Forum Focus
Putting *The Greenest Building* Report to Work for Historic Preservation

MAY 2012

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Putting The Greenest Building Report to Work for Historic Preservation

In February 2012 the National Trust for Historic Preservation’s Preservation Green Lab released *The Greenest Building: Quantifying the Environmental Value of Building Reuse*. This report marks the first of its kind in the United States to compare the environmental consequences of reusing and retrofitting an existing building for energy efficiency versus building new. The findings make a compelling case that the preservation, retrofit, and reuse of a historic building is almost always a more environmentally sustainable option than new construction. This white paper is designed to help preservation professionals and advocates use the data contained within the report to advance their own efforts to save historic places. In it you will find:

- Definitions of common green building terms as well as an explanation of the building types and impact categories used in the report.
- Concise explanation of the report’s scientific methodology (Life Cycle Assessment) and the study’s research objectives and steps.
- Breakdown of the report’s findings and what they mean for historic preservation.
- Guide to how to use the report to make the case for historic preservation.

**THE GENESIS OF THE REPORT**

Historic preservationists have long considered their efforts essential to the environmental sustainability of the cities, towns, and rural areas in which they work. Yet the oft-repeated assertion, first made by Carl Elefante, AIA, in the Summer 2007 issue of *Forum Journal*, that “the greenest building is...one that is already built” is largely based on anecdotal evidence and a few high-profile case studies.

Now, this groundbreaking report replaces anecdote with fact and offers a carefully researched, scientific approach to quantifying the benefits of reuse and retrofit over new construction. It goes much further than previous studies of its kind, which have compared the environmental impacts of reuse and new construction for just one building type in one climate region. *The Greenest Building* is far more ambitious. It examines six building types across four distinct climate zones and examines environmental impacts in four different categories.

This research was commissioned by the National Trust’s Preservation Green Lab (www.preservationnation.org/greenlab) and conducted by Cascadia Green Building Council (www.cascadiagbc.org), Green Building Services (www.greenbuildingservices.com), SKANSKA (usa.skanska.com), and QUANTIS (www.quantis-intl.com). This team offered unparalleled experience and expertise in the fields of green building and life cycle assessment.
GETTING THE WORDS RIGHT

British Thermal Unit (BTU): Factor used to measure the amount of energy used for heating and cooling.

Building Transportation Energy: The energy used to transport occupants to and from a building.

Ecoinvent Database: International supplier of consistent and transparent life cycle inventory (LCI) data.

Embodied Energy: The initial energy investment required to produce a material or product. It includes the up-front energy investment for extraction of natural resources, manufacturing, transportation, and installation of materials, referred to as initial embodied energy.

Energy Use Intensity (EUI): Unit of measurement that describes a building’s energy use relative to its size.

Environmental Protection Agency (EPA): The main regulatory agency of the United States government regarding environmental issues.

Electricity Grid: An interconnected network for delivering electricity from suppliers to consumers.

Joule: The International System unit of electrical, mechanical, and thermal energy. A megajoule is equal to one million joules.

Life Cycle Assessment (LCA): An approach to evaluating the potential environmental and human health impacts associated with products and services throughout their respective life cycles.

Net-Zero Building: A structure that generates as much energy as it uses.

Operating Energy: Energy needed to operate a building, including the energy required to heat and cool a building, as well as energy needed to run appliances, lighting, electronics, etc.

Passive Design: Passive design features use natural elements, often sunlight, to heat, cool or light a building.

Passive Survivability: Maintaining livable conditions in a building in the event of a prolonged power outage.

Recurring Embodied Energy: Energy needed over time to maintain, repair, or replace materials, components or systems during the life of a building.

Vehicle Miles Traveled (VMT): The total number of miles driven by all vehicles within a given time period and geographic area.

Source: http://usgreenbuilding.stratumweb.com/glossary.asp
UNDERSTANDING THE METHODOLOGY AND RESEARCH PROCESS

LIFE CYCLE ASSESSMENT
So how do you measure the impact of a building on the environment? Life Cycle Assessment (LCA) is a methodology used to evaluate the potential environmental and human health impacts associated with products and services throughout their life cycles. When applied to buildings, this methodology measures what effect buildings—whether existing or new—have on the environment over the course of their entire life cycle beginning with the extraction of raw materials through demolition and disposal.

The LCA methodology allows for a clear understanding of not only what environmental impacts occur but when they occur within the life of the building. Specifically, The Greenest Building study measured four environmental impacts: Climate Change, Human Health, Ecosystem Quality, and Resource Depletion. These are explained more fully below.

Figure 1: Life Cycle Stages

- **Extraction** of raw materials for production of both new and replacement materials.
- **Transformation** and refinement of raw materials.
- **Manufacture** of products and distribution to suppliers.
- **Transportation** of products to building site.
- **Use** of building including construction-related activities and operating energy of the building over its lifespan.
- **End of Life** disposal of materials, including transportations, to landfill, recycling or incineration.

RESEARCH OBJECTIVES
- Calculate and compare the environmental impacts of buildings that are reused and retrofitted versus the demolition of an existing building and replacement with new construction.
- Determine at what point in a building’s life cycle the most significant impacts on the environment occur and why.
- Examine how building type, geography, energy performance, and electricity-grid mix affect a building’s environmental impacts over its life span.
BUILDING TYPES
The project team selected six building types for the study based on the following criteria: the most prevalent building types in the U.S. by square footage; building types that are most frequently torn down and replaced with new construction; and the availability of high quality data for researchers. The building types include:

• Single-Family Residential
• Multi-Family Residential
• Urban Village Mixed Use (a Main Street style building)
• Commercial Office
• Elementary School
• Warehouse

STEPS IN THE RESEARCH PROCESS
Phase I – Researchers reviewed existing literature and carried out a pilot LCA in order to test the study methodology, including an evaluation of key assumptions.

Phase II – Using the findings of Phase I, researchers selected case studies to be used in the larger study.

Phase III – A LCA was run on each of the six building types for a reuse/retrofit scenario and a demolition/new construction scenario across four cities (Portland, Phoenix, Chicago, and Atlanta) representing different climate regions. This ensured that the findings of the study were more broadly applicable across the country.

A note on normalizing: No two buildings are ever exactly the same, but researchers made every effort to make the comparisons as accurate as possible by adjusting factors when appropriate. For example, if the new construction building came with a parking garage, but the existing building did not, the energy consumption of the parking garage was not included in the comparison.

Researchers found that energy retrofits undertaken on historic commercial buildings bring immediate results in lessening environmental impacts. Pictured here is the White Stag Block in Portland, Ore.

PHOTO BY SALLY PAINTER
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IMPACT CATEGORIES
The report examined consequences of reuse and retrofit as compared to new construction across four impact categories. The categories—Climate Change, Human Health, Ecosystem Quality, Resource Depletion—were selected because they have been included in previous assessments and are comprehensive enough to represent a range of environmental impacts.

Climate Change demonstrates the impact of construction and rehabilitation in terms of global warming by measuring the emissions of CO₂ and other greenhouse gasses.

Human Health looks to calculate the damage caused by the release of substances that can lead to toxicity, cancer, respiratory problems, and UV radiation, to name a few.

Ecosystem Quality examines the effect of construction and rehabilitation on the health of wildlife and habitat. For example, it determines the likelihood of species loss.

Resources Depletion comes into play when nonrenewable resources are consumed or when renewable resources are used much faster than they can be regenerated. This includes measuring the amount of energy needed to acquire new materials.

UNDERSTANDING THE RESULTS
Three primary findings emerged from the study and all generally suggest that the greenest building is often the one already built. Each finding, however, must be accurately represented and its limitations explained if it is to be an effective means of arguing for the preservation and reuse of existing buildings over new construction.

1. Building reuse almost always yields fewer environmental impacts than new construction when comparing buildings of similar size and functionality.

After comparing the reuse and retrofit of an existing building to new construction across the six building types, researchers found that, over a 75-year life span, the number of environmental impacts was always lower for the existing buildings. That being said, the degree to which the impacts were lower depended on building type, region/climate, and impact category. For example, in the examples illustrated in the chart on page 9 the reuse of an office building in Chicago showed a 20 to 27 percent less environmental impact than that associated with new construction in the ecosystem quality category.

The one exception to the finding that renovated buildings performed better than new construction was in the case of the renovation of a warehouse to a multi-family dwelling. The particular warehouse building examined for
The Greenest Building study demonstrated somewhat higher human health and ecosystem quality impacts than a comparable new building; however, more careful selection of materials for the rehabilitation project could have reduced the environmental impacts in these categories.

2. Reuse of buildings with an average level of energy performance consistently offers immediate environmental savings compared to more energy-efficient new construction.

It has long been assumed that because new energy-efficient buildings have significantly less carbon dioxide emissions, any negative environmental impacts brought about by their construction are quickly offset by their efficiency benefits. The Greenest Building report found that this is simply not the case. Rather it takes a new building, even one that is 30 percent more efficient than an average-performing existing building, 10 to 80 years to overcome the climate change impacts resulting from its construction.

At some point during a building’s lifetime, however, the environmental impacts associated with new construction equal those associated with building renovation. The study found that this “year of carbon equivalency” occurs at year 42 for the commercial building in Portland, for example. That is, it takes approximately 42 years for the efficient, new commercial building in Portland to overcome the climate change impacts that were expended during its construction process to make its environmental impacts equal to a comparable renovated building.

Table 1: Number of Years Required for New Buildings to Overcome Climate Change Impacts from Construction Process

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Chicago</th>
<th>Portland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban Village Mixed Use</td>
<td>42 years</td>
<td>80 years</td>
</tr>
<tr>
<td>Single-Family Residential</td>
<td>38 years</td>
<td>50 years</td>
</tr>
<tr>
<td>Commercial Office</td>
<td>25 years</td>
<td>42 years</td>
</tr>
<tr>
<td>Warehouse-to-Office Conversion</td>
<td>12 years</td>
<td>19 years</td>
</tr>
<tr>
<td>Multifamily Residential</td>
<td>16 years</td>
<td>20 years</td>
</tr>
<tr>
<td>Elementary School</td>
<td>10 years</td>
<td>16 years</td>
</tr>
<tr>
<td>Warehouse-to-Residential Conversion*</td>
<td>Never</td>
<td>Never</td>
</tr>
</tbody>
</table>

*The warehouse-to-multifamily conversion (which operates at an average level of efficiency) does not offer a climate change impact savings compared to new construction that is 30 percent more efficient. These results are driven by the amount and type of materials used in this particular building conversion. The warehouse-to-residential conversion does offer a climate change advantage when the energy performance levels of new and existing building are assumed to be equal (see Figure 14). Thus, it may be particularly important to retrofit warehouse buildings for improved energy performance while renovating them. Furthermore, care should be taken to select materials that maximize environmental savings.
On average, it takes about 20-30 years for most building types in most climate zones to reach the year of carbon equivalency.

3. The report also found that the types and quantity of material used in renovation and reuse can dramatically alter the outcomes, reducing or even negating entirely the benefits of reuse. A building is really only as good as its parts. If a rehabilitation retrofit scenario uses environmentally damaging materials or requires substantial new materials to be used at the site, the environmental impact begins to track with that of new construction. This is one of the reasons why the warehouse to multi-family retrofit had more of an environmental impact than a newly constructed multi-family building.

A note on climate: Overall the data shows that regardless of the region in which the study was conducted, reuse has less of an impact on the environment than new construction. However, the actual extent of the difference in environmental impacts between reuse and new construction varied from city to city.

A CLOSER LOOK AT ONE EXAMPLE

*The Greenest Building* report looks at six different building types. It assesses two scenarios -- reuse/retrofit and demolition/new construction -- for each type, then considers these scenarios in four different climates. The result is an understanding of how reuse versus new construction affects the environment in the four climate areas. The chart on page 9 details the finding for one building type: the commercial office. In the chart, new construction represents 100 percent impact while the colored bars represent the impacts of reuse and retrofit scenarios in each of the four climate zones. In all impact categories across all climate zones, the renovated building has lower impacts than new construction. Looking specifically at human health, for example, the impact of the renovation and retrofit project was 15 percent lower than new construction in Portland, 12 percent lower in Phoenix, 14 percent lower in Atlanta, and 15 percent lower in Chicago.

The report found that the renovation and reuse of existing commercial office buildings (The Vance Building-top) always yields fewer environmental impacts than new construction (bottom) when comparing buildings of similar size and functionality such as these two office buildings in Seattle, Wash.
TAKEAWAYS

The Greenest Building: Quantifying the Environmental Value of Building Reuse demonstrates and supports some of the key principles that link historic preservation to the sustainability movement. First, reuse matters. In reusing structures there is significant opportunity to avoid further damage to the environment and help communities achieve their short-term carbon reduction goals. That being said, it is critical to emphasize that reuse isn’t enough and that retrofit matters. By retrofitting existing buildings with appropriate energy upgrades, owners and developers can harness substantial emissions reductions over time. Finally, the study reveals the importance of materials as a factor in determining environmental impacts of both rehabilitation and new construction. While this study does not evaluate individual materials, the buildings surveyed indicated that where building renovation requires a substantial amount of new materials (and these materials were not carefully selected) any environmental benefits from reuse and retrofit can be lowered or eliminated.
Distilled down to its key points, The Greenest Building report demonstrates:

1. The retrofit and reuse of a historic building is almost always a more environmentally sustainable option than new construction.

2. These sustainability advantages are found in diverse climate zones and in the most common building types: single- and multi-family residential, urban village mixed-use structures, commercial office buildings, and elementary schools.

3. Energy retrofits for existing buildings bring immediate benefits. A newly constructed building, even one that is 30 percent more energy efficient, will take from 10 to 80 years to overcome the climate change impacts resulting from its construction. Most buildings in most climate zones will take between 20 to 30 years to compensate for the climate change impacts that occur during the new construction process.

4. The quality and quantity of materials used in construction, whether for new construction or renovation, significantly affect its environmental impacts. Careful space planning and careful selection of materials can help to reduce such impacts.

To review the Greenest Building Report in its entirety visit www.preservationnation.org/greenlab.