EXECUTIVE SUMMARY

The task of changing cultural and social paradigms falls to those who are willing to disprove what is perceived as impossible. In the two years since the Living Building Challenge was announced, there has been phenomenal interest from clients and design firms attracted by the simplicity of the concept and an appreciation for the new milestone it defines on the path to a restorative future. Often, the questions that arise after building owners begin to comprehend the magnitude of building a Living Building are "What is the cost premium?" and "What might the payback be?" This study commissioned by the Cascadia Green Building Council, a Chapter of the US and Canadian Green Building Councils, takes direct aim at those very questions. The results are enlightening and encouraging.

Introduction

The genesis for this study in many ways began with the David and Lucile Packard Foundation: Los Altos Project Sustainability Report[1]. The report, first completed in 2001 and updated in 2002, was the first comprehensive look at the costs of all levels of LEED construction from Certified through Platinum. Bookending this analysis was a benchmark market-rate building and at the top end, a Living Building, at that point still a conceptual framework and not a rating system. Although the Packard matrix demonstrated that the level of Living Building was the best long-term economic choice, the anticipated first cost premium was significant for the proposed foundation headquarters located in the Bay Area of California. At that time, many of the requirements of the Living Building Challenge were not defined and thus could not be priced.

Since 2002, there has been a remarkable uptake in the number of LEED projects in the marketplace. This shift, along with a general increase in the number of projects pursuing green building goals and using green materials has reduced the first cost premiums to create a LEED building. In the July 2007 report "Cost of Green Revisited", Davis Langdon found "there is no significant difference in average cost for green buildings as compared to non-green buildings."[2]

The cost premium to achieve a Living Building has not been looked at comprehensively since the last revision of the Packard study in 2002. Achievement of this highest documented level of sustainable design continues to be highly sought after, although a true Living Building has yet to be completed and certified. The purpose of this study is to provide much needed, up-to-date information on the incremental cost between LEED Gold buildings and Living Buildings, and answer the questions regarding the anticipated payback. Because the costs of high performance buildings can vary significantly by building type and location, a range of building types in a variety of climate zones were studied. A huge motivator for this study was understanding the differences in cost that geography, size and building typology make.

"Over the next five to seven years, we need to transform the way we design, build and manage the built environment. The Living Building Challenge is the next logical step in moving closer to sustainable building practices. This cost study exercise is one piece in creating a path to get there. Many of the cost premiums identified are either the result of needed technological innovation or are a product of a key missing element-locally sourced materials and systems. As we emerge from the current economic crisis, a tremendous opportunity exists to create new businesses and local enterprises that can provide these materials and systems. It is time to re-invent ourselves."

-Dennis Wilde
Gerding Edlen Sustainable Solutions

Projects Studied:
See Report for additional information regarding the reference buildiings.

UNIVERSITY CLASSROOM
Oregon State University
Kelley Engineering Center

SCHOOL K-8
Sherwood Elementary & Middle School

LOW RISE OFFICE
Cascade Station Corporate Center II

MID RISE OFFICE
Cascade Station Corporate Center I

MIXED USE RENOVATION
NW 14th & Everett Mixed Use

SINGLE FAMILY RESIDENCE
Bacon-Brenes Residence

MULTI FAMILY RESIDENTIAL
Tupelo Alley Mixed Use Development

HIGH RISE MIXED USE
12th & Washington

HOSPITAL
Providence Newberg Health Center

Genesis of the Living Building Challenge

In 2006 at Greenbuild, the Cascadia Region Green Building Council formally announced the Living Building Challenge[3]. However, the idea for the Living Building emerged much earlier in connection with the NIST-funded EpiCenter project in Bozeman, Montana in the mid-nineties, with the term and concept coined by Jason F. McLennan and developed with Bob Berkebile of BNIM Architects. From its early beginnings as a guiding framework for what was to be the most advanced sustainable design project in the world, the ideas behind "living" buildings continued to grow and develop. In 2005, McLennan, the lead researcher for the EpiCenter project, turned the conceptual idea of a "living" building into a building rating system based around a set of sixteen simple, yet profound prerequisites that became the Living Building Challenge version 1.0, which McLennan gifted to Cascadia in August 2006. Three months later the Challenge was launched. Version 1.3, released in August 2008, which can be downloaded at http: www.cascadiagbc.org provided the conceptual framework for this financial study.

Study Methodology

In order to put a price tag on an idea, in this case, the Living Building Challenge, the idea must be translated into a model, with form, place and quality defined.

For the study, a team led by SERA Architects, joined by Skanska USA Building, Gerding/Edlen Development, New Buildings Institute and Interface Engineering, with the staff of Cascadia, conceptually transformed nine LEED Gold buildings into Living Buildings. The buildings, all of which were completed at least through construction documents, were selected to represent a variety of development models ranging from a single family residence developed by an individual owner, to a publicly developed university classroom building, to a seventeen story mixed-use skyscraper developed by a Portland area green developer. The buildings characterize a range of uses, each of which was evaluated in four climate cities: Portland (temperate), Atlanta (hot -humid), Phoenix (hot-arid) and Boston (cool), to determine the base building's energy and water usage.

The entire study team engaged in a dialogue to identify and sketch the characteristics of the projects to be studied in order that conceptual level cost estimates could be prepared. The project's base estimates were normalized to January 2009 dollars so baseline costs could be established. A Living Building Prerequisite Cost Summary which outlines the cost approach for each of the sixteen prerequisites is included in the body of the text. Several prerequisites do not add significant cost including **1) Responsible Site Selection** and **2) Limits to Growth**. Others, such as prerequisites **5) Materials Redlist** and **8) Appropriate Materials / Service Radius** are more difficult to quantify. Four prerequisites – **4) Net Zero Energy, 10) Net Zero Water, 11) Sustainable Water Discharge** and **12) A Civilized Environment** – were responsible for the greatest change to each building's characteristics and thus, were the focus of the redesign efforts. A set of design modifications, energy conservation strategies, and rainwater collection techniques were proposed for each building to arrive at a reduced building water and energy usage before photovoltaic's and water reuse strategies were applied. The team endeavored to employ the least expensive strategies for all prerequisites, only utilizing expensive systems when the climate conditions dictated they were required.

The estimating team took a considered approach to anticipating the complete scope of each project, adding allowances for a full tenant build-out if it was not included in the base project. Living Buildings demand an integrated approach to design using highly skilled and experienced architects and engineers; likewise, the estimate could not assume that features would be bolted-on in isolation of one another. The cost estimating team worked with the design team throughout the process to define and estimate the design intent. The cost model reflects a best net-value interpretation of strategies and systems necessary to achieve Living Building goals. Living Building revisions reflect regionally sensitive interpretations of the baseline building, including materials and systems appropriate to local building practices. The estimates incorporate industry-recognized contingencies, regional cost data derived from Skanska's cost database, and soft costs adjusted to approximate the updated pricing.

Payback

For the Living Building Financial study, we performed a simplified life cycle cost analysis. First the cost estimating team compared the LEED Gold building baseline costs to the costs projected for the Living Building Modification (adjusted to January 2009 dollars), to arrive at the present worth for each building. Energy and water for LEED Gold baseline building were calculated using a differential escalation rate of 3% for energy and water in accordance with FEMP. Current energy and water rates were multiplied by the present worth factor of 24.165. (This factor reflects a 30-year life-cycle, 4.5% discount rate and 3% differential escalation.) The total life cycle cost looks at both the annual cost and the present worth of the building to arrive at a present worth for the LEED Gold building. The Living Building does not have annual costs added to it, because of its Net-Zero Energy and Net-Zero Water usage.

Results

Conceptual estimating is part science and part art.

The cost models endeavor to establish a cost increment for Living Buildings, recognizing that every project will vary from these results in response to its unique requirements, location and market conditions. More important than the absolute numbers derived for the small sample of specific projects analyzed in this study are the general insights gained in what influences the costs of a Living Building and the range of potential costs that one might find. We believe that the results are exciting and encouraging for the rapid adoption of living buildings everywhere.

1 See http://www.bnim.com/fmi/xsl/research/packard/index.xsl for complete information of the Packard matrix and report. Visit the Packard Foundation website at http://www.packard.org/home.aspx for more information on the foundation.

2 *See the* Davis Langdon website http://www.davislangdon.com/USA/Research/ResearchFinder/2007-The-Cost-of-Green-Revisited for more information on the Cost of LEED study.

3 See Cascadia's website http://www.cascadiagbc.org/resources.living-buildiings for more information on the Living Building Challenge.

Key Findings

Living Buildings can be built cost effectively in today's market driven economy given the rising costs of energy and water. The first cost premiums for many building types are significantly lower than what many would predict for an energy and water independent structure. The degree of cost effectiveness depends on the interplay of four factors: client, climate, scale and building use – as originally thought by the study team. The study found that two additional factors: 1) the availability of incentives and 2) the costs of energy and water, can tip the scales for economic competitiveness.

1. **Client Type Matters**
   Who the building is developed for and their goals and priorities greatly affect the initial budget for the base building which in turn affects the first cost premium for Living Buildings.

   Living Buildings are more likely to be built in market sectors where building owners and developers also consider operational costs, as opposed to those that are more first cost driven. Public buildings (University Classroom and Elementary School), which are typically designed and constructed as fifty to one hundred year buildings, had the lowest cost premium, followed by buildings built by green developers for a market niche, followed by market driven developments, with speculative buildings costing the most.

2. **Climate Matters**
   Climate exerts a significant influence on the cost premium to create a Living Building.

   Extremes in climate affect both the demand for energy and the availability of water in the form of rainfall. The milder a climate, is the less energy is expended to achieve human comfort. Both the quantity of rainfall and its frequency throughout the year affect the cost premium to achieve Net Zero Water. Atlanta and Phoenix consistently had the lowest energy use intensity and had the highest production per unit of area for photovoltaics. Although Portland had a slightly higher overall EUI, it's lack of extreme temperatures and relatively abundant rainfall translated into elimination of systems for some building types, reducing the overall cost premium. Alternately, Boston's more extreme temperatures led to increased energy use for the base building, both for heating and cooling, while Phoenix's low water availability led to higher water collection and treatment costs.

3. **Scale Matters**
   The scale of the building, both in absolute size and the ratio of floor area to roof area, affects the cost premium to build a Living Building.

   The absolute scale of the building affects the affordability of many of the systems necessary to achieve Living Building status. For very small buildings, such as the Single Family Residential building, the cost of adding the systems necessary to achieve Living Building status are great compared to first cost, driving up the cost premium. For larger buildings, the cost premium for Living Building features relative to the total project cost is much less, minimizing the cost premium.

   The relationship of the building's floor area to its roof area also affects the affordability of achieving Living Building status, since roof area is the determinant for both the size of the photovoltaic array which can be easily installed without building additional infrastructure, and for the amount of rain water that can easily be collected. To achieve net zero energy, buildings with

a large floor area to roof area ratio needed to provide additional structure to support photovoltaics not integral to the building, which added cost. To achieve net zero water, the most economical buildings were those who could meet their water needs with rainfall alone, since they did not need to provide the additional treatment required to grey and black water to potable standards.

4. Building Use Matters

The primary and secondary uses of a building greatly affect its energy and water usage, which in turn affects the cost premium to build a Living Building.

The building's use determines the base energy and water consumption before conservation strategies are applied. The base building's Energy Use Intensity and water usage affects the project's ability to achieve net zero energy and net zero water for a given floor to roof area ratio. When the same size and height buildings are considered, we see the differences resulting from building use . Residential buildings, like the Multi-Family Residential Building, are constrained by the project's ability to collect rainfall for use far in advance of exceeding the project's ability to achieve Net Zero Energy. The opposite is true for office buildings, where the energy produced by the project's photovoltaics governs.

5. Incentives Matter

The availability of incentives for green building projects can dramatically decrease the first cost of a project.

Living Buildings are more likely to be built in market sectors where building owners and developers have robust incentives in place for the incorporation of green building practices. Portland is the second most expensive city in the study to build based solely on construction cost, rising to third most expensive after the Living Building features have been added. After incentives have subtracted, the cost premium reduces to it being the least costly climate to build in for all building types.

6 Cost of Energy and Water Matters

The cost of energy and water affects the payback.

The cost of energy is lowest in Portland and highest in Boston. Phoenix has the lowest cost for water, with Atlanta having the highest cost. Boston, the city with the highest energy cost and a very high water rate and the highest first cost premium, had the lowest payback in eight of the nine buildings.