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Review of the Energy Rating Systems for Historic Preservation

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Abstract

When considering the rehabilitation of historic buildings, we should not just think about how much energy we can save, but in addition, what sustainable measures could be implemented as to not destroy the cultural integrity/authenticity or the historic structure of the building. Therefore, performing rehabilitation measures on historic buildings is more complex than buildings that do not contain the same architectural importance or value. This research focuses on assessing the energy rating systems ('green building certification' programs) and discusses if those systems can address historic values and building preservation. In this literature review, we have examined the process of assessing a historic building under existing energy rating systems addressing the historic value and the potential for energy efficiency, as well as the economic values that can be found in this building typology and surrounding communities. By assessing the historic value of a building, we can identify the best compromises between the recommended improvements and the preservation of the building while including the community in which the building is located. The development of an energy rating system for historic properties could be achieved if further research is conducted, the appropriate tools and models are formulated, and thorough analysis and case studies achieved.

Introduction

According to recent statistics presented by the United Nations Environment Programme (UNEP), buildings accounted for 40% of global energy use, 25% of global water use, 40% of our resources, 60% of global electricity use, and emit 1/3 of our greenhouse gas emissions in 2001; making buildings the largest contributor of greenhouse gases out of any other sector (UNEP, 2016). This should come as no surprise when one considers that most Americans spend approximately 90% of their time indoors (Klepels, et al., 2001). For decades, research and development has led to energy efficient technologies such as the reduced energy intensive lighting systems and the simulation software (software to stimulate building operation) that allows buildings to be designed or retrofitted to their full energy saving potential. These trends in the market have led to an overall shift in how we design and construct our buildings.

Overall, it has shaped public policy and led to the implementation of energy codes and national standards that establish a baseline design (a minimum requirement) for energy efficiency in new buildings and major building renovations. In addition to codes and standards, various energy rating systems or in other terms, 'green building certification' programs or green rating systems, have been created to offer guidance and assistance to property owners seeking additional means of sustainability and energy efficiency in their buildings. Various certification programs such as Leadership in Energy & Environmental Design (LEED) and the Green Globes program, have spent decades researching and developing a set of criteria among a set of categories related to environmental impact, energy efficiency, sustainability, and indoor environmental air quality for building typologies that include multifamily new construction, residential homes, and existing commercial buildings. However, the criteria for historic buildings have been neglected by leaders in this industry over the years. With the underwhelming focus of integrating energy efficiency in historic preservation through local and federal building standards and public policy, an alternative option must be explored.

Considering the growth and popularity of green building certification programs in recent years, it would be beneficial to explore a similar approach for historic buildings. This literature review aims to identify existing energy rating systems that address historic properties, draw attention to missed opportunities, and examine the

development of a new rating system that would explicitly address historic properties and their unique characteristics.

Historic Buildings Rehabilitation– Standards, Codes and Compliance: What are Historic Buildings?

A historic property is "a prehistoric or historic district, site, building, structure, or object included in or eligible for inclusion in the National Register of Historic Places," according to the Advisory Council on Historic Preservation (ACHP, 2015). Eligibility for these buildings requires the evaluation of the building's significance, age, and integrity. It is important to keep in mind that not all buildings holding cultural and architectural significance will be recognized by, or officially listed under the National Register of Historic Places, because they may not be able to meet ACHP's National Register Criteria for Evaluation. However, Section 106 of the National Historic Preservation Act of 1966 requires the federal government to consider the views of the public or any involved agencies in regards to the effects of a project carried out on a culturally significant building. Under this ruling, "A historic property need not be formally listed in the National Register in order to be considered under the Section 106 process" (ACHP, 2015). With that in mind, a well-rounded energy rating system would address all buildings holding architectural significance and should consider defining historic properties based off a number of criteria, such as being federally listed or not, with a percent of total buildings holding some architectural significance. Such definitions and recognition would broaden the audience for this type of rating system and aim to raise awareness to architectural details worth preserving.

Federal Standards for Historic Rehabilitation

Any building undergoing a rehabilitation that is under the jurisdiction of the federal government and is listed in the National Register of Historic Places must follow the standards laid out by the Secretary of the Interior which are known as The Secretary of the Interior's Standards for the Treatment of Historic Properties (Weeks and Grimmer, 1995). These Standards assist in the maintenance and the long-term

preservation of the historic properties within the government's portfolio of buildings. The Standard defines rehabilitation as, "…the act or process of making possible a compatible use for a property through repair, alterations and additions while preserving those portions or features which convey its historical, cultural, or architectural values" (NPS, 2011). Furthermore, preservation, rehabilitation, restoration, and reconstruction are the four areas of treatment analyzed in historic buildings under this standard. Abiding by the National Park Service's and the Secretary of Interior's standards is an appropriate way of conducting rehabilitation to federal buildings. Nevertheless, a private building owner is not encouraged to implement energy efficiency measures or sustainable practices according to the federal law.

International Energy Conservation Code (IECC)

Under Chapter 501.6 of the 2015 International Energy Conservation Code, the provisions that govern historic buildings stated, "no provisions of this code relating to the construction, repair, alteration, restoration and movement of structures, and change of occupancy shall be mandatory for historic buildings..." (IECC, 2015). The IECC Chapter 501.6 presents a vast amount of missed opportunities for implementing energy efficiency and sustainability measures under code compliance. In addition, there has also been a lack of decision making amongst policy leaders regarding historic preservation and energy efficiency. Addressing the energy needs in an energy rating system could help facilitate the conversation and raise awareness to the energy potentials of historic properties.

Global Overview of Energy Rating Systems

An energy rating system or a green rating system is a system that addresses the environmental and sustainability of a structure. They rate and reward a building that addresses the performance and compliance with specific environmental goals and requirements set by the certification body. It also addresses the building's resiliency to current and future climate conditions to increase the energy efficiency and thermal comfort, and to modernize and improve mechanical building systems.

Currently there are some outlined rating systems that included energy/energy efficiency as a rating category, and therefore it is worthwhile to check if those systems are applicable to historic buildings and if they can highlight the advantages of building restoration and preservation. As a result, one could decide to either use an existing rating system or develop a new system to address sustainability for historic buildings. Table 1 lists more than 20 green rating systems that have been developed and applied to various building typologies around the world.

Once exploring the table presented, it is notable that many countries have implemented one or multiple rating systems to assess sustainability opportunities of various buildings and communities. This presents a global trend in building design and management to promote resources/energy reservation and carbon emission reduction. Some countries even took it upon themselves to create their own rating systems, whereas others just tailor an existing system to meet their specific conditions. Currently, LEED is the most popular and widely adopted rating system for building revision. Most rating systems are applicable new and existing buildings. In addition, many rating systems developed sub-systems to address specific requirements for various buildings. For example, LEED has been developed for New Construction and Major Renovation (LEED-NC), Commercial Interior (LEEC-CI), and Core & Shell (LEED-CS), etc. Within those rating systems, the historic building's renovations are usually treated as the existing buildings for analysis. Different rating systems assess buildings across a number of environmental impact/performance categories. Almost all rating systems include energy, water, materials, resources, and indoor environment quality, but the credits/scores weighted to those categories differ among the rating systems depending on the main concern of the specific place. Similar buildings may achieve different levels of certification under different rating systems. This is due to the high levels of variation in scores/grades and their assigned weight for different impact categories varying.

Overall, the existing green building rating systems do not treat historic buildings as a specific building category (see table 1). In other words, none of them address the preservation of historic or cultural values of a building. In many systems, preserving historic values of a building will not earn any credit towards the buildings rating in the certificate application. Alternatively, a building with a good rating may potentially

damage its authenticity/cultural background (Powter et al., 2005). In addition, some rating systems also excluded several important aspects of sustainability such as durability and life cycle energy use, where preserved historic buildings have the potential to flourish. Therefore, "point seeking" and strictly applying the criteria of those building rating systems may actually take away the building's potential for maximum sustainability.

US Energy Reviewing System

When the implementation of a national rating system that is intended to be applied on historic properties is evaluated, one must consider the stakeholders involved, including government bodies. It was seen for instance, that every five years under Section 433 of the Energy Independence and Security Act of 2007, the Department of Energy (DOE) and the General Service Administration (GSA), are to establish which third party green building rating system or systems will be adopted for federal buildings. Therefore, a meeting was held in 2012 to decide which third party will be applied for the following five years period (US House of Representatives, 2012). The Pacific Northwest National Laboratory (PNNL) did the comparative reports to fulfill the goal. While the reviews did not explicitly focus on historic properties, they did in fact present findings on green building rating systems in general and thus, it was the system the United States Government favored most. The hearing allowed for a panel of witnesses from various industries to come forth and provide written testimonies on the energy rating systems reviewed in the 2012 report as well as alternatives to achieving energy efficiency targets. Despite of the tendency to favor LEED, some testimonies strongly urged the House of Representatives to reframe from using LEED as a way of meeting energy efficiency goals. The overall hearing presented two promising opportunities: first, the hearing represented an open dialog that was taking place in regards to building standards and energy rating systems. While the federal government could ultimately decide to endorse just one rating system, they solicited feedback and statements from prominent professionals in the industry including public comment, research, and testimonials keeping an open door policy regarding adoptability of energy rating systems. Second, the research conducted by many of the participants present missed

opportunities by energy rating systems and in particular, LEED. If developing a new rating system, regardless being specific to historic buildings, competition and recognition in the market will be central to its implementation and adoption by users. Addressing the missed opportunities by LEED, the most popular of rating systems, could promote an advantage in the market and endorse a more scientifically proven rating system that would yield higher energy reduction results. Overall, the goal of the research is to develop a system, or use an existing system to address historical buildings sustainability and how a rating system will improve the efficiency without the building losing its original identity.

Methods

Researchers and building certification practitioners have realized the difficulties with using existing green building rating systems for historic buildings. Therefore, developers of select ratings systems have proposed a solution to the problem by modifying existing energy rating systems where they can add specific requirements or criteria on the historic value and preservation. The following review outlines several modified energy rating systems for historic buildings.

Cavallo (2005) presented a study that compared energy efficiencies of three historic residential buildings that conducted renovations under the restrictions imposed by the historic-preservation standards in Illinois. The rating system applied in this study was proposed by the Illinois' Division of Energy and the Illinois Historic Presentation Agency and included many criteria in the EPA's Energy Star Homes program. The Architectural Energy Corporation's REM/Rate, a popular software tool for residential energy analysis was also applied. The study discussed how to apply this rating method in other States as well. Critically speaking, this article did not specifically mention if preserving the historic values would provide any advantage in the rating system. In addition to comparing the three historic buildings, the study did not compare their energy performance with non-historical buildings under the same rating system.

Powter and Ross (2005) proposed to include 'qualitative values' (culture and social values) in rating heritage properties considering that the quantifiable values (energy use and efficiency) have been emphasized in the existing sustainability rating

systems. "Culture-heritage conservation" is the concept proposed and is defined as protecting cultural objects by promoting the use of existing resources. Early discussions on the development of an assessment system for historic buildings indicate that 20 percent of points should be assigned to culture-heritage criteria. The article also reviewed existing sustainable-building assessment systems and how they were applied to the heritage properties. Improving existing rating systems were addressed by introducing the **environmental-sustainability assessment criteria** developed by the Heritage Conservation Directorate (HCD) of Public Works and Government Services Canada (PWGSC). The rating system was originated from Green Global for Existing Buildings and covered heritage buildings and the “projects affecting heritage property”. It addresses “both performance improvements and environmental and cultural sustainability”. The article also outlines the tools and research needed to develop a more effective assessment system for heritage properties which should be considered and further researched. Important key points from the article included: indicators and measures for cultural sustainability and performance of heritage properties, tools with appropriate data to support assessment of performance of traditional materials and assemblies, data on energy performance of buildings, particularly those erected between 1940s and 1970s, application of state-of-the-art modeling tools to heritage buildings, and a compilation and analysis of projects and buildings that achieve environmental and cultural sustainability goals.

Jackson (2005) proposed to include the ‘embodied energy’ into the analysis of the historic preservation projects. ‘Embodied energy’ is the “sum of all the energy required to extract, process, deliver, and install the materials needed to construct a building” which is the same concept of life cycle energy used in life cycle assessment (LCA). Involving ‘embodied energy’ in the rating system can address preserving or reusing materials and resources in old buildings because the life cycle energy will be reduced as a result of using existing materials. The article additionally pointed out that the LEED-NC 2.1 rating system considered the reduction of the embodied energy in an implicit way but still was not considered as a category. Thus, the suggestion of using embodied energy on a future rating system could be taken into account on historic buildings. (The ‘embodied energy’ and LCA have been included into LEED v3 and

updated in v4). One shortage of this paper is that it did not mention how to include more important culture and social values in a rating system.

Frey (2007) analyzed the incorporation of “green” technologies into historic buildings under the LEED New Construction (LEED-NC) program and provided solid recommendations for improving green building standards in historic preservation. In this thesis for a Master degree, the history behind the creation of a rating system for sustainable buildings was examined. The thesis applied the revised LEED-NC rating system into comparison of historical buildings vs. non-historical buildings. Based on the analysis, historic buildings tend to accumulate fewer points on sustainable site, water efficiency, indoor environmental quality, equal points on energy and atmosphere, and outscore on materials and resources. At the end of the analysis, the author not only proposed to add LCA as a comprehensive approach but also gave a series of recommendations for each LEED-NC criteria.

In the article by Campagna (2008), the benefits of changing LEED to favor historic building preservation were discussed. The article mentioned that the Sustainable Preservation Coalition has been advising the USGBC to incorporate preservation, social, and cultural values into LEED. LEED v3 2009 has made changes in response to suggestions from the Sustainable Preservation Coalition and other organizations. Among the changes, the system encourages the construction or renovation within a sense of community, the use of public transportation, and included the innovation and regional bonuses.

The WBDC Historic Preservation Subcommittee of 2014 explored the potent revisions within five categories of the LEED rating system toward historical buildings and provided some kind of guidance to get the best outcome in terms of preservation and sustainability. The report suggested special attention to several sections - subsections including 1) Sustainable Sites - Heat Island Reduction; 2) Water Efficiency - Water Use Reduction; 3) Energy and Atmosphere - Minimum Energy Performance (shutters, awnings, overhangs, effective use of windows, etc.); 4) On-Site Renewable Energy, Green Power, and Reuse of Historic Windows, Materials and Resources - Source Reduction and Waste Management, Optimize Use of Indoor Air Quality Compliant Products, Exterior and Interior Materials; and 5) Indoor Environmental

Quality - Outside Air Introduction and Exhaust Systems, Controllability of Systems, Daylighting and Views.

Finally, Boarin et al. (2014), conducted a case study to assess historic buildings through GBC Historic Building; a new rating system developed by GBC Italia. The new rating system was stemmed from the International LEED, but included 'historic values' as a new area in order to address "all the specific issues related to preservation". In addition, the new system treats "the energy efficiency as an opportunity to preserve and protect historical buildings, and not necessarily a change to its original content to be avoided". GBC Italia is one of the few rating systems that included historic values into analysis, which "bridges the gap between energy efficiency, environmental sustainability, and cultural heritage preservation". The way to rate historic values in this system could be referenced in developing an energy rating system for historic buildings in the U.S.

Conclusions

When historic buildings were first constructed, they integrated natural daylight, ventilation, and in some cases solar orientation. Heating most likely came from locally grown timber and materials that were delivered to the site by human and animal power (low embodied energy). Keeping historic buildings entirety, re-using and refurbishing them, keeping a percentage of their original components, and upgrading their thermal and mechanical properties could provide excellent end results which are more sustainable.

The approach of European cities, which is a rich living symbol of Europe's culture and how they see historic buildings, is much different than the approach used in the United States. Europe is more likely to rehabilitate their buildings because they are staple tourist attractions which helps their economy flourish. Europe's buildings are still lived in, used as museums, or being occupied as office spaces. Europeans look at buildings as a value for both the community and nature. With this in mind historic buildings need to be addressed using a joint task that includes conservation and energy efficiencies. By convening a team of multidisciplinary, one can achieve the reduction of energy and make a positive impact.

On the other hand, in the United States, the Secretary of the Interior is responsible for establishing standards that address historic buildings that fall under the Department of Interior authority. This includes all federal agencies and the buildings these agencies occupy. There are two standards: The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring & Reconstructing Historic Buildings and the Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings. These two standards are only used for federal buildings and buildings' owners or other agencies whether state, county, or local who are receiving funds from the federal grant-in-aid funds. Otherwise, these standards are only voluntary and are used as guidance for the rehabilitation on any historic building. Thus, a combination of both the European and the United States guidelines for Historic Rehabilitation should be the basis for the development of a rating system. Furthermore, LEED and Green Globes should also be considered as they address the credit category. Depending on the scope of rehabilitation, Passive House concepts could also be incorporated into the rating system addressing the interior of the building.

Evaluating the historic contents of the building is necessary; forming and utilizing an Integrated Design Approach could conduct this evaluation. A preservation specialist should also be included when assessing the components and materials of the building. Furthermore, a level 2 energy audit must be performed before the rehabilitation process begins. The existing building should be evaluated for the purpose of determining the existing energy consumption and what modifications can be applied; i.e. interior and exterior impact, and what options can be implemented for the improvement of the thermal performance. Also, the economic impact the building has on the community should involve the local Historical Society and the National Historical Society depending on the location of the building. Research on if the building is listed on any federal, state, or local Historical Society registry should be conducted and determine the location to mass transit if the building is situated in an urban area.

Overall, the interest of developing a rating system for historic buildings is gaining momentum among organizations, institutions, academics, and the public and private sector. There are now published guidelines. However, these guidelines only apply to

federal buildings that are owned by federal authority. In addition, for private owned buildings are not listed in the local Historical Society, current rating system only includes the exterior components, such as windows, doors, facade and cladding, but no attention is given to any interior components of the buildings. This is mainly because the local authority is only interested in the original look and feel of the building. Lastly, the current guidelines do not address the energy efficiency or any other component of a green building system. For the private sector, the federal standards are only voluntary.

By developing a rating system that specifically addresses historic buildings, we are not only including the federal holdings but also opening it up to both the private and public sector. Energy rating systems will act as a guideline addressing both public and private holdings while addressing the economic value and energy efficiency potential while maintaining the historic registry of the building, if previously listed as such. An energy rating system should consider the occupants, the operation, and the maintenance. In terms of sustainability, restoring, and rehabilitating our existing buildings will reduce our carbon and ecological footprint, improve energy efficiency, preserve open space from development, and build a strong community.

Table 1

A Review of Current Green Building Rating Systems Worldwide

Rating Systems	**Building Types**	**Rating Areas**
UNITED STATES		
LEED	New Construction Commercial Interiors Core and Shell Existing Buildings	Sustainable sites-water efficiency-energy and atmosphere-materials resources-indoor environment quality-innovation and design processes
Green Globes	Office Buildings	Project management-site-energy-water-resource, building materials and solid wastes-emission and other impacts-indoor environment

Rating Systems	Building Types	Rating Areas
Built Green – Colorado	Detached Homes	Energy-site-health and safety-material resource efficiency-resource conservation
Built Green – Washington	Detached Homes Multi-family Residential	Site-water-health and indoor air quality-material efficiency
Living Building Challenge	New Construction Major Renovations (All buildings)	Site-energy-materials-water-indoor quality-beauty and inspiration
Energy Star	Residential	Energy-water
NAHB Model Green Home Building Guidelines	New Construction Major Renovations (Single-detached, low rise residential)	Lot design-resource-energy-water-indoor environmental quality-operation, maintenance and homeowner education-global impact
Chicago Green Homes (CGH), Green Homes Guide	Residential	
Rating Systems	Building Types	Rating Areas
Green Building Standard (NGBS)		
CANADA		
LEED	Same as LEED-U.S	Same as LEED-U.S
Green Globes	Same as Green Globe-U.S	Same as Green Globe-U.S
Built Green	Single-detached Multi-family Residential	Operational systems-building materials-finishes-indoor air quality-ventilation-waste-water-business practices
AUSTRALIA		
Rating Systems	Building Types	Rating Areas

Rating Systems	Building Types	Rating Areas
Australia Greenhouse Building Rating (AGBR)	Tenancies Base Buildings Whole Buildings	Light and Power Central services
ASIA		
Building Environment Assessment Method (BEAM) – Hong Kong	New Buildings Existing Buildings (All buildings)	Site-materials-energy use-water use-indoor environment quality-innovation and performance enhancement
Comprehensive Assessment System for Building Environment Efficiency (CASBEE)–Japan	New Construction Existing Building Renovation Home	Energy efficiency-resource efficiency-loading environment-indoor environment
Ecology, Energy Saving, Waste Reduction and Health (EEWH) – Taiwan		Biodiversity-greenery-soil water content-daily energy saving-carbon dioxide emission reduction-waste reduction-indoor environment-water resource-sewage and garbage improvement
BCA Green Mark – Singapore	New Buildings Existing Buildings	Energy efficiency-water efficiency-site and project management-indoor environment quality and environment protection-innovation
LEED – India		
Rating Systems	Building Types	Rating Areas
Pearl BRS – Abu Dhabi	Community, Building and Villas	Management-site-water-energy-IEQ-materials-innovation
GBI – Malaysia		Site-water-energy-IEQ-materials-innovation
EUROPE		

Rating Systems	Building Types	Rating Areas
Haute Quality Environnementale (HQE) - France	Building Development And Operations	Eco-construction-Eco-management-comfort-health
Germany Sustainable Building Certificate (GSBC) – Germany		Modeled after the American and British standards
Building Research Environment Assessment Method Consultancy (BREEAM) – UK	New Building Major Refurbishment Tenant Fitout Eco-Homes	Management-health-energy-transport-water-materials-land use- wastes-pollution
WORLDWIDE		
SBTool	All Buildings	Site-energy and resource consumption-indoor environmental quality-service quality-social and economic aspects

(Source: Light House 2015; Fmlink.com; Waidyasekara et al. 2013; Reed et al. 2013; Say and Wood 2008; Nguyen and Altan, 2011; Smith et al., 2006; Fowlera et al. 2006; Vierra 2014; Yudelson, 2016; and FGAA, 2011).

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