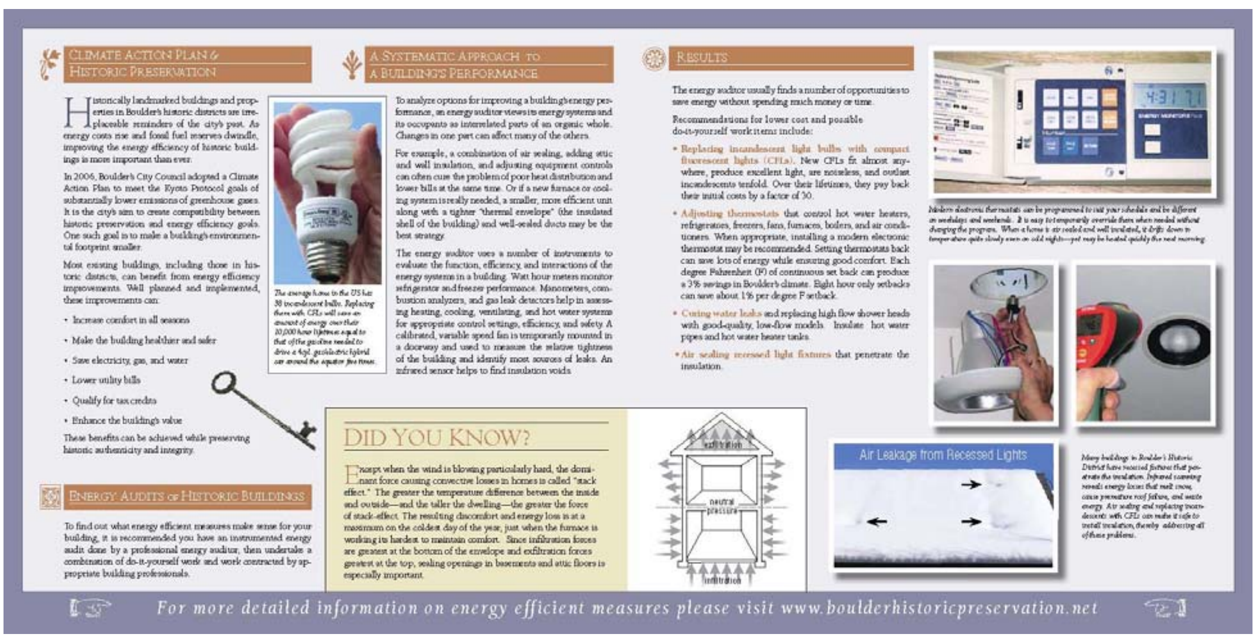
Printed on 100% post-consumer recycled paper

Making Your Historic Building Energy Efficient

The technology for enhancing the energy efficiency of historic buildings is getting better all the time. Acting now will extend their useful lives and reap benefits for both present and future users.

City of Boulder

Sponsored by the city of Boulder's Historic Preservation Program and the Office of Environmental Affairs at www.bouldercolorado.gov



Climate Action Plan & Historic Preservation

Historically landmarked buildings and properties in Boulder's historic districts are irreplaceable reminders of the city's past. As energy costs rise and fossil fuel reserves dwindle, improving the energy efficiency of historic buildings is more important than ever.

In 2006, Boulder's City Council adopted a Climate Action Plan to meet the Kyoto Protocol goals of substantially lower emissions of greenhouse gases. It is the city's aim to create compatibility between historic preservation and energy efficiency goals. One such goal is to make a building's environmental footprint smaller.

Most existing buildings, including those in historic districts, can benefit from energy efficiency improvements. Well planned and implemented, these improvements can:

- Increase comfort in all seasons
- Make the building healthier and safer
- Save electricity, gas, and water
- Lower utility bills
- Qualify for tax credits
- Enhance the building's value

These benefits can be achieved while preserving historic authenticity and integrity.

The average home in the US has 38 incandescent bulbs. Replacing them with CFLs will save an amount of energy over their 10,000 hour lifetimes equal to that of the gasoline needed to drive a 4cyl. gas/electric hybrid car around the equator five times.

A Systematic Approach to a Building's Performance

To analyze options for improving a building's energy performance, an energy auditor views its energy systems and its occupants as interrelated parts of an organic whole. Changes in one part can affect many of the others.

For example, a combination of air sealing, adding attic and wall insulation, and adjusting equipment controls can often cure the problem of poor heat distribution and lower bills at the same time. Or if a new furnace or cooling system is really needed, a smaller, more efficient unit along with a tighter "thermal envelope" (the insulated shell of the building) and well-sealed ducts may be the best strategy.

The energy auditor uses a number of instruments to evaluate the function, efficiency, and interactions of the energy systems in a building. Watt hour meters monitor refrigerator and freezer performance. Manometers, combustion analyzers, and gas leak detectors help in assessing heating, cooling, ventilating, and hot water systems for appropriate control settings, efficiency, and safety. A calibrated, variable speed fan is temporarily mounted in a doorway and used to measure the relative tightness of the building and identify most sources of leaks. An infrared sensor helps to find insulation voids.

Energy Audits of Historic Buildings

To find out what energy efficient measures make sense for your building, it is recommended you have an instrumented energy audit done by a professional energy auditor, then undertake a combination of do-it-yourself work and work contracted by appropriate building professionals.

Did You Know?

Except when the wind is blowing particularly hard, the dominant force causing convective losses in homes is called "stack effect." The greater the temperature difference between the inside and outside—and the taller the dwelling—the greater the force of stack-effect. The resulting discomfort and energy loss is at a maximum on the coldest day of the year, just when the furnace is working its hardest to maintain comfort. Since infiltration forces are greatest at the bottom of the envelope and exfiltration forces greatest at the top, sealing openings in basements and attic floors is especially important.

exfiltration

neutral pressure

infiltration

Results

The energy auditor usually finds a number of opportunities to save energy without spending much money or time.

Recommendations for lower cost and possible do-it-yourself work items include:

- **Replacing incandescent light bulbs with compact fluorescent lights (CFLs).** New CFLs fit almost anywhere, produce excellent light, are noiseless, and outlast incandescents tenfold. Over their lifetimes, they pay back their initial costs by a factor of 30.
- **Adjusting thermostats** that control hot water heaters, refrigerators, freezers, fans, furnaces, boilers, and air conditioners. When appropriate, installing a modern electronic thermostat may be recommended. Setting thermostats back can save lots of energy while ensuring good comfort. Each degree Fahrenheit (F) of continuous set back can produce a 3% savings in Boulder's climate. Eight hour only setbacks can save about 1% per degree F setback.
- **Curing water leaks** and replacing high flow shower heads with good-quality, low-flow models. Insulate hot water pipes and hot water heater tanks.
- **Air sealing recessed light fixtures** that penetrate the insulation.

Modern electronic thermostats can be programmed to suit your schedule and be different on weekdays and weekends. It is easy to temporarily override them when needed without changing the program. When a home is air sealed and well insulated, it drifts down to temperature quite slowly even on cold nights—yet may be heated quickly the next morning.

Air Leakage from Recessed Lights

Many buildings in Boulder's Historic District have recessed fixtures that penetrate the insulation. Infrared scanning reveals energy losses that melt snow, cause premature roof failure, and waste energy. Air sealing and replacing incandescents with CFLs can make it safe to install insulation, thereby addressing all of these problems.

For more detailed information on energy efficient measures please visit www.boulderhistoricpreservation.net

Available from www.boulderhistoricpreservation.net

APPENDIX D

CITY OF BOULDER, COLORADO POLICIES, REGULATIONS AND GUIDELINES REGARDING HISTORIC PRESERVATION AND ENVIRONMENTAL SUSTAINABILITY

City of Boulder Policies, Regulations and Guidelines Regarding Historic Preservation and Environmental Sustainability
Council Goals

- **Environmental Goal:** To enact and enhance city policies that will cause the Boulder community to become a nationwide environmental leader among communities. The City will be a role model of exemplary environmental practices.

Boulder Valley Comprehensive Plan Policies (2005)
Community Design Section

- **Respect unique community identity**

The community's unique identity and sense of place is in part characterized by its history and should be respected by policy makers. (Policy 2.01)

- **Preserve historic resources**

Building, districts and sites of historic, architectural, archeological, or cultural significance shall be identified and protected. (2.33)

- **Coordinate with other goals/policies**

Develop a Boulder Valley-wide preservation plan to ensure coordination between preservation goals and zoning, land use, growth management, transportation and housing goals, and ensure consistency among policies that affects the community's historic resources (2.35)

Resource Conservation Section

- **Limit use of non-renewable energy**

Limit use of non-renewable energy resources by conserving energy and converting to renewable resources. (Policy 4.39)

- **Support conversion to renewable energy**

Support private decisions to use renewable energy, develop local renewable energy where economical, and preserve future options for renewable energy for when they become cost effective. (4.39)

- **Upgrade existing buildings**

Continue efforts to improve energy-efficiency of existing buildings. Improve codes, standards and regulations assuring energy and resource efficiency in new construction, remodels and renovations. (4.41)

• **Be sensitive to historic preservation**
Energy conservation programs will be sensitive to historic preservation. Encourage renovation of existing buildings over demolition. (4.41)

• **Reduce waste**
Support programs and activities that reduce the amount of waste that must be landfilled; emphasize source reduction and reuse. Reduce solid waste produced in the city by achieving 50% waste diversion by end of 2005. (4.42)

• **Reuse materials**
Develop policies and programs which promote the reuse of materials salvaged after deconstruction in development and construction practices. (4.41)

• **Favor low-waste products**
Encourage use of products that are durable, repairable, reusable, recyclable, and economically viable. (4.43)

Air Quality Section

• **Reduce greenhouse gas emissions**
Implement cost-effective actions that will reduce community's greenhouse gas emissions. This requires integration of land use, building code, and energy supply policies. (Policy 4.36)

Master Plans
Draft Waste Reduction Master Plan: 50% waste reduction
Upcoming Climate Action Plan: 7% greenhouse gas emissions reduction
Regulations (Ordinances)
Historic Preservation Ordinance

• **Follow energy-efficiency policies**
In reviewing applications for alterations to landmarks or structures in a historic district, follow relevant city policies, including energy-efficient design (Legislative Intent, B.R.C. 10-13-1(c))

• **Alteration** applications may not be approved unless the proposed work…:

◊ **Preserves architectural features**
…preserves and does not damage the exterior architectural features of the property

◊ **Does not harm special interest or value**
…does not adversely affect the special character or special historical, architectural, or aesthetic interest or value of the landmark and its site or the district

◊ **Is compatible character-wise**
Proposed architectural style, arrangement and materials are compatible with the existing character (Standards for Landmark Alteration Applications, B.R.C. 10-13-18(a-b(1-3))

• **Consider economics and energy-efficiency**
In reviewing alteration applications, consider economic feasibility of alternatives and incorporation of energy-efficient design (Standards for Landmark Alteration Applications, B.R.C. 10-13-18(c))
Resource Conservation – Green Points Ordinance
• **Encourage cost-effective resource-conserving building methods**
Ordinance purpose is to encourage cost-effective and sustainable residential building methods to conserve fossil fuels, water and other natural resources, to promote the reuse and recycling of construction materials, to reduce solid waste, and to promote enhanced indoor air quality. (B.R.C. 9-3.3-24(a))

• **Points required for residential construction**

◊ Points required for new residential construction, additions and interior remodels Number of points required depends on project square footage (larger project requires more points).

◊ Points are awarded for use of resource-conserving materials and building practices. Number of points awarded for a particular material or practice is commensurate with its level of resource conservation. (B.R.C. 9-3.3-24(a))

• **Recycle construction waste**
Point options for recycling construction waste, including clean wood. Painted or treated wood not accepted. (B.R.C. 9-3.3-24(c)(4) and Green Points Guideline 1.2)

• **Donate salvage materials**
Point options for donating unused or salvaged materials, including windows and doors, to organizations such as ReSource 2000. (B.R.C. 9-3.3-24(c)(2) and Guideline 1.4)

• **Use higher energy-efficiency windows and insulation**
Point options for windows, insulation and other items that exceed the minimum requirements of the Energy Conservation and Insulation Code (10-7). (B.R.C. 9-3.3-24(f) and Guidelines p.4-5)

• **Replace single-pane windows**
Point options for replacing single-pane windows with double-glazed windows. Lower U values yields more points. (B.R.C. 9-3.3-24(i)(5-7) and Guideline 6.2)

• **Insulate walls**
Point options for insulating wall cavities and exterior walls (9-3.3-24(i)(9) and Guidelines 6.3, 6.5, 6.9)

• **Reduce air leakage**
Point options for testing and reducing air infiltration rates by sealing exterior and interior penetrations. (B.R.C. 9-3.3-24(j)(4) and Guideline 7.5)

• **Use reflective windows**

Point options for using reflective film or glass on east and west windows. (9-3.3-24(j)(2) and Guideline 7.1.2)

• **Use shade landscaping**

Point options for landscaping that shades east and west windows. . (9-3.3-24(j)(2) and Guideline 7.1.4)

• **Provide window overhangs**

Point options for providing south window overhangs. (9-3.3-24(j)(2) and Guideline 7.1.5)

• **Provide solar collectors**

Point options for solar collectors for hot water heating (Guideline 8.1), for space heating (8.6) and for generating electricity (8.7), which must be mounted in an appropriate (effective) location on the roof or ground and at an appropriate (effective) angle. (9-3.3-24(k)(3) and (6))

• **Provide south-wall glazing**

Point options for glazing south wall to provide 20-60% of passive solar space heating of building. ((9-3.3-24(k)(2)(B-D)) and Guideline 8.4)

Energy Conservation Ordinance

• **Building standards regulate energy conservation**

Regulate building standards to minimize energy consumption for heating, cooling, lighting, and ventilating and encourage passive solar heating. (10-7-1) 2000 *International Energy Conservation Code* adopted (with amendments) as City standard (B.R.C. 10-7-2)

• **Plan for waste reuse and recycling required**

A check list indicating waste reuse and recycling methods must be included in compliance form for demolition, new construction and remodels/additions of residential buildings greater than 500 square feet (B.R.C. 10-7-2(b))

• **Only addition, not entire building, must comply**

For additions to existing buildings, only the addition is required to comply with the energy conservation code. (B.R.C. 10-7-2(d))

• **Maximum U-factor allowed for replacement windows is 0.45**

Replacement fenestration products (where the entire unit, including the frame, sash and glazing, is replaced) shall meet prescriptive fenestration U-factor criteria (B.R.C. 10-7-2(d))

• **Maximum U-factors allowed for replacement solid and glazed doors**

(B.R.C. 10-7-2(d))

• **No limit on south wall glazing**

No maximum area limitation on the amount of glazing in south-facing walls, provided the windows have operable insulated shutters or other devices to reduce heat loss and are shaded from direct sunlight during cooling periods (B.R.C. 10-7-2(k)(2))

Administrative Rules & Guidelines

Secretary of the Interior's Standards for Rehabilitation (adopted by Landmarks Board 1990)

• **Avoid removal or alteration of historic materials or character-defining features**

Removal of historic materials or alteration of features that characterize a property should be avoided. (Standard 2, p.4)

• **Repair rather than replace**

Deteriorated historic features should be repaired rather than replaced. (Standard 6)

• **Replacement should match original**

Where the severity of deterioration requires replacement of a distinctive feature, the new feature should match the old in design, color, texture and, where possible, materials. (Standard 6)

Energy Retrofitting Section

• **Use care in energy retrofitting**

Retrofitting to make a historic building more energy efficient should be carried out with particular care to ensure historic character is preserved. (Standards p.28)

• **Avoid water-content wall insulation**

Applying urea of formaldehyde foam or other thermal insulation with water content into wall cavities is not recommended. (p.28)

• **Avoid incompatible exterior wall insulation**

Resurfacing historic building materials with more energy efficient but incompatible materials, such as covering masonry with exterior insulation, is not recommended (p.28)

• **Avoid glazed passive solar walls where visible or damaging**

Installing passive solar devices such as a glazed "trombe" wall on highly visible elevations or where historical material must be removed or obscured is not recommended. (p.28)

• **Avoid water damage by storm windows**

Interior storm windows that allow moisture to accumulate and damage the window are not recommended. (p.28)

• **Avoid tinted or reflective glazing**

Tinted or reflective glazing is not recommended on character-defining or conspicuous facades. Use lightly tinted glazing on non-character-defining facades only if other energy-conservation alternatives are not possible. (p.29)

• **Solar greenhouses should be carefully located**
Solar greenhouse and other energy-conservation additions should be placed on non-character-defining facades and should not obscure or damage character-defining features. (p.29)

General Design Guidelines for Boulder's Historic Districts and Landmarks
Energy Efficiency Section

• **Energy efficiency improvements should protect historic character**
Ensure the energy efficiency concerns are addressed in ways that do not damage or diminish the historic character of the building, site or district. (General Guidelines, Section Introduction 8.2)

• **Preserve historic energy-conserving features**
Retain and preserve the historic, inherent energy-conserving features, including shade trees, porches, operable windows, transoms, shutters and blinds. (8.2.1 and 8.2.3)

• **Use traditional or appropriate means of increasing energy efficiency**
Increase thermal efficiency by using traditional practices, such as weather stripping and caulking, and by introducing appropriate energy-efficient features, such as storm windows and storm doors. (8.2.2)

Windows Section

• **Windows important to character**
Windows are one of the most important character-defining elements of a historic structure (Section Introduction 3.7)

• **Publicly visible windows more important**
Windows on facades visible from public streets, particularly the front façade, are especially important. (Introduction) Protection of front façade windows may supersede protection of windows elsewhere. (3.7.1)

• **Poor window design damages character**
Improper or insensitive treatment of windows can seriously detract from architectural character of historic structure. (Introduction)

• **Preserve windows**
Windows should be preserved. (Introduction) Retain and preserve existing historic windows, including their functional and decorative features, such as frames, sashes, muntins, sills, heads, moldings, surrounds and hardware. (3.7.1)

• **Repair rather than replace**
Repair of historic windows is always preferred within a rehabilitation project. Replacement should be considered only as a last resort. (Introduction) Repair rather than replace the functional and decorative features of original windows through recognized preservation methods. (3.7.3)

• **Repairs for energy efficiency**
Repairs can often improve energy efficiency of older windows (3.7.18).

• **Storm windows, interior panels alternatives to replacement**
Storm windows and interior energy panels are alternatives to replacement. Interior installation and wood storm windows preferred. Metal storm windows may be appropriate if frame proportions, profile and color matches original (3.7.18).

• **Replace only deteriorated portion**
If replacement of a feature is necessary, replace only the deteriorated feature in kind rather than the entire unit (3.7.3) If sashes are deteriorated beyond repair but frames are salvageable, then only replace sashes (2.7.4)

• **Match original**
Replacement features should match materials, design and dimensions of original (3.7.3). Replacement sashes should match original. (3.7.4). If repair infeasible, replacement windows should match originals in size, materials, method of operation and detailing (3.7.4).

• **Wood replacement preferred, alternatives considered**
Most appropriate to replace wood windows in kind; however, other material may be considered if operation, dimensions, profile and finish similar to original (3.7.7).

• **True-divided-light preferred**
Most appropriate to replace true-divided-light windows in kind, matching original dimensions, profile and detailing. High quality simulated-divided light windows may be allowed if same muntin size as original. Snap-in muntins and other inauthentic details inappropriate. (3.7.8)

• **Use shutters only if appropriate**
Use shutters only if appropriate to style of house; reintroduce shutters where documented originals are missing. (3.7.15-16)

Doors

• **Doors important to character**
Front doors are among most important elements of historic buildings. Original size, proportion, placement, details and frame contribute to character. (Section 3.8 Introduction)

• **Preserve doors**
Retain and preserve original doors and openings (3.8.1) and their character-defining features (3.8.2) and hardware (3.8.3)

• **Repair rather than replace**
Repair and restore damaged portions whenever possible. (3.8.4)

• **Storm doors preferred**

To improve energy conservation, consider storm door instead of replacement. Wood storm doors most appropriate; metal may be appropriate if simple design and bare metal not visible. (3.8.7)

• **Match original**

If replacement necessary, match original appearance and materials as closely as possible. (3.8.5 and 3.8.9)

Roofs

• **Roof important to character**

The roof is one of primary character-defining features of historic buildings. Ensure roof alterations do not compromise historic integrity. (Section 3.1 Introduction)

• **Preserve original character**

Historical roofing materials not required, but attempt to preserve type, unit scale and texture of original roofing. In some cases, material type is important to preserve, for example, metal and tile. Replace wood shingles with dimensional, composition shingles. (3.1.2)

• **Retain and re-use details and trim**

Retain and repair salvageable trim, brackets, cornices, parapets, bargeboards, gable-end shingles and other details. (3.1.2)

Solar Collectors

• **Location should be inconspicuous**

Solar collectors should not alter roof profile nor be highly visible, especially from front of building. Mount collectors flush on rear-facing roof or inconspicuously on ground. (3.1.4) Not appropriate to locate them on character-defining roofs or where prominently visible from street. (8.3.4) Collectors should be flat to pitch of roof and located out of sight or on ground and not visible from street (Mapleton Hill Guidelines V.3.)

APPENDIX E

EMBODIED ENERGY MODEL

- <u>Building Concept Model</u>—The simplest method requires minimum information. Consequently, the results are generally correct but not precise.

  - <u>Embodied Energy</u>: Based upon building type and gross size, a single calculation is required for energy emobdiment of construction, and for energy emobdiment of demolition. The approach measures the energy embodied in materials for existing buildings in terms of present day levels.

  - <u>Demolition Energy</u>: Based upon building type and gross size, a single calculation is required to estimate the amount of energy needed to raze, load, and haul away construction materials.

  - <u>Operational Energy</u>: Based upon the building type, location, and gross size, a single calculation is required for an approximation of total annual operational energy.

APPENDIX F

BRECKENRIDGE, COLORADO SOLAR PANEL ORDINANCE

Question #2

ORDINANCE NO. 26

Series 2008

AN ORDINANCE AMENDING POLICY 5 (ABSOLUTE) ("ARCHITECTURAL COMPATIBILITY") OF SECTION 9-1-19 OF THE BRECKENRIDGE TOWN CODE, KNOWN AS THE "BRECKENRIDGE DEVELOPMENT CODE", BY ADOPTING PROVISIONS CONCERNING SOLAR PANELS; AND MAKING CONFORMING AMENDMENTS TO THE BRECKENRIDGE DEVELOPMENT CODE

BE IT ORDAINED BY THE TOWN COUNCIL OF THE TOWN OF BRECKENRIDGE, COLORADO:

Section 1. Section 9-1-5 of the Breckenridge Town Code is hereby amended by the addition of the following definitions:

NON-PRIMARY ELEVATION:	The portion of a structure which does not front on a public street or other public right of way. If a corner lot, the primary elevation is the elevation where the primary entrance is located.
SOLAR PANEL:	An electrical device consisting of an array of connected solar cells which converts solar energy into electricity or hot water/liquid for space heating or domestic hot water production. Also referred to as photovoltaic (PV) panel or solar array.
SOLAR DEVICE:	Solar membranes, solar shingles, solar in glass, non-PV technology, and solar hot water systems, and similar solar technology.

Section 2. The definition of "Class C - Minor Development" set forth in Section 9-1-5 of the Breckenridge Town Code is hereby amended by the addition of the following item:

— Installation of solar panel or solar device within the Conservation District

Section 3. The definition of "Class D Development" set forth in Section 9-1-5 of the Breckenridge Town Code is hereby amended by the addition of the following item:

— Installation of solar panel or solar device outside the Conservation District

Section 4. Policy 5 (Absolute)("Architectural Compatibility") of Section 9-1-19 of the Breckenridge Town Code is hereby amended by the addition of a new subsection D, to be entitled "Solar Panels and Solar Devices", which shall read in its entirety as follows:

D. Solar Panels and Solar Devices

(1) Within the Conservation District: The preservation of the character of the Conservation District and the historic structures and sites within the Conservation District are of the utmost importance. The Town encourages the installation of solar panels and solar devices as an alternative energy source. However, there may be instances where solar panels or solar devices are not appropriate on a particular building or site if such a device is determined to be detrimental to the character of the Conservation District.

(2) Within the Conservation District, no solar device~~s~~ shall be installed on a structure or site without first obtaining a Class C minor development permit. Solar panels and solar devices are encouraged to be installed on a non-historic building or building addition and integrated into the building design. To ensure that the character of the Conservation District and its historic structures and sites are protected, an application for a development permit to install a solar panel or solar device within the Conservation District will be reviewed under the following requirements:

(a) Solar panels or other solar devices on roofs shall be placed on a non-character defining roofline of a non-primary elevation (not readily visible from public streets). Solar panels and solar devices shall be setback from the edge of a flat roof to minimize visibility and may be set at a pitch and elevated if not highly visible from public streets. On all other roof types, solar panels and solar devices shall be located so as not to alter a historic roofline or character defining features such as dormers or chimneys. All solar panels and solar devices shall run parallel the original roofline and shall not exceed nine inches (9") above the roofline.

Applications for new structures within the Conservation District are encouraged to include building integrated solar panels and other solar devices into the initial design, including a similar roof color, rather than as a later addition. Solar panels and solar devices which contrast with the color of the roof of new or historic structures are inappropriate if found to be detrimental to the character of the Conservation District.

(b) Detached arrays of solar panels and solar devices at a historic site may be located in the rear or side yard if the arrays are not highly visible from the public streets and do not detract from other major character defining aspects of the site. The location of detached solar arrays shall also consider visibility from adjacent properties, which shall be reduced to the extent possible while still maintaining solar access.

(c) Character defining elements such as historic windows, walls, siding or shutters~~,~~ which face public streets or contribute to the character of the building~~,~~ shall not be altered or in connection with the installation of solar panels or solar devices. Solar devices in non-historic windows, walls, siding or shutters which do not face public streets are encouraged.

(2) Outside the Conservation District: The Town encourages the installation of solar panels and solar devices on structures or sites located outside the Conservation District as an alternative energy source. The following regulations shall apply to the installation of solar panels or solar devices outside the Conservation District:

(a) No solar panel or solar device~~s~~ shall be installed on a structure or site without first obtaining a Class D development permit. The director shall have the right to reclassify an application as a Class C minor application, and to require review by the Planning Commission, if he feels the purpose of this code would be best served by the reclassification. Reclassification shall be done pursuant to the definition of "Classification" in Section 9-1-5 of this chapter.

(b) Solar panels and solar devices shall run closely parallel to the roofline and shall not exceed nine inches (9") above the roofline. New structures are encouraged to include building integrated solar panels and solar devices into the initial design, rather than as a later addition.

(c) Detached arrays of solar panels and solar devices may be located in the rear or side yard if not highly visible from the public streets. The location of detached solar arrays shall also consider visibility from adjacent properties, which shall be reduced to the extent possible while still maintaining solar access. Detached solar arrays which serve the residence on the site may be located outside of the building or disturbance envelope if no significant existing vegetation must be removed for the installation and an adequate buffer is provided to adjacent properties.

Section 5. Except as specifically amended hereby, the Breckenridge Town Code, and the various secondary codes adopted by reference therein, shall continue in full force and effect.

Section 6. The Town Council hereby finds, determines and declares that this ordinance is necessary and proper to provide for the safety, preserve the health, promote the prosperity, and improve the order, comfort and convenience of the Town of Breckenridge and the inhabitants thereof.

Section 7. The Town Council hereby finds, determines and declares that it has the power to adopt this ordinance pursuant to: (i) the Local Government Land Use Control Enabling Act, Article 20 of Title 29, C.R.S.; (ii) Part 3 of Article 23 of Title 31, C.R.S. (concerning municipal zoning powers); (iii) Section 31-15-103, C.R.S. (concerning municipal police powers); (iv) Section 31-15-401, C.R.S.(concerning municipal police powers); (v) the authority granted to home rule municipalities by Article XX of the Colorado Constitution; and (vi) the powers contained in the Breckenridge Town Charter.

Section 8. This ordinance shall be published and become effective as provided by Section 5.9 of the Breckenridge Town Charter.

INTRODUCED, READ ON FIRST READING, APPROVED AND ORDERED PUBLISHED IN FULL this 27th day of May, 2008. A Public Hearing shall be held at the regular meeting of the Town Council of the Town of Breckenridge, Colorado on the 10th day of June, 2008, at 7:30 P.M., or as soon thereafter as possible in the Municipal Building of the Town.

ATTEST: TOWN OF BRECKENRIDGE

Mary Jean Loufek, CMC, Town Clerk

John G. Warner, Mayor

This Ordinance was published in full in the Summit County Journal, a newspaper of general circulation within the Town of Breckenridge on June 6, 2008.

The public hearing on this ordinance was held on June 10, 2008.

READ, ADOPTED ON SECOND READING AND ORDERED PUBLISHED BY TITLE ONLY, this 10th day of June, 2008. This ordinance is available for inspection in the office of the Town Clerk.

ATTEST:

TOWN OF BRECKENRIDGE

Mary Jean Loufek, CMC, Town Clerk

John G. Warner, Mayor

APPROVED IN FORM

Town Attorney Date

This ordinance was published by title only in the Summit County Journal, a newspaper of general circulation within the Town of Breckenridge on June 20, 2008.

APPENDIX G

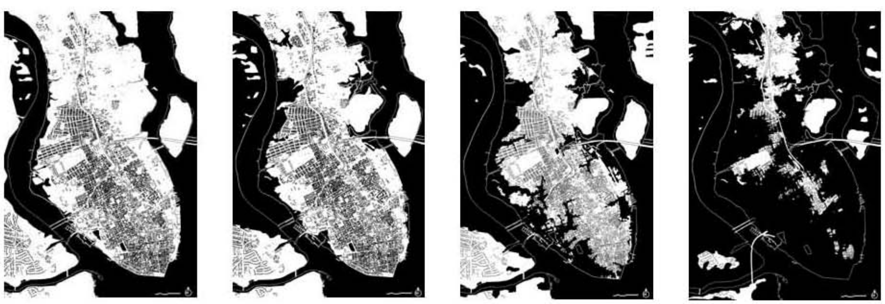
SUSTAINABILITY AND PRESERVATION - CHARLESTON, SOUTH CAROLINA

Sustainability and Preservation

Widespread preservation and sustainability activism emerged in the United States in the 1960s and 1970s in recognition that valuable resources were being lost or neglected. Since then, preservation has matured and sustainability has evolved to include alternative energy options, global warming, green building rating systems, and a comprehensive awareness of human impacts on the Earth's systems. Perhaps because of its environmental focus, sustainability has not yet become solidly allied with preservation.

However, the concept of sustainability is expanding rapidly. The relationship between historic preservation's intrinsic ethos of waste reduction and materials reuse and the effect on the planet of global climate change is just now being recognized and explored. This awareness is gradually expanding the traditional horizons of the environmental movement—reduce, reuse, and recycle—to include very different disciplines, practices, and priorities. A field that once focused only on specialized environmental issues now brings together global problems such as climate change with local issues such as land use patterns, the economy, and historic preservation to seek lasting solutions at all levels.

Outreach and community engagement should be at the forefront in sustainability and preservation efforts. Only with the backing of a citizen majority can long-term changes be shaped and implemented.



6.1 *Sea level rise (left to right): 1 foot rise; 3 foot rise; 6 foot rise; 12-foot rise. Environmental studies can help planners understand the implications of climate change on historic Lowcountry areas (above: Clemson Architecture Center, Global Climate Change Study, 2007).*

A Green and Historic City

Sustainability means a number of things for Charleston as a city. It means addressing the impacts of climate change and mitigating environmental damage like air pollution. It should encourage preservation of rural landscapes through wise land use patterns as Charleston continues to grow. Sustainability in the long run means keeping the local economy vital and maintaining a dynamic local culture. And the energy efficiency and storm preparedness of both historic and non-historic buildings must be increased, both for successful historic preservation and for sustainability.

Global climate change has serious implications for historic Lowcountry areas in terms of livability and even existence. While the extent of climate change has not been determined, acknowledged effects include a rising sea level, more frequent and intensive hurricanes, and compounded flooding problems. Predictions of the extent of a rise in sea level range from 0.92 feet to 7.6 feet in the next hundred years, but any rise will endanger historic resources on low-lying ground *(Figure 6.1)*.[1,2] Increased frequency and severity of storms will pose increased threats to the fabric of historic buildings, making the Disaster Preparedness and Recovery section of this Plan increasingly important.

Historic building materials have other intrinsic advantages. Historic buildings may use less energy than newer buildings, due to features—careful siting and orientation, cross-ventilation, operable windows, and insulation—that make buildings more responsive to the local climate.[7,8] Historic building materials are often more durable and can handle more extreme conditions. For example, most old-growth timber and lime plaster will dry out after flooding, as opposed to newer lumber and gypsum plaster.[5]

The green building movement emphasizes resource conservation and energy efficiency. This is not intrinsically opposed to historic preservation; indeed, the embodied energy of existing buildings likely exceeds by far the energy required to construct a new building, even with energy savings accounted for. However, many of the techniques used to improve energy efficiency—double-paned windows, new mechanical systems, and newly developed technologies—may damage the historic building fabric.

Energy efficiency of both historic and nonhistoric buildings can be increased without damaging the original fabric. Weatherizing, insulation, energy-saving appliances, and strategic landscaping present a few major approaches. Efforts to increase energy efficiency in noninvasive ways should be addressed by citywide policies and public education programs.

Preservation already includes materials reuse. In Charleston, the commitment should be formalized to reuse historic materials that otherwise would be destined for the landfill. Building demolitions annually contribute 65 million tons to landfills in the U.S., while renovations add 60 million tons per year.[10] Besides generating needless waste, such actions may lead to the permanent loss of valuable architectural components.

A salvage program for historic building materials should be organized to accept donations, resell building materials, offer educational and home improvement workshops, and engage community members through volunteering and/or job training.[11] A partnership with the Charleston County Solid Waste Landfill can save valuable architectural components from the landfill—and save the county money by reducing the volume of the waste stream.

City Policy

- ◆ Continue efforts to make Charleston more environmentally sustainable, including reduction of greenhouse gas emissions, improvement of public transportation, and the creation of energy efficiency programs

Public Education

- ❖ Publish a Preservation Manual for Charleston that details types of buildings and materials, as well as how to conserve and adapt buildings for modern use[12] **A**
- ◆ Appoint a sustainability coordinator to work with the City, County, nonprofits, the preservation community, and the environmental community
- ❖ Encourage local preservation organizations to staff an educational program, with community education seminars and presentations that reach out to and engage all communities; include programs on weatherizing and insulating historic houses

Materials Reuse

- ❖ Organize a salvage program, such as the one run by HCF
- ❖ Provide consultation sessions and workshops to homeowners and tenants through a nonprofit-run educational program

◆ Recommendation ❖ Repeated recommendation **L** Legal issues **A** See Resources section

6.3 *Windows, one of the most important components of historic buildings, can be sustainably reused or adapted for modern living.*

Finally, protecting the historic environment keeps quality of life high by maintaining a sense of shared community history and stewardship. Preservation of historic buildings nurtures continuing financial and social investment in communities. Conversely, demolishing historic buildings conveys the idea that community heritage is shallow enough to be disregarded.

Inherently Sustainable

Preservation tenets are underpinned by the key sustainability concept of "embodied energy"—that is, the total energy that has been used in the building's lifecycle, from gathering and processing raw material to constructing the building to demolishing and removing it. Preserving historic buildings takes advantage of embodied energy by valuing the energy already expended, instead of setting in motion another energy extraction cycle to construct new buildings. Preservation also diverts materials from landfills by preventing building demolition and reusing historical materials to repair existing structures.

Windows, one of the most important components of historic buildings, provide a good example *(Figure 6.3)*. The energy needed to manufacture a new energy-efficient window is more than the energy saved by the new window over its entire lifecycle. Historic windows that have been properly repaired may have nearly the same insulation ability as new weatherized windows.[6]

Historic preservation has an intrinsic ethos of waste reduction and materials reuse.

Forward-thinking local policy about urban design, historic resources, land use, and disaster preparedness must address these impacts. Mayor Riley has signed the U.S. Mayors Climate Protection Agreement and challenged the City of Charleston to reduce carbon emissions by 7 percent below 1990 levels by 2012.[3] The Charleston Green Committee has been charged with creating the comprehensive emissions reduction plan.

Land use patterns, or how developments are located and designed, impact both sustainability and preservation. Zoning that allows sprawling new development in the outer reaches of West Ashley, James Island, Johns Island, and Daniel Island leads to the construction of houses and roads on formerly undeveloped land. Traffic to and from new development creates air pollution, and the construction and maintenance of the roads and infrastructure that serve these outlying developments takes money away from existing infrastructure. More critically, the amount of rural land available as a cultural and environmental resource is reduced.

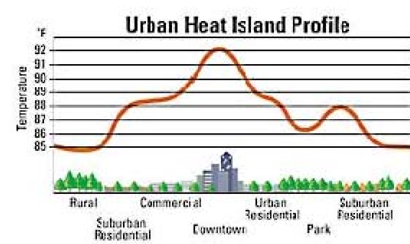
Preservation of rural areas means preservation of delicate ecological systems and cultural heritage. Johns Island and other undeveloped parts of Charleston contain forests and agricultural lands that absorb rainwater, enabling groundwater recharge and preventing flooding due to runoff. These natural areas absorb less solar heat than developed areas, preventing heat islands; they also keep surface and air temperatures lower through shading and evapotranspiration. When this rural land is developed, all these benefits are lost, along with valuable habitat for wildlife and irreplaceable cultural and natural heritage.

Reinvestment in existing areas of development preserves rural land from development, maintains quality of life, and reduces environmental impacts. Like "smart growth" planning, where compact mixed-use and transit-oriented development reduces the need for car trips, the historic peninsula neighborhoods that developed before cars became common offer easy access to housing, jobs, and transportation. Focused development promotes sustainability for Charleston and its residents: people are able to walk, bicycle, or take public transportation to meet daily needs, and carbon emissions and costly infrastructure needs are reduced. Charleston's Gathering Places initiative aims to mitigate the negative impacts of scattered development by creating concentrated nuclei of shops and transportation throughout the city.

Economic sustainability, a relatively new player in the sustainability sphere, is supported by historic preservation. Much of the money spent in preservation-related activities is spent locally, including tourist dollars and construction funds.[4] In Charleston, lodging, sales, and jobs from tourism contributed an estimated $3.06 million to the city's economy in 2006, with heritage tourism playing a significant role in drawing visitors.[5]

"Peninsula Urban Impact: The two greatest direct impacts on urban design will be sea level rise and increased storm intensity.... As sea level rises so will the water table, which reduces the vertical fall available for drainage and below-grade capacity of storm water retention.... The problem of collecting and managing runoff will become more difficult as the distance between land and the water table decreases."

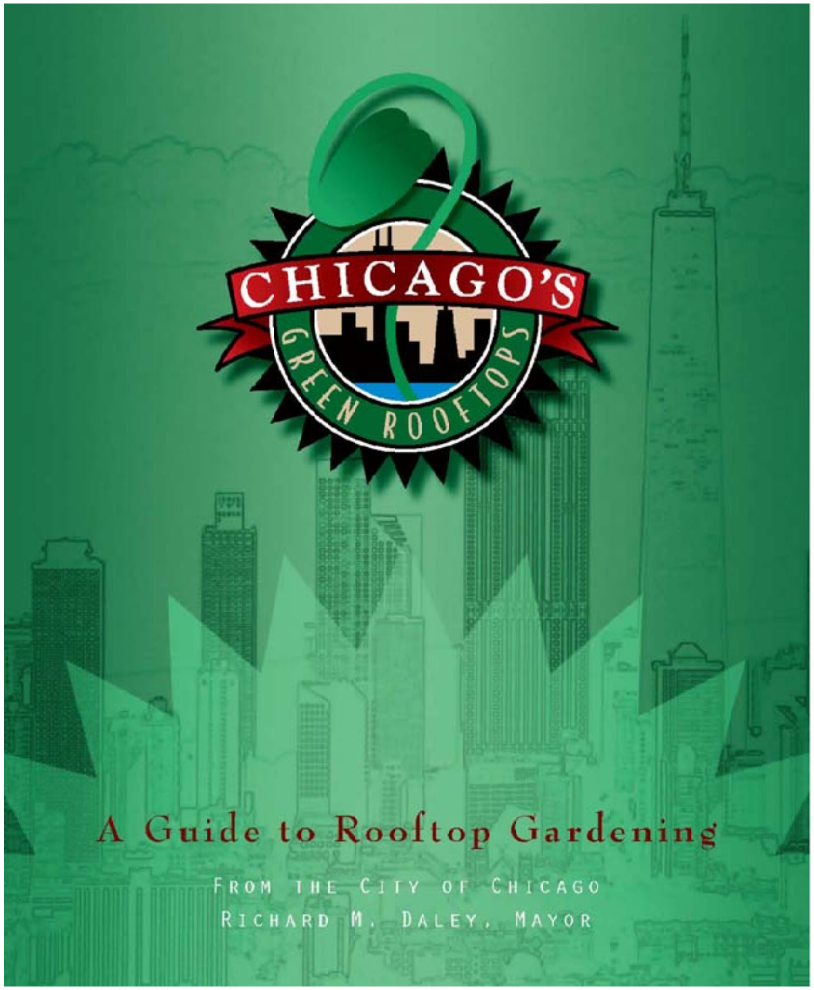
(Clemson Architecture Center, Global Climate Change Study, 2007)



6.2 Urban and suburban growth creates a "heat island effect," where urban air and surface temperatures are higher than nearby rural areas (Environmental Protection Agency).

APPENDIX H

A GUIDE TO ROOFTOP GARDENING



A GUIDE TO ROOFTOP GARDENING

FROM THE CITY OF CHICAGO
RICHARD M. DALEY, MAYOR

Prepared by the
Chicago Department of Environment

This booklet is provided by the City of Chicago Department of Environment, Mayor Daley's Landscape Task Force and the Green Roof Infrastructure Committee. Flair Communications Agency generously contributed the beautiful design. The printing is made possible by ComEd.

A Message from Mayor Richard M. Daley

Rooftop gardening is an attractive and energy-saving alternative to a conventional rooftop.

Rooftop gardens can keep buildings cooler, save energy, extend the useful life of the roof, and add beauty and useable space.

The City of Chicago is using rooftop gardens, along with light-colored coatings and rooftop solar panels, to replace traditional black tar roofs and improve air quality. Rooftop gardening, like greening on boulevards and in parking lots, reduces dark, heat-trapping surfaces, which in turn lowers temperatures and reduces air pollution.

Any roof can be made more energy efficient with the use of light-colored materials, and many roofs are suitable for some kind of gardening. This booklet is offered as a guide to evaluating your options and designing your own rooftop garden.

The Seeds of a Solution

An Introduction to Rooftop Gardens and the Urban Heat Island Effect

Building owners have many great reasons to install a rooftop garden — adding beauty to their property, pursuing a hobby, or lowering heating and cooling bills. In addition, rooftop gardens can actually help lower air temperatures and improve air quality for everyone.

WHAT IS THE URBAN HEAT ISLAND EFFECT?

The Urban Heat Island Effect is the difference you feel when you go from an asphalt parking lot to a tree-shaded park on a hot summer day. It is also the difference in temperature between a city and the rural area that surrounds it. Dark surfaces absorb and radiate heat, raising temperatures as much as 6 to 10 degrees Fahrenheit. The result is more than uncomfortable. It has consequences for our environment, our checkbooks and our health.

If your rooftop is a dark color, you are paying too much for your air conditioning. But you are not alone. In Chicago, about 60% of all roofs are dark colored. These dark surfaces absorb heat, and so it takes more energy to cool the building's interior. Not only must your air conditioner work harder to keep your building cool, but power plants, one source of air pollution, must work overtime to keep up with the increased demand for energy. The result is higher prices and degraded air quality.

A high concentration of dark surfaces can raise air temperature in that area because the surfaces trap heat. Higher temperatures help create more smog because pollution—from vehicles, homes and factories—is magnified when chemicals in the air react with heat and sunlight. Ground-level ozone is a component of smog and a danger to human health. It irritates the eyes, aggravates asthma, and causes permanent lung damage.

SKETCH OF AN URBAN HEAT ISLAND PROFILE

Source: Lawrence Berkeley National Laboratory

REDUCING THE URBAN HEAT ISLAND EFFECT

The key to reducing the Urban Heat Island Effect is to reduce the total area of dark, heat-absorbing surfaces such as rooftops and pavement.

Dark roofs can be made cooler by coating them with reflective materials, similar to the way light clothes are more comfortable than dark clothes on a hot day. Many light-colored roofing materials cost about the same as dark-colored roofing materials. Solar panels are another solution. They help shade a roof in addition to generating clean, renewable energy.

The use of vegetation on a roof is an excellent option. Plants reflect heat, provide shade, and help cool the surrounding air through evapotranspiration. A rooftop garden cuts the energy use within the building, especially for cooling. The insulation a garden provides helps conserve both heating and cooling energy.

Rooftop gardens absorb rainfall and reduce urban runoff that otherwise would collect pollutants and empty into sewers. A rooftop garden filters and moderates the temperature of any water that is released to the sewer.

In addition, plants actually filter the air. Plants improve air quality by using excess carbon dioxide to produce oxygen. On a neighborhood or regional level, temperatures are lowered and air pollution is reduced when the overall area of dark surfaces is reduced and the area of reflective and shaded surfaces is increased.

The layers of a rooftop garden protect the constructed roof from damage and can extend both the warranty and the useful life of the roof.

A rooftop garden can add usable leisure space to a property that is attractive not just to people, but to wildlife such as birds and butterflies.

ROOFTOP GARDEN TYPES

UNDERSTANDING THE OPTIONS

A simple rooftop garden can be created with planting containers or potted plants. This kind of garden is the most common for homeowners to construct because they are relatively low in cost and easy to maintain. A container garden provides the benefits of reflectivity, shade, and evapotranspiration. Compared to a green roof system, it is not as effective at insulating or reducing stormwater runoff.

A more elaborate rooftop garden is one where the garden actually becomes the roof. In that case, specially designed layers separate the garden from the "hard" roof, provide drainage, supply nutrients, and even add contours. This type of rooftop garden is referred to in the industry as a "green roof system."

There are two types of green roof systems — "extensive" and "intensive." An extensive green roof weighs less than an intensive green roof. It generally has shallower growing material and heartier plants that require little maintenance.

Intensive green roofs are the most like gardens on the ground—with deeper growing material, more intricate or delicate plantings, and more maintenance needs such as irrigation and pruning.

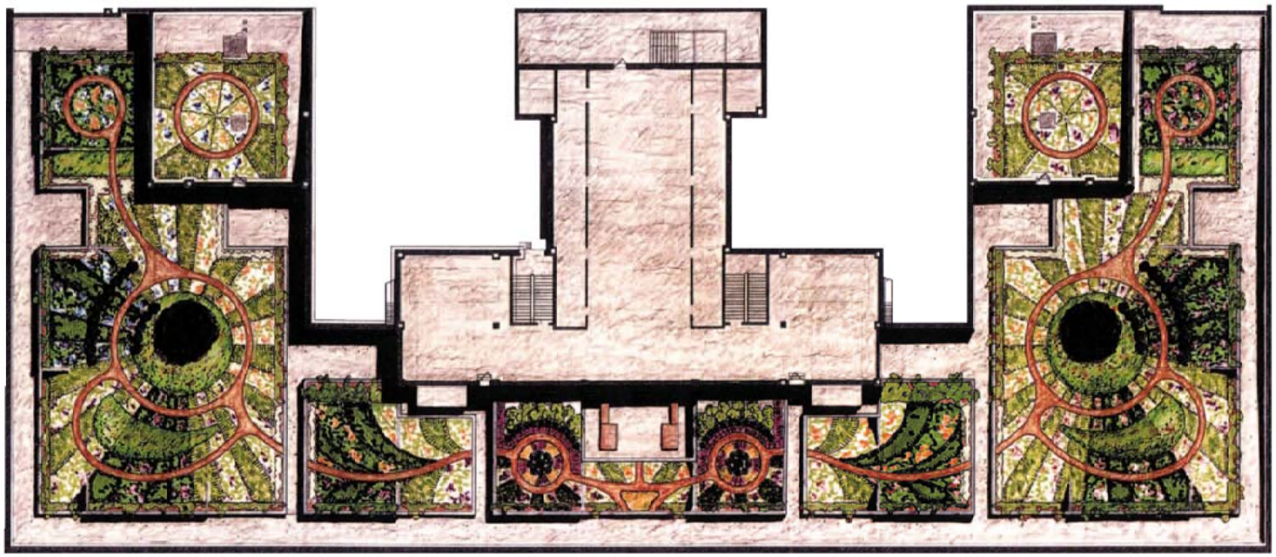
The type of rooftop garden you design depends partly on your interest in gardening and maintenance, and on the environmental benefits you may wish to achieve. Most importantly, you must evaluate the structural capacity of the building in order to assess your options. The next section walks you through the steps of designing a rooftop garden suitable for your building.

A ROOFTOP GARDEN DESIGN GUIDE

Going green is not as complicated as it seems. The following section will take you step-by-step along the path to a beautiful — and beneficial — rooftop garden.

TAKING THE INITIATIVE

Topping Off City Hall: A Case Study



Mayor Richard M. Daley's vision of a green-topped City Hall is now a reality. After extensive planning, construction on the 20,000 square-foot garden began in April 2000. The Mayor planted the first plant at a dedication ceremony on September 20, 2000. This garden is funded through a settlement agreement between the City and ComEd.

The project is the first of its kind in the City of Chicago and will be a showcase of the possibilities that can grow out of plans for a green roof. The design includes both extensive and intensive systems, as well as climbing plants.

The green roof contains 20,000 plants in all, consisting of more than 100 varieties, including shrubs, vines, and two trees. Thousands will be able to enjoy the green roof from the many taller buildings that surround City Hall, even though the rooftop will not be open to the general public.

Scientists will monitor City Halls rooftop garden for its air quality benefits. This includes energy use within the building and temperature readings on top of the roof. For comparison, the adjacent Cook County building, which is the same height and area as City Hall but which has a black tar roof, will be monitored.

The City also will monitor temperature, rainfall, wind speed, and wind direction. This data will help evaluate the garden itself and help the City advise other rooftop gardeners about what works best.

Planning a Rooftop Garden

Following are the steps for planning a garden on a rooftop:

1) Consider:
- *Condition of the Roof*
- *Structural Capacity of the Roof*
- *Access to the Roof*

2) Determine:
- *Weight of Garden*
- *Cost*

3) Design:
- *Special Design of a Green Roof System*
- *Irrigation*
- *Drainage*
- *Selection of Plants and Growing Media*
- *Maintenance*

4) Obtain Permits

Condition of the Roof

The most cost-effective time to construct a rooftop garden is when the roof needs to be replaced or newly constructed. This way you can make features, such as a waterproof membrane, a root-resistant layer, or certain containers, part of the new roof.

Working with an existing, intact roof is not impossible, but it will mean taking into account the roof's faults, such as existing leaks, damage, and inability to resist roots and standing water.

Structural Capacity of the Roof

Prior to designing and constructing your rooftop garden, you must first determine if your roof can support the additional weight of soil and plants. A licensed structural engineer or architect must be hired to conduct a structural analysis. The purpose is to determine the amount of weight the roof can support at different locations on the roof.

The structural capacity largely will dictate the type of rooftop garden that you can build. Roofs with limited structural capacity may require lighter-weight techniques such as containers or an extensive green roof system unless structural, and possibly costly, reinforcement measures are instituted. New buildings can be designed with adequate structural capacity for any type of garden.

Access to the Roof

An important consideration is access to your roof. In addition to access for the people who will be constructing and enjoying your garden, you will need to transport materials for construction and maintenance, and may need to consider the need for electricity. Typical access includes stairs or fire escapes. Generally, Chicago's Building Code requires two separate exit paths.

Weight of Garden

Weight considerations are at the heart of planning a rooftop garden of any type. You must determine the weight of the garden you wish to plant and make sure it does not exceed the structural capacity of your roof. With the structural capacity determined by the licensed architect or structural engineer, an architect or landscape architect can design the garden.

To determine the weight, you must take into account: what system(s) you will use to store water, the growing media and plants you wish to use, the kind of containers you may want, equipment for heating, ventilating and air conditioning, and snow loads. Weight capacity might limit the number of people who may access the roof.

The following are estimates you may find useful:

- *Water stored in tanks weighs about 8 lbs/gallon.*
- *Extensive green roof systems weigh about 20-34 lbs/ft².*
- *Intensive green roof systems weigh about 80-150 lbs/ft².*
- *The City of Chicago Municipal Code requires at least 30 lbs/ft² for the design snow load.*

Cost

In addition to the cost of the structural analysis and design assistance, your construction budget should include any needed structural or safety improvements, irrigation systems, garden materials, maintenance costs, transportation, and fees associated with any ongoing professional assistance and permits.

Container gardens can easily be adapted to fit your budget, depending on the type (wood, fiberglass, ceramic, terra cotta, concrete) and quantity you use. Green roof systems, as a general rule of thumb, cost about 50% more than a conventional roof. An extensive green roof system is generally less costly than an intensive garden. Either kind of green roof system can increase the useful life of your roof by about 50% over a conventional roof because the green roof system layers protect the "hard" roof from exposure to harsh weather.

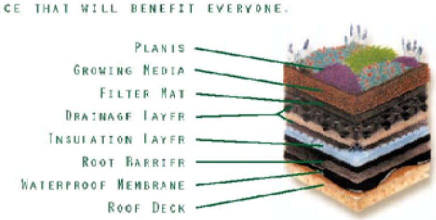
Design of a "Roof Garden"

Typically, the cross section of a green roof begins (starting from the bottom) with an insulation layer, a waterproof membrane to protect the building from leaks, and a root barrier to prevent roots from penetrating the waterproof membrane. For the waterproof membrane, look for products that can withstand the effects of acids released by some plant roots.

A drainage layer, usually made of lightweight gravel, clay, or plastic is next. The drainage layer keeps the growing media aerated in addition to taking care of excess water. Since a green roof system covers the entire roof, drainage points must be accessible from above for maintenance purposes. In some designs, and with certain products, the drainage layer can do double duty, serving to store water for use by the plants at a later time. On top of the drainage layer, a geotextile or filter mat allows water to soak through but prevents erosion of fine soil particles.

Finally, the top layers consist of growing media, plants, and a wind blanket. The growing media is lightweight material that helps with drainage while providing nutrients to the plants. A wind blanket is used to keep the growing media in place until the roots of the plants take hold.

A COMPLETE GREEN ROOF CONSISTS OF MANY LAYERS. THESE LAYERS MIMIC THE CONDITIONS FOUND IN NATURE, CREATING AN ENVIRONMENT SUITABLE FOR PLANT GROWTH. IN THIS WAY, ROOFTOPS CAN BE CONVERTED FROM DEAD SPACE INTO VIABLE GREEN SPACE THAT WILL BENEFIT EVERYONE.



Source: American Hydrotech, Inc.

Irrigation

The City encourages landcaping with native plants as an environmentally beneficial garden design. In addition to providing habitat, native plants usually survive well on rainwater. Still, there may be times during the year when rainfall will be insufficient to supply the water requirements of even drought-tolerant plants.

You should plan for the need to supplement rainfall with irrigation. Examples of irrigation systems include, but are not limited to, rainwater storage tanks, drip irrigation systems, moisture sensors to regulate irrigation needs, or hose-bibs for manual watering. You will need to hire a licensed plumber or irrigation contractor to design and install an irrigation system or new water connections on your roof.

Drainage

The water drainage system is an essential component of any rooftop garden.

A key environmental benefit of rooftop gardens is that they absorb rainwater and reduce runoff to sewer systems. Still, any excess water not absorbed by the growing media, used by the plants, or stored by the water storage system must be effectively drained from the rooftop. Failure to do this will create "bathtub" conditions that may cause root rot and disease as well as add significant weight beyond the roof design load.

Most gardens should be able to use the existing rooftop drainage system with only minor modifications. Typical drainage systems include gutters, downspouts, drains, and screens or barriers to prevent erosion of the growing media and clogging of the drainage system.

Selection of Plants and Growing Media

Since natural soils are heavy, particularly when wet, rooftop gardeners typically use lightweight growing media consisting of high-quality compost and recycled materials. The purposes of these materials are to be water permeable, to retain water and air, to resist rot, heat, flying sparks, frost and shrinkage, to provide nutrients appropriate to the chosen plants, and to provide a rooting medium. Plants appropriate for extensive green roofs favor poor soils. Generally, the growing media should be as deep and have as great a volume as possible within the constraints of the structural capacity, in order to provide plants with stability in wind and keep the system from becoming too dry.

Rooftops can be hostile environments for plants due to the effects of wind, heat, rain, and shadows. Extra insulation may be needed inside and/or outside of planting containers to protect plants from freeze/thaw cycles in winter. A rule of thumb is that wind speed doubles for every ten stories of building height. Windy conditions increase the loss of moisture from growing media and leaves, so drought-tolerant plants often survive best. Many plants, especially native varieties, are suitable and attractive options for rooftop gardeners.

The Chicago Department of Environment's web site, WWW.CITYOFCHICAGO.ORG/ENVIRONMENT, contains a list of plants to consider and information about their use on Chicago's City Hall Roof.

Maintenance

Rooftop gardens must be maintained just like any garden, for instance by watering or weeding. The amount of maintenance will depend on the types of plants used and the garden design. Larger plants, shrubs, and trees must be pruned to ensure safety during windy conditions. Drains and gutters must be inspected and cleared more frequently than without a garden, because of the plant material.

Permits and Zoning Requirements

Before you begin constructing any kind of rooftop garden in the City of Chicago, you will need to have the Chicago Department of Buildings review your plans, and you will need to obtain the proper permits.

Terminology is important. A "rooftop garden" is presumed to mean it will be accessible to people. Thus there will be requirements such as ensuring proper barriers at the edge of the roof, raising exhaust stacks on the roof, providing two exits, or calculating a higher garden weight to account for people. A "green roof" means the garden will not be accessible to people except for occasional maintenance.

To obtain a permit, you will need drawings that document the design. If your home is a free-standing single-family house, you may draw the plans yourself. If your building has more than one dwelling unit, or if the building is commercial or industrial, the plans must be prepared by an architect licensed in the state of Illinois.

For most applicable permits, you will need to provide four sets of drawings produced, certified, and stamped by a licensed structural engineer and/or architect. These include:

- *Drawings of existing roof conditions, including dimensions of all structures on the roof.*
- *Structural framing drawings.*
- *Weight capacity of the existing roof. This includes calculations of snow load, snow drift load if your roof abuts a taller part of the building, and the weight of plant material both wet and dry.*
- *Drawings of the proposed garden. This includes all plant, soil and subsoil layers, irrigation and drainage, a landscape diagram of where plants will be and their growing heights, and any changes being made to the roof such as raising exhaust stacks or adding guardrails.*

There is a fee for a building permit, which includes a review by the Zoning Department. The Building Department may return a correction sheet to you which details any changes you need to make to your submittal before it can be approved for a permit. After construction begins, a building inspector also may visit your site to assure that the construction conforms to the approved plans.

The City of Chicago Department of Buildings web site, WWW.CITYOFCHICAGO.ORG/BUILDINGS, has additional information on obtaining permits.

APPENDIX I

EXCERPTS FROM THE VERMONT DIVISON OF HISTORIC PRESERVATION STUDY ON THE ENERGY EFFCIENCY OF HISTORIC WOODEN WINDOWS IN COLD CLIMATES

BACKGROUND AND SIGNIFICANCE

A literature review was undertaken to determine the nature of previous work and findings relevant to the study. These are the key points from that review deemed significant to the Vermont Historic Window study. The full study is available from the National Park Service website.

1. Whole Building Energy Losses

One of the primary purposes of building renovation is to reduce energy consumption and costs via thermal losses due to air infiltration. A large body of pre- and post-renovation data for whole building energy consumption does not exist. However, a reduction in building energy requirements may be accomplished by reducing air infiltration through sills, walls, basements, attics, doors, and windows. Estimated energy costs associated with air infiltration range from 33% of total building energy costs (Sherman et at., 1986) to as much as 40% (Giesbrecht and Proskiw, 1986). Upon completion of whole building retrofitting, reductions in energy costs attributable to infiltration have been estimated to range from 19% based on a 55 house sample (Jacobsen et at., 1986) to 50% for a single townhouse (Sinden, 1978). Most saving estimates fall between 30-37% (Giesbrecht and Proskiw, 1986; Harrje and Mills, 1980; Nagda et at., 1986). Giesbrecht and Proskiw also found twostory houses showed lower reductions in infiltration after renovations (24.4%) than singlestory houses (36.9%), likely due to leakage between floors.

2. Window Energy Losses

Of concern to this study was the portion of total house leakage attributable to infiltration through and around windows. Estimates of window contribution vary more widely than whole house leakage estimates. Two separate studies found the fraction of window leakage to be approximately 20% of whole house leakage (Tamura, 1975; Persily, 1982). An estimated 37% of the total heat loss from a house may be due to infiltration through windows and doors (Lund and Peterson, 1952), while a 20 house survey showed these sources are unlikely to exceed 25% (Bassett, 1984). The use of a mathematical model estimated 25% of heat loss through a loose fitting, nonweatherstripped window was attributable to infiltration (Klems 1983). The modeled window was assumed to be typical of windows found in older housing. A reasonably tight double-pane window, typical of new construction, was estimated to have 12% of its thermal losses attributable to infiltration by the same model. Energy costs associated with infiltrative losses became a significant portion of total fenestration energy costs when air leakage rates exceeded 0.5 cubic feet per minute per linear foot crack (cfm/Ifc) based on the Residential Fenestration (RESFEN) computer model developed by Lawrence Berkeley Laboratory (LBL), University of California, Berkeley (Kehrli, 1995). Various leakage rates at 0.30 inches of water pressure were modeled with RESFEN, then reduced to total window energy losses at 0.016 inches of water pressure, the assumed average heating season interior/exterior pressure differential. Costs due to infiltration as a percentage of total window energy costs varied from 15% at 0.5 cfm/Ifc to 41 % at 2.0 cfm/Ifc for a two story house, based on the RESFEN simulation.

3.. Window Weather-stripping

The intent of weather-stripping a window is to reduce the amount of air infiltrating through the sash/jamb junctions and the meeting rails. Infiltrative losses were reduced from 37% to 17% of total house thermal losses when metal rib-type weatherstripping was installed around the windows (Lund and Peterson 1952). This corresponded to an approximate 24% reduction in building energy costs.

4. Storm Windows

The installation of storm windows, either exterior or interior, presents its own range of advantages and disadvantages. In general, properly installed new storm windows in combination with existing single-glazed windows may achieve U-values comparable to insulating glass and reduce air infiltration while lowering maintenance costs and extending the life of the window (National Park Service, 1986). Thermal transmittance (U-values) refers to the amount of heat a one foot square section of window would lose per hour for every one degree Fahrenheit temperature differential and has units of Btu/ft2-hr-°F. Lower numerical values for thermal transmittance imply better thermal efficiency. Disadvantages of exterior storm windows include visual obstruction of an historic window and its attendant details, while interior storm windows may increase condensation and cause moisture related problems to the primary sash. The negative visual effect of exterior storm windows may be reduced by using single lite storm sash. Interior storm windows have avoided the problem of condensation by incorporating vent holes and a sealed fit (Park, 1982). The use of interior storm windows can also reduce infiltration by reducing air movement through the sash or rough opening into the building interior. Whole house energy consumption was reduced by 12% in a test house in England fitted with interior storm windows (Rayment and Morgan, 1985).

5. Rating New Windows

Many builders, contractors, and individuals purchasing new windows for either new construction or renovation are increasingly aware of energy considerations and choose windows based on rates of sash air leakage and thermal transmittance (U-values) as well as appearance. These ratings are provided by window manufacturers and are the results of independent testing by accredited simulation laboratories. Laboratories are accredited by the National Fenestration Rating Council, with each accredited laboratory having one or more certified simulators. Air leakage tests are conducted according to ASTM E 283- 91, *Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.* Thermal transmittance tests follow ASTM E 1423-91, *Standard Practice for Determining the Steady State Therma/ Transmittance of Fenestration Systems* (Kehrli). For sash air leakage, test results are generally provided as cubic feet per minute per linear 5 foot-crack (cfm/lfc) at a differential of 0.30 inches of water pressure. National standards for sash air leakage at 0.30 inches of water allow a maximum sash flow of 0.37 cfm/lfc for new windows in order to be certified (National Wood Window and Door Association, 1996). ASTM E 1423-91 is both a complex and expensive laboratory testing process, averaging $1200 per test (Kehrli). Researchers at the Lawrence Berkeley Laboratory (LBL), have developed an interactive computer program to calculate the thermal transmittance of windows. This program, WINDOW 4.1, is based on actual window testing following the E 1423-91 method and is consistent with the rating procedure developed by the National Fenestration

Rating Council (NFRC 100-91: *Procedure for Determining Fenestration Product Thermal Properties).* Test data listed by window manufacturers are the results of WINDOW 4.1, the LBL computer simulation program. Manufacturers provide a random sample of their higher and lower end window models to the accredited testing laboratories to ensure actual compliance with certifiable specifications (Weidt).

6. Window Performance

Should a renovation project be designed with replacement windows, it is likely that windows will be chosen based on the results of the manufacturers' data. The maximum 0.37 cfm/Ifc allowable sash flow for certification is often exceeded by windows, as shown by both field and production-line testing (Kehrli, 1995). An on-site study of window leakage rates was done in the Minneapolis/St. Paul metropolitan area, comparing listed air leakage rates of 192 windows to actual measured leakage rates after installation in new residential constructions. Window models from sixteen manufacturers were tested, which included both double- and single-hung windows. Of all the window tested, 60% exceeded the manufacturers' listed performance specifications while 40% exceeded the 1979 industry maximum of 0.50 cfm/Ifc for certifiable windows. More specifically, 79% of double-hung and 100% of single-hung windows exceeded the manufacturers' lab data. Installation technique, as performed by the various contractors, showed no significant effect on window performance (Weidt, 1979). The Weidt study also showed double-hung windows had lower air infiltration rates per linear foot crack than did single-hung windows within any manufacturer. Infiltration rates expressed as cfm/Ifc may be a misleading statistic when comparing different window types. As an example, a typical double-hung window has approximately 70% more operable linear crack per sash area than a single-hung window of identical size. If the two windows show equal air leakage rates per linear foot crack, more air is actually moving through the double-hung window due to its larger operable linear crack perimeter. When infiltration is expressed as cfm/sash area or cfm/ventilation area, single hung windows outperform double hung windows (Weidt, 1979).

7. Non-infiltrative versus Infiltrative Thermal Losses

Within the confines of how the predominant energy loss of a window occurs, there is some debate. Those advocating non-infiltrative thermal losses being much greater than 6 infiltrative losses, recommend all single-glazed sashes be replaced with double-pane insulating glass (Kehrli). Energy losses due to direct heat transmission through a window were observed to be consistently greater than those due to air leakage, regardless of the leakage rate considered (Klems, 1983). In a comparison of energy requirements between a test house and an idendical control, it was estimated that replacing single-glazing with double-glazing reduced losses via thermal transmission such that building space heating requirements were reduced by 9% (Rayment, 1989). If double-pane insulating glass is to be used and the original sash retained, there must be adequate wood thickness to accommodate the rabbeting necessary to insert thicker, double-pane glass. The wood must also possess the strength to support the extra weight (National Park Service, 1986). This has been done in some old single-lite sash but presents a more complicated problem in multi-lite sash where muntins are present. As compared to a single-lite window, the larger glass/wood edge perimeter of a multi-lite window will reduce the thermal improvements of double-pane insulating glass by allowing more conduction through the edges.

Others believe that air infiltration is a larger contributor to poor energy performance than single-glazing and any steps taken to reduce infiltration are nearly always cost effective (National Park Service, 1986). The Colcord Building in Oklahoma City reduced its space heating costs by 25% when its loose fitting, single glazed windows were renovated. Renovation included reglazing with new putty compound, painting, bronze V-strip spring weatherstripping, and the addition of removable interior acrylic storm panels (Park, 1982). It was undetermined what fraction of heating cost reductions were attributable to the interior storm window and what fraction arose from the other renovations. The addition of acrylic storm panels in the Colcord Building constituted a second glazing layer which served to decrease non-infiltrative losses through the windows. Acrylic panels were chosen over glass due to weight considerations, but provided the additional benefit of decreasing non-infiltrative losses by 15% as compared to ordinary glass storm panels. Storm windows in general provide a second glazing layer, reducing non-infiltrative thermal losses. Exterior storm windows provide the additional benefit of lowering window maintenance costs as well as prolonging window life by preventing accumulations of moisture (Fisher, 1986).

8. Air Infiltration through the Rough Opening

A significant source of infiltration may be the gap between the rough opening of the building and the frame of a window unit (Flanders et al, 1982). Estimates of infiltrative contributions through window rough openings range from 12% of whole building energy loads in loose construction (typical of affordable housing stock) to 39% in tighter construction (Proskiw, 1995). Air leaking through the rough opening/frame juncture around an otherwise tight window will adversely affect the overall performance of the window unit (Louis and Nelson, 1995). The conventional method used to seal this gap in new construction is to insert fiberglass insulation between the rough opening and frame, even though fiberglass 7 insulation is not intended to be an air barrier material. A laboratory study in Winnipeg, Canada, showed the conventional sealing method still allowed significant air leakage through the rough opening (Proskiw, 1995). The amount of air attributable to leakage through the rough opening was estimated for both loose and tight houses. A loose house was assumed to have 5 ACH50 (5 air change) per hour at 50 Pa, or 0.20 in. H2O), typical of older houses. A tight house was assumed to have 1.5 ACH50. Ratios of rough opening to whole house leakage were based on laboratory results, which gave estimates of 14% rough opening leakage for tight houses and 4% for loose houses. The two most efficient and cost effective methods for sealing rough openings were low expansion urethane foam and casing tape, reducing estimates of rough opening leakage to less than one percent of whole house leakage (Proskiw, 1995). Casing tape is the tape normally used for taping joints between exterior sheets of insulated sheathing.

Older buildings often do not have any barrier between the frame and rough opening, allowing air access to the window unit with little impediment. Proskiw estimated 39% of total house air leakage was from rough openings in a loose house typical of older construction. The most effective means of reducing extraneous leakage require removal of both interior and exterior trim. Trim removal provides exposure and access to the window frame/rough opening junction, allowing thorough sealing. Care must be taken when using expandable foam to prevent overfilling, which could lead to window jamb distortion. It is possible to drill small holes in the jamb to insert foam, but three potential drawbacks exist. Insertion holes may be visible, but more importantly, there is a greater risk of overfilling the cavity with foam, which would cause distortion of the jamb. A complete seal also cannot be ensured without visual inspection. Removal of the trim provides this opportunity.

9. Air Infiltration and Relative Humidity

Relative humidity plays a significant role in infiltration through old wooden windows by influencing the fit of the sash to the frame. The physical change in wood dimensions as wood absorbs or releases atmospheric moisture affects the gap dimensions between the sash and frame, directly influencing infiltration. Temperature also affects wood dimensions but relative humidity is a more important factor than wood temperature, with cold wood expanding more from absorption of outside moisture than from temperature changes (Lstiburek). While cold air in the winter does not carry a large amount of moisture, its relative humidity is approaching saturation due to the decreased amount of moisture the cold air may hold. This implies that some moisture absorption may occur in the winter with a corresponding degree of swell.

10. Routine Maintenance

Significant reductions in infiltration may be accomplished by routine maintenance of an existing window while improving its integrity. Routine maintenance includes removing the glass, applying back putty, reinserting the glass, repointing and reglazing. Excess paint 8 should be removed and any necessary sash or frame repairs done along with the installation of good quality weather-stripping (NPS, 1986). Repainting the sash, frame, and glazing will help provide a good seal against the elements.

11. Benefits of Renovating Historic Windows

The advantages of renovating existing windows versus replacement in an historic building include saving the historic value and design of the window as well as the interior/exterior appearance. For these reasons, it is advantageous to investigate methods of rehabilitation in an historic building. It has been shown in both the Colcord Building in Oklahoma City (Park, 1982) and the Delaware Building in Chicago (Fisher,1985) that effective window rehabilitation can be accomplished at a lower cost than replacement windows while still resulting in significant energy savings.