GREEN LUXURY:
A CASE STUDY OF TWO GREEN HOTELS

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ABSTRACT

The hotel industry is beginning to implement green design and construction practices, saving energy, water, and resources and thus helping to preserve the environment. In addition, green building practices also can provide healthy and comfortable indoor environments to hotel occupants including guests and employees. However, there is the potential for conflict between green building practices and hotel guests' satisfaction and comfort, as the conservation of resources could detract from the quality of a guest's visitor experience. This study adopted a case study approach to identify and analyze green design and construction practices that create a green and luxurious environment without damaging the hotels' financial position. An in-depth literature review was conducted to identify green design and construction practices, design features of premium hotels, and major design conflicts between the twin goals of green building and a luxurious hotel environment. Two LEED platinum hotels (the Proximity Hotel and the Bardessono Hotel, both in the United States) were selected and data collected on their green design and construction practices, luxurious design features, and operation and maintenance practices from multiple sources, including the owner, designer, contractor, engineer, and LEED consultant. From the perspective of the entire lifecycle of the building, this data was analyzed to identify green design and construction practices that not only provide a green, luxurious environment but also enhance the hotels' financial strength.

KEYWORDS

green building, green design and construction practice, hotel industry, case study

INTRODUCTION

Throughout the design, construction, operation, and end-of-life-cycle processes that make up a building's life, the built environment of which it is a part exerts both positive and negative impacts on the earth, its resources, the people that live on it, and their communities. As part of the effort to reduce these negative environmental impacts and maximize benefits, the concept of "sustainability" has gained widespread acceptance over the past twenty years, encompassing ecological, economic and social aspects of the built environment (Ahn & Pearce 2007).

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In the building sector, green design and construction practices include: increasing efficiencies, thereby saving energy, water, and other resources; furnishing satisfying, productive, healthy, and high quality indoor spaces; using environmentally preferable materials; and educating building occupants about efficiency and conservation (Ahn & Pearce 2007; Kibert 2008). Hotel industry business owners seeking to be environmentally responsible, both for economic and financial efficiency, and to satisfy their own personal ethics are introducing green building practices (Tzschentke et al. 2004; Bader 2005). This trend towards green hotels not only addresses environmental concerns by saving energy, water, and resources, but is also expected to improve guest satisfaction and comfort (Becker 2009; Millar & Baloglu 2008). Guest satisfaction, intent to return, and likelihood to recommend a hotel are important factors for success in the hospitality industry. Therefore, in developing a new hotel the design team generally focuses on areas known to be strongly linked to these factors, namely the lobby, the guestrooms, the bathrooms, food and beverages, spas, the outside environment, and the artwork displayed around the hotel (Heide & Gronhaung 2009).

However, there is often the perception of some conflict between guest satisfaction and comfort and green building practices in hotels that aspire to sustainability. According to Kirk (1995), this may arise as a result of the conservation of resources, including water and energy, which could detract from a guest's experience and comfort. For example, luxury hotels are generally more spacious and include plush or exotic materials, sophisticated lighting that feels warm and inviting, and bathrooms with large bathtubs and multiple showerheads (Schor 2008). These luxury attributes of hotels are seldom compatible with green building practices, which tend towards smaller spaces, and materials and products that are non-exotic, recycled, natural, or rapidly renewable, with increased use of fluorescent lighting to reduce energy use and an emphasis on the conservation of water (McLennan 2004; Becker 2009). In addition, a green hotel is often assumed to be unattractive in appearance and uncomfortable (McLennan 2004). To counteract these tendencies and assumptions, it is therefore necessary to identify green building practices that can be implemented over the building's entire life cycle to reduce its environmental impact, maximize social and economic opportunities, and improve guest satisfaction and comfort. The researchers therefore conducted a case study of the Proximity Hotel in Greensboro, NC, and the Bardessono Hotel in Yountville, CA—the only hotels in the United States at the time of this study to have achieved the highest LEED rating of Platinum while at the same time providing their guests with a comfortable and luxurious environment—in order to identify and analyze what types of green building practices are appropriate and practicable for those seeking to implement green building practices.

BACKGROUND STUDIES AND LITERATURE REVIEW

This section provides background for the concept of sustainability and green practices in the building sector. Current hotel design features that provide luxury environments to guests and enhance their satisfaction are identified, along with the types of green building practices that can be implemented in hotels to achieve the goals of sustainability. Finally, the conflicts between the twin goals of achieving sustainability while at the same time providing a luxurious hotel environment are examined.

Design Features for Luxury Hotels

The American term "hotel" was borrowed in the 1760s from the French term *hôtel*, which originally referred to a nobleman's residence, large official building, or town hall (Becker,

2009). Even though hotels in the USA were introduced in response to travellers' need for lodging, they represented high quality guesthouses that were above the level of the taverns and small inns commonly found at that time (Becker 2009). Consequently, hotels tended to serve as architectural examples of American excellence and represented a distinctly American vision of mobility, civil society, and democracy (Sandoval-Strausz 2007), although this perception of hotels has faded somewhat over time due to the wide variety of industry market segmentation, including a large increase in supply of inexpensive, lower quality chain hotels (Becker 2009). However, this trend has reversed in recent years, with several chain hotels creating boutique brands such as the W hotel that provide excellent service to guests who are looking for hotel experiences with style, service, comfort, and luxury that are personal, authentic, and creatively intriguing. These hotels often explore high fashion architecture, hotel design, and distinct interiors that influence hotel guest satisfaction, intent to return, and their likelihood to recommend a hotel (Heide & Gronhaung 2009). Based on reviewing a number of articles that discussed appropriate design features for luxury hotels, this study identified key design features that can promote a hotel to luxury status (Becker, 2009; Heung et al. 2006; Curtis 2001; Bernstein 1999; Cohen & Bodeker 2008; Heide & Gronhaung 2009;). (Table 1)

For example, common attributes of a luxury hotel include more space, plush or exotic materials, sophisticated lighting that feels warm and inviting, and bathrooms with large bathtubs and multiple showerheads (Becker 2009). These design features make guests' visits more comfortable but may create a perceived conflict with sustainability because major green

TABLE 1. Design features for luxury hotels.

Design Features	Design Features for Luxury Hotels
Lobby Design	• Social interaction spaces not only for guests but also for the local community • Staged to provide a theatrical introduction to the environment and hotel spaces
Guestroom	• Safety, comfort, privacy, quiet and spacious guestrooms • Unique design details, technology, and controllable lighting • Comfortable indoor environment • Comfortable office spaces within the room • Stylish furniture, plush materials and high tech entertainment devices
Bathroom	• Spacious bathroom • Deep tubs, his and her lavatories, walk-in showers, marble and chrome finishes • Quality and appearance of amenities • Technology such as a small plasma television, flexible lighting
Artwork	• High quality artwork in guestrooms, hallways, lobbies, staircases, and elevators • Gallery areas in the hotel
Spa	• Attention to interior design, increasing guest relaxation • Transition areas and generous public spaces • Multiple relaxation areas: outdoor and indoor • Environmental controls for guest comfort • Spa cuisine-health, organic options
Food & beverage	• Organic food and unusual food items • Top quality food and beverage
Landscaping and exterior environment	• Parks/gardens with trees and plants • Open space with trees and plants • Diverse colors and textures

building strategies focus on reducing humans' environmental footprint by reducing resource consumption to the necessities. Sometimes such luxury attributes may be perceived to be incompatible with green building practices, which often focus on reducing resource consumption over the building life cycle to minimize environmental footprint.

Sustainability and Green Building Practices

Green buildings represent the response of the building sector to the need to minimize negative environmental, social, and economical impacts in the building sector. Through using green building practices, it is possible to work toward the aim of "meeting the needs and aspirations of today without compromising the ability of future generations to meet their own needs" (Brudtlland 1989). To achieve a green building, green design and construction strategies should be incorporated at the planning stage to the demolition phase of the building. A green building relies upon a fully integrated "whole building" approach that covers the entire phase of building cycle including design, construction, operation, and demolition (Boecker, et al. 2009). Multiple studies have demonstrated how green buildings that incorporate green building practices offer benefits. For example, they can help mitigate building issues and problems, including environmental problems associated with existing buildings, and also provide healthier indoor environments to building users. Major benefits that can be provided by a green building are shown in Table 2 below (Fisk 2000; Kats 2003a; Kats 2003b; Ding 2004; Bohdanowicz 2006; Kibert 2008; USGBC 2009; Boecker, et al. 2009; Ahn 2010; Ahn, et al. 2011):

To achieve these benefits, green building practices continue to evolve, with considerable advances in the field during the first decade of the 21st century (McLennan 2004). One of the main indicators of the success of this movement is the increasing acceptance of green building rating systems, mainly the LEED (Leadership in Energy and Environmental Design) green building rating system developed by the U.S. Green Building Council (USGBC) in many business sectors, including the tourism and hotel industry.

The LEED Green Building Rating System

The LEED green building rating system has been developed and maintained by the USGBC for over a decade, with the first version of LEED, 1.0, being released in 1998 (USGBC 2009). Since the introduction of the LEED rating system to the market, the rating system has been extensively modified several times and the current version, 3.0, was published in 2009. There are now a number of different LEED rating systems, including LEED for New Construction, LEED for Existing Buildings: Operations & Maintenance, LEED for Schools, and so on, that provide green building practices for different types of building uses and different phases of a building's life cycle (USGBC 2009). LEED rating systems serve as a third-party certification program and provide nationally accepted benchmarks for the design, construction and operation of high-performance green buildings. The LEED rating system also promotes a whole-building approach to green building by recognizing performance in five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality (USGBC 2009).

Balancing the Twin Goals of Sustainability and a Luxurious Hotel Environment

Given the potential for conflicts between luxury and green building practices, it is important to understand how green building practices can be successfully implemented at each stage of hotel design, construction, operation, and demolition. According to Heung et al. (2006),

TABLE 2. Major green building practices and their potential benefits.

Categories	Major Practices	Specific Benefits
Sustainable Site	• Sustainable site planning and landscaping • Solar orientation of building • Public transportation • Stormwater management	• Reduce environmental impacts • Efficiency of site use • Heat island effect • Reduction of civil infrastructures
Energy Efficiency	• Solar orientation • High efficiency envelopes (efficient windows and high R-value insulation) • High efficiency HVAC system • Building automation systems • Daylighting and high efficiency lighting • Onsite renewable energy sources (photovoltaics)	• Energy saving • Reduction in greenhouse gases • Lower operating costs
Water Efficiency	• Water saving fixtures and technologies • Rainwater harvesting system	• Water saving • Lower operating costs
Materials & Resources	• Green supplies and materials • Construction waste management • Recycled content materials • Regional materials, locally sourced • Rapidly renewable materials	• Resource saving • Reduce environmental impacts
Indoor Environment Quality	• Daylighting & high efficiency lighting • Adequate air filtration • Low VOC materials • Mold prevention • Enhanced acoustical performance	• Productive and healthy indoor spaces • Provide optimal indoor • environment to building users • Improved occupant health and wellbeing
Building Operation & Maintenance	• Green cleaning supplies • Indoor pest prevention and control • Waste reduction and recycling • Energy and water conservation • Green grounds keeping • Electronic versus paper communication • Guest education/communication program	• Reduced environmental impacts • Reduced operational and maintenance costs
Demolition	• Exposed ceiling • Nylon 6 recycled carpet	• Reduce construction waste

green hotels can be defined as those that "adopt policies that are safe, healthy and environmentally friendly, implement green management practices, advocate green consumption, protect the ecology and use resources properly". In addition, the most widely accepted definition of sustainability by Brundtland (1989) is "meeting the needs and aspirations of the present without compromising the ability of future generations to meet their own needs", although Sheehan notes that this definition is insufficient to describe green hospitality because hospitality should not be about sacrifice but rather comfort, building suspense, setting desirable expectations and satisfying current needs. Sheehan goes on to construct a definition specifically for sustainability in the hotel industry as follows: "Sustainability is about fulfilling our guests' current dreams and desires without sacrificing future generations' dreams and desires. The objective is to achieve sustainability without making it about sacrifice" (Sheehan 2007).

To simultaneously achieve sustainability and satisfy guests, researchers and practitioners have identified a number of green building practices that can be implemented in hotels. One approach is to adopt the LEED green building rating system developed by the USGBC since it provides third-party verification that a building is designed and built using green building strategies aimed at improving buildings' performance including energy savings, water efficiency, lower CO_2 emissions, improved indoor environmental quality, stewardship of resources and sensitivity to their environment impacts (Becker 2009; Coleman 2009; Hasek 2007; Sheehan 2007). However, Sheehan pointed out that a hotel must implement a greater number of green building practices, particularly interior strategies, compared to other commercial enterprises because even a relatively basic hotel must provide a comfortable environment for its guests. This is particularly important for a luxury hotel, which is also required to devote additional resources to meet a Mobile star rating standard. For example, the need to increase the number of plumbing fixtures in the guestrooms and include extra furniture such as chairs and tables to meet a star rating is inherently inefficient (Becker 2009). Additional strategies that can be applied in green hotels are listed in Table 3 below.

These green building practices can be implemented without affecting the quality of the guest experience. Kasim (2004) argued that if a proper synergy between a great guest experience and a hotel's sustainability goals could be reached, it would open new opportunities for business endeavors. However, several studies have suggested that a green hotel must strike a delicate balance between providing a superior guest experience and green building practices (Kasim 2004; Becker 2009). Green building decisions in the hotel must also improve guest satisfaction (Heung, et al. 2006) and it is vital for a hotel to maintain guest satisfaction while at the same time supporting the growth of sustainability in the hotel (Becker 2009; Sheehan 2007). Researchers have also identified a first cost premium for some green hotels compared to conventional hotels due to implementing green building practices (Sheehan 2007; Becker 2009).

It is therefore necessary to develop a better understanding of how to accomplish the goals of sustainability in a hotel while maintaining a luxury environments for guests' satisfaction, as well as the first cost premium incurred by implementing green building practices. To answer these research questions, this study adopted a case study research approach because this offers a useful way to explore the complex issues involved in achieving the objective of a green hotel and shed new light on the cause-effect relationship of implementing green building practices.

TABLE 3. Additional strategies in hotels.

Areas	Strategies
Interior	• Lighting, air conditioning and heating: Intelligent control systems that monitor the presence of guests in the room, together with their preferences and patterns (Heung, et al. 2006; Sheehan 2007) • Fewer furniture pieces (Sheehan 2007) • Carpet tiles (so only a few tiles need be replaced instead of the entire carpet in the event of damage); Green Label Plus carpets (Sheehan 2007) • Materials selected for durability (Sheehan, 2007)
Operation	• Fresh air and clean drinking water (Heung, et al. 2006) • Green products and services (Manaktola & Jauhari 2007) • Operational coordination with guests, i.e., reusing towels and bedding for a multi-night stay (Sheehan 2007) • Clear standards for operations and housekeeping (Kasim 2004) • Recycling programs (Millar & Baloglu 2008)

RESEARCH METHOD: CASE STUDY METHOD

The purpose of this study is to identify, analyze, and generalize green building practices that can balance the twin goals of sustainability and luxurious environment while at the same time enhancing a hotel's financial strength. To achieve the purpose of the study, the case study research method was chosen because it provides a detailed and in-depth contextual analysis of a limited number of event conditions and their relationships (Soy 1997). To create a valid case study based on methodological guidelines (Yin 2003) the following process was undertaken in this research:

- Determine and define the research questions
- Select the cases and determine data gathering and analysis techniques
- Collect data
- Evaluate and analyze the data.

With the purposes of this study, this section demonstrates how the hotels in the case study were selected and how the data was collected. For this research, a set of criteria were developed based on the study's purposes of identifying affordable strategies that support sustainability while at the same time maintaining the luxury environment guests expect. The following criteria were used to select the case study hotels: LEED platinum certification; luxury classification by the AAA Diamond Rating System & the Mobil Travel Guide star ratings or pricing segments (Luxury hotel: Room price range between $140–$450 a night[1]); and location (United States). Based on the first two criteria, the study team identified three LEED platinum hotels listed as of January 18, 2011: the Proximity Hotel in Greensboro, NC, the Bardessono Hotel in Yountville, CA, and the ITC Royal Gardenia in Bangalore, India. The two US hotels were therefore selected for inclusion in the case study, since both met the luxury classification criteria by a price range (Proximity Hotel: $190–$350; Baredessono Hotel: $399–$699).

Because case study research relies on the collection of large amounts of information from multiple sources, the research team developed a systematic approach to gathering data from the stakeholders in these two cases. First, data was collected from the operators of the two hotels concerning the green building practices implemented during hotel operation. Then, green design and construction data was solicited from the architects, engineers and contractors involved in the design and construction phase. In addition, as part of the analysis and evaluation process, the authors contacted project stakeholders shown in Table 4 to gather additional data and verify collected data from stakeholders.

TABLE 4. Contacted stakeholders in the case studies.

Contacted Party	Proximity Hotel	Bardessono Hotel
Owner/Operator	General manager of the hotel (LEED AP)	General manager of the hotel
Architect	Principal at Center Point	Project architect at WATG
Contractor	Project manager & LEED specialist at Weaver Cooke construction	Project manager at Cello & Maudru Construction Company
Engineer	Mechanical engineer (Energy simulation; mechanical design and construction)	None
LEED Consultant	LEED expert in Quaintance-Waver Restaurant & Hotels (LEED consulting role)	Principal of the LEED consulting firm

[1]Walker 2005, P. 139 (Listing of Hotels by Price Segments)

The data collected was compiled and analyzed in order to identify commonalities and differences across the two case studies, and to identify strategies that appeared to work well in each case. These commonalities were then assembled as a set of possible strategies to be considered for future luxury hotel projects to increase their sustainability.

CASE STUDY: PROXIMITY AND BARDESSONO HOTELS

The Proximity Hotel

The Proximity Hotel, a 147-room hotel that includes a restaurant and 5,000 square feet of conference, meeting, and event facilities, opened in early November 2007 (Figure 1). The hotel was developed by Quaintance-Weaver Restaurant & Hotels (QWRH) and in 2008 received the first LEED Platinum (highest rating) designation ever awarded to a hotel by the USGBC. With an AAA Four Diamond Rating with room price range between $190 and $350, the Proximity Hotel demonstrates that green building and luxury need not be mutually exclusive. To achieve their goals of green building, luxury and long-term economic viability, the project team implemented over seventy green building practices, which are summarized in Table 7.

FIGURE 1. The Proximity hotel in Greensboro, NC.

Project Size: 102,000 sq. ft, with 147 rooms and a restaurant
Project Cost: $26 million
Green Features: First LEED Platinum hotel
Developer: Quaintance-Waver Restaurant & Hotels
Architect: Centerpoint Architecture
Contractor: Weaver Cooke Construction

The Bardessono Hotel

The second case in this study is the Bardessono Hotel, a boutique luxury hotel (price range between $399–$699) located in Yountville, California in the heart of the Napa Valley (Figure 2). The hotel includes 62 luxury rooms, a spa with four treatment rooms, a 75-foot-long rooftop infinity pool, a fine-dining restaurant, and a meeting space. Bardessono was developed by MTM Luxury Lodging (MTM) located in Kirkland, Washington and opened in February 2009. Recognizing the value of sustainability and environmental issues, as well as the importance of providing a luxurious guest experience, the MTM development team was guided by the following mission statement: "A hotel can provide a fully luxurious guest experience and be very green at the same time, and environmental initiatives can be implemented in a manner that is practical, economic and aesthetic". To achieve those goals, Bardessono has implemented green building practices not only during the design and construction phase of the development but also at the operation stage of the hotel. The hotel was awarded the LEED Platinum certification by USGBC in January 2010. The green building strategies implemented by the hotel are also summarized in Table 7.

FIGURE 2. The Bardessono hotel, Yountville, CA.

Project Size: 55,159 sq. ft, with 62 guest rooms and a restaurant
Project Cost: $46 million
Green Features: Second LEED Platinum hotel in the USA
Developer: MTM Luxury Lodging
Architect: WATG
Contractor: Cello & Maudru Construction Company

ANALYSIS AND DISCUSSION

The case study analysis of the two hotels began by adopting a general strategy to analyze the data collected about each case study. Data were categorized in terms of the phase of the project life cycle, namely the pre-design, design, construction, and operation phases of the hotel. Data from the two cases were compared for each phase to highlight the similarities and differences in the approaches adopted by these two very different hotels to achieve harmony between sustainability and luxury. The study also measured performance outcomes for implementing green building practices during design and construction, and ensuring customer satisfaction during facility operations.

Pre-design Phase

Both the Proximity and Bardessono projects were initiated by private developers, both of whom combined a passion for sustainability with the desire to provide high quality services to their guests to create luxury and comfort accommodation. The developers of both hotels emphasized the importance of the pre-design process in balancing luxury and sustainability by including green building practices while at the same time considering the first cost premiums from adopting green building practices.

According to its general manager, the Proximity Hotel was initiated by Dennis Quaintance, CEO of QWRH who wanted his hotel to contribute sustainable environment and society and to create a project concept based on the Proximity Mill in Greensboro that incorporated design elements found in Manhattan-style lofts. To achieve these goals, QWRH selected Centerpoint Architecture (of Raleigh, NC) to build a green boutique hotel in Greensboro, NC that could save energy and water compared to other hotels while providing a luxury environment to hotel guests. To achieve these goals, QWRH and Centerpoint then assembled an integrated project team that included a general contractor, engineer, HVAC consultant, and an in-house LEED expert for the project design and construction. The integrated-project team adopted the LEED rating system as a benchmark for the design, construction, and operation of high performance of green building. Based on the established goals with the support of the LEED rating system, the project team evaluated many different and new green building strategies and technologies to identify adaptability of new green strategies and technologies, initial

cost premiums, and life cycle cost saving opportunities (Figure 3). The integrative design process in Figure 3 has been developed by the study team through interviewing major stakeholders of the project and studying the design process of two hotels. This pre-design process for the Proximity hotel project took over 18 months because the integrated project team adopted a systems approach that emphasized the way the green building strategies and technologies adopted would interact with one another synergistically within the whole.

The Bardessono Hotel, developed by MTM luxury lodging that manages unique and boutique hotels, is a luxury boutique hotel that has incorporated green building strategies. MTM selected WATG, one of the world's leading design companies for the hospitality industry, to design Bardessono hotel. Other stakeholders, including Cello & Maudru Construction Company (general contractor), O'Briend & Co. (LEED consultant), Luminae Souter (lighting designer), Ecotope (mechanical engineer), and Travis Fitzmaurice (electrical engineer), were also involved in the project as part of the integrated project team tasked with building one of the greenest luxury hotels in the world. The first step in the pre-design phase was to define a project mission: "Achieve the twin goals of sustainability and luxurious environment while at the same time enhancing the hotel's financial strength". Based on this mission statement, the integrated project team established green hotel goals, defined the process that should be followed to achieve these goals, and developed a clear understanding of the expected results from green building practices at the pre-design phase. Understanding the two main goals of the project, WATG developed a conceptual design of the hotel while studying adoptable green building strategies and technologies with the support of O'Briend & Co. and other stakeholders (Figure 4). In addition, one of the first processes was to conduct a four-hour green design charrette with members of the project team to identify and evaluate the project's green design

FIGURE 3. Integrated design process in the Proximity hotel.

FIGURE 4. Integrated design process in Bardessono hotel.

features using the LEED for New Construction (LEED NC) rating system and design considerations and a list of factors known to impact guest satisfaction and cost premiums. In addition, the integrated project team, led by O'Briend & Co., also studied potential government incentives related to incorporating green building strategies and technologies.

Based on the processes adopted in developing these two greenest luxury hotels, the pre-design process was arguably one of the most important steps in the development process. This allowed the achievement of sustainability and luxury while minimizing the first cost premiums by adopting green building strategies and technologies. Specifically, the following procedures contributed to the successful completion of the pre-design process for both of the two hotels in the case study:

- Establish clear project goals including sustainability, cost, the level of the quality, and others
- Assemble an integrated project team that has experienced in green building and high performance building (must include a hotel management team)
- Have a facilitator (or consultant) whose primary role is not to produce building design or parts of it, but to be accountable for the process of design
- Establish a collaborative working environment and trust among stakeholders
- Study many possible green building strategies and technologies
- Develop holistic or systemic thinking with the intent of producing something where the whole is grater than the sum of the parts
- Set priorities for achieving sustainability, luxury, and economic goals
- Develop a joint decision making framework to make critical decisions and resolve critical conflicts
- Study potential government incentive opportunities and standards.

As evidenced by these two cases, by adopting an integrated design process, it is possible to successfully create luxury hotels with green features.

Design Phase

One of the most important phases of the building life cycle is design, where the building is transformed from an idea to a set of buildable documents, including drawings and specifications. In order to achieve harmony between sustainability and luxury, the project teams in both cases adopted an integrated design process and a systems approach (Figure 3 & 4) when selecting not only optimal green building design practices, but also design considerations and factors that impact guest satisfaction. There are a number of options for adapting the design elements of a building to make its life cycle greener, so during the design phase of the project both design teams collaborated closely with the management teams of their respective hotels, government officials, contractors, cost consultants, civil engineers, mechanical and electrical engineers, structural engineers, LEED consultants, and building technologists.

The integrated design process used in both cases involved establishing a base hotel design that incorporated the requirements for a luxury hotel; opportunities for green building practices; a performance profile showing energy, water use, and related costs for the hotel; and the projected marketing strategy for the hotel. Ranges of possible solutions were examined, including evaluations of the performance of individual strategies from the perspective of green building, cost including first cost and life cycle cost, and luxury design features for the hotel described in Table 1. Different combinations of higher performing group strategies were tested in order to optimize performance, refining the design and reiterating the analysis throughout the process. Through this integrated design process and a systems approach, the project teams developed sets of optimized green building practices for their respective hotels.

Site Strategies

Both the Proximity and Bardessono hotels adopted similar green building site strategies to reduce carbon emissions associated with transportation, and to protect surrounding habitats, manage stormwater runoff, reduce the heat island effect, and eliminate light pollution. In addition, both project teams also considered how the hotel grounds should be landscaped because this would be an important factor enhancing guest relaxation and enjoyment once the hotels entered their operational phase (Figure 5). Both hotels also have a bicycle rack with bicycles that are available for guests to ride on nearby bicycle trails.

FIGURE 5. Hotel landscape with local native and adaptable plants.

FIGURE 6. The restored stream at the Proximity hotel.

One notable site strategy used on the Proximity Hotel project involved restoration of 700 linear feet of the stream next to the hotel by reducing erosion, planting local, adaptable plant species, and rebuilding the buffers and banks (Figure 6). In addition, a vegetated rooftop has been planted on the adjacent restaurant and convention hall to reduce urban heat island effects and provide green roof space to guests. In the Bardessono Hotel project, development was also held back from the creek a minimum of 35 feet and the areas in between was being planted in native riparian plants with the purpose of crating a health vegetative environment for animals and fish and minimizing any silting of the creek through runoff.

Water-Related Strategies

To enhance water efficiency, both hotels installed high-efficiency fixtures and fittings, including water closets, dual flush toilets, waterless urinals, and low-flow showers that reduce water consumption in the hotel. Since those fixtures are known to be closely related to guest satisfaction and a vital part of luxurious bathroom environments, the design teams considered not only the need to reduce water consumption but also the quality and design of the fixtures in the two hotels (e.g., Figure 7). By implementing these water saving strategies, a reduction of about 34% of potable water was achieved compared to conventional hotels (Table 5). In addition, major strategies adopted for landscaping the hotels' surroundings were to plant native and adapted plants; to install drip irrigation systems; and to avoid using turfgrass anywhere on either site.

Proximity used a non-potable water source for plant irrigation and also installed refrigerators in the hotel kitchen that used geothermal energy instead of water cooled systems, providing significant water saving. As a result of those water saving strategies, Proximity is able to save 3 million gallons of potable water per year, and Bardessono is able to save 1.1 million gallons per year. The major strategies related to water efficiency in both hotels were to identify water saving fixtures on the market; to plant native and adaptable trees and plants; and to install a drip irrigation system or water saving irrigation system if permanent irrigation of landscape is required.

Energy-Related Strategies

Energy is a very important issue when seeking to achieve the dual goals of sustainability and luxury because it affects not only the initial and operating costs of the hotel but also has a major impact on the indoor environment and greenhouse gas emissions, with a consequent

FIGURE 7. Water fixtures in the bathroom at the Proximity hotel.

TABLE 5. Water Saving Opportunities in the Both Hotels.

	Proximity Hotel	Bardessono Hotel
Baseline case (gal)	1,204,915 gallons/year	603,618 gallons/year
Design case (gal)	801,537 gallons/year	398,400 gallons/year
Total water savings	33.5%	34%

strong impact on guests' comfort and satisfaction. Both hotels adopted an integrated design process and a systems approach to optimize the objectives of energy savings, a high quality indoor environment, aesthetics, and cost-effectiveness. In addition, energy-modeling tools (in the case of the Proximity Hotel TRACE and the Bardessono Hotel eQUEST) were used to determine the impact of the HVAC system selected on operation costs, identify any potential indoor air quality issues related to acoustics, and quantify first cost and life cycle costs. Both hotels also purchased Green-e accredited Tradable Renewable Certificates (Proximity-35% and Bardessono-70%), which are designed to encourage the development and use of renewable energy technologies in the United States.

Significant features for energy saving at the Proximity Hotel included the installation of a geothermal refrigeration system, variable speed hoods, sensor technologies, regenerative elevators, insulated precast envelope, and maximum use of daylight. In addition, the Proximity installed 100 solar hot water heating panels covering 4,000 square feet of rooftop to provide 60% of the hotel's hot water (1,413MBtu; 8.49% of the building's energy costs).

Through integrating these energy saving strategies, the Proximity Hotel was expected to lower its energy consumption by 42.5% (7,938MBtu/year) compared to conventional hotels. All project stakeholders aggressively looked for energy saving strategies including passive design strategies, active systems, and new systems technologies such as regenerative elevators (the first regenerative elevators installed in the USA). Installing the first regenerative drive model of the Otis' Gen2 elevator at Proximity is expected to save 587 MBtu/year compared to a conventional elevator. The team also studied the initial cost premium of those energy saving strategies, potential energy saving opportunities, and also operation cost saving opportunities with the support of energy simulation and life cycle cost analysis.

The Bardessono Hotel also incorporated a number of energy saving strategies, including improving insulation, using overhangs, employing low-e glass windows, lowering interior lighting power density, and incorporating geothermal heat pumps, natural ventilation, LED and fluorescent lamps, high efficiency HVAC systems, and 940 PV panels (889MBtu/year) to lower its energy consumption by 31.5% (2980MBtu/year) (Table 6). All hotel guest rooms include sensors that can detect whether guests are in their room, then automatically control thermostats to allow the temperature to rise or lower a few degrees and thus reduce excess energy demand. In addition, all rooms are designed with overhangs to reduce the heat gain from the summer sun, yet allow the winter sun to enter and warm the rooms. When cooling is required, the automatic motor system can lower exterior venetian blinds to reduce the heat gain from the sun, then later raise the shades as needed by guests. The Bardessono also installed a ground source heat pump system with seventy-two 3,000 foot wells on the property that can provide 70 degree water to the air-handling units. Installing high efficiency HVAC systems (3.2 COP and 13.4 SEER) and domestic water heating systems (COP 2.89 with equivalent jacket losses) in the spa and hotel facilities reduces Bardessono's annual gas consumption by approximately 11.2% compared to the ASHRAE standard. Finally, pv panels laid flat on the rooftops, invisible to surrounding properties, are able to generate about 260,540 kWh/year to reduce the demand for electricity from the grid. Although the ground source heat pump system and the PV panel installation required a major initial investment, the project team studied payback period and life cycle cost opportunities before making a final decision to include them.

Materials-Related Strategies

The project teams for both hotels examined and chose a range of green strategies related to materials and resources, including materials reuse, use of recycled content, regional materials, and green furniture or products. Each of these strategies can reduce considerable waste in construction by using green building materials that have minimal environmental, social, and health impacts during extraction, processing, transportation, use, and disposal (Pearce, et al. 2012).

In the Proximity project, the Bistro bar is made of salvaged, solid walnut trees that died of natural causes through sickness or storm, and room service trays made of Plyboo (bamboo plywood). In addition, the project team also chose building materials with recycled content that includes reinforcing steel with 90% post consumer recycled content, gypsum wall board with 100% recycled content, asphalt with 25% recycled content, and staircase steel with 50% recycled content. The Proxmity also used building materials, art work (500 pieces of art), and furniture from regional vendors, artists, and furniture makers to reduce transportation and packing and to promote local economic growth (Figure 8).

TABLE 6. Energy saving strategies in the both hotels

	Proximity Hotel		Bardessono Hotel	
	Proposed Design	Baseline Design	Proposed Design	Baseline Design
Exterior wall	8" Precast concrete panels with internal insulation (U=0.5)	Mass U = .151	Wood frame, R-21, ½" GWB, U=0.057	Wood frame, R-13, U=0.089
Roof construction	Concrete deck, U = 0.05	Metal deck, U = 0.063	R-30, U=0.034	R-30, U=0.034
Floor/slab	4"LW concrete with 2" insul.	4"LW concrete with 2" insul.	Slab above grade, F=0.70	Slab above grade, F=0.730
Exterior wall	8" Precast concrete panel with internal insulation (U=0.5)	Mass U = .151	Wood frame, R-21, ½" GWB*, U=0.057	Wood frame, R-13, U=0.089
Roof construction	Concrete deck, U = 0.05	Metal deck, U = 0.063	R-30, U=0.034	R-30, U=0.034
Fenestration type	Low-e Guardian glass	Double clear	Low-e Guardian glass	Double clear
Fenestration U-factor	U = 0.27	U = 0.57	U = 0.29	U = 1.22
Fenestration visual light transmittance	0.67	0.76	0.70	0.81
Shading devices	N/A	N/A	Solar shading systems	N/A
Interior Lighting Power Density (W/sf)	Restaurant =1.163, Meeting rooms = 1.163, Hotel =.548	Restaurant = 1.60, Meeting rooms = 1.0, Hotel = 1.0	Main building =0.92, Spa = 1.17, Guest rooms =1.32	Main building =1.16, Spa = 1.32, Guest rooms =1.1
Daylighting	N/A	N/A	Overhang	N/A
Exterior lighting power (kW)	12.50 kW	30.732 kW	13.35 kW	13.35 kW
Primary HVAC System	Water Cooled Chiller, Fan Coil Units, Boiler, Rooftop air handlers, energy recovery units, DOAU for the guestrooms	PTAC units with hot water heat for all residence rooms. Split system dx cooling with gas furnace for remainder of the hotel. Rooftop units with electric cooling, and gas heat for the restaurant and meeting rooms	Main Building: PSZ-AC & PSZ-HP Spa: WS-HP Guest Rooms: WS-HP (Ground heat source pump system)	Main Building: PSZ-AC & PSZ-HP Spa: WS-HP Guest Rooms: WS-HP
Natural ventilation	Natural ventilation	N/A	Natural ventilation	N/A
Economizer control	N/A	N/A	75 deg F High-limit shutoff	75 deg F High-limit shutoff
Solar panels	14,138 (therms)	N/A	197.4 kW	N/A
Energy use (electricity)	7,778 (37% savings)	12,348 MBtu	3,389 MBtu (34.5% savings)	5,171 MBtu
High efficient elevator	587MBtu	N/A	N/A	N/A
Natural gas	4,961 MBtu (21.6% savings)	6329 MBtu	3,993 MBtu (7.2% savings)	4,301 MBtu

*Gypsum wall board

FIGURE 8. 500 pieces of local art from artist-in-residence at Proximity Hotel.

In the Bardessono, the design team chose to use the following products obtained locally or on-site:

- Monterey Cypress on the exterior of several buildings
- Walnut wood for the hotel's flooring, entry doors, and several public rooms
- Redwood recycled from wine casks for the ceilings of some of the public spaces and several public room doors
- California Bay trees for slabs for the desks in the guest rooms.

The design team also chose to use recycled Tufa limestone for the Bardessono exterior walls and interior public spaces. Landscape features and permanent signage structures were made from rammed earth, celebrating the soils of Napa Valley (Figure 9).

Indoor Environmental Quality

Indoor environmental quality was another major consideration at the design phase in both case studies because design decisions directly affect the quality of the indoor environment and hence guests' comfort and satisfaction. Both project teams used low volatile organic compound (VOC) emitting materials to reduce the quantity of indoor air contaminants in the building and additional outdoor air ventilation to improve indoor air quality (IAQ) and promote comfort. Intelligent controls were used for lighting and thermal systems, and daylighting strategies were implemented to provide an optimal indoor environment for guests. For example, over 95% of all regularly occupied spaces in both the Bardessono and Proxmity, including offices and meeting and conference rooms, have access to natural daylighting and views of the outdoors. In addition, automatically controlled exterior Venetian blinds at Bardessono were installed to admit sunlight and heat early in the morning but keep them out later in the day. In Proximity, indoor air quality has been improved by circulating large amounts of outside air into guestrooms (60 cubic feet per minute) and doing so in an energy efficient way by employing energy recovery technology where the outside air is tempered by the air being exhausted.

Innovative Social Sustainability Strategies

Finally, both project teams implemented novel strategies to achieve the dual goals of sustainability and a luxurious hotel environment with respect to society and culture. For example,

FIGURE 9. Harvested stone as a building material and signage made from rammed earth.

the Proximity Hotel worked with regional artists to create original art for each guest room and the lobby, and both hotels were designed to reflect the local climate and culture. Local people were also involved in joint efforts to promote the community and the hotel.

Construction Phase

During the construction phase of the hotels, both project teams incorporated a number of green building strategies and practices. Attempts were made to minimize site disturbance and pollution and to implement erosion and sedimentation control plans, construction waste management plans, and indoor air quality management to eliminate potential contaminants in the hotel. Careful materials selection and sourcing, measurement and verification, and commissioning were also employed on both projects.

In the Bardessono Hotel, the stone featured on both the exterior and interior of the building was recycled from the stone blocks of an old wine cellar on the property (Figure 9). In the Proximity Hotel, architectural precast concrete wall panels were installed as a cladding system to not only boost the thermal performance of the building but also to reduce solid waste at the construction stage. The Proximity's insulated wall panels were made from recycled and recyclable materials only 90 miles (145 km) from the construction site. In addition, the contractor and the precast concrete supplier implemented just-in-time delivery to reduce the need for on-site storage and to improve productivity (Figure 10).

The contractors on both projects developed construction waste management plans to divert construction debris from disposal in landfills and incineration facilities. Due to the active implementation of construction waste management plans, both the Proximity and Bardessono hotels recycled or diverted 1,535 tons (86.9%) and 1,053 tons (92%), respectively, of on-site generated construction waste from landfill disposal. In both projects, the project teams also used a variety of strategies to manage indoor air quality during the construction phase of the project, including developing and implementing a construction Indoor Air Quality (IAQ) management plan that followed the LEED-referenced Sheet Metal and Air Conditioning National Contractor Association (SMACNA) Guidelines. To implement their

FIGURE 10. Precast concrete wall panel system in the Proximity Hotel.

IAQ management plans, the contractors protected all HVAC equipment, both temporary and permanent, from dust and odors during construction. In addition, proper ventilation during construction was also maintained on both projects to ensure worker health and safety and to exhaust pollutant from the workspace. Finally, building commissioning was implemented on both projects to ensure proper function after construction was complete, including HVAC systems, kitchen equipment, solar hot water heating, PV systems, geothermal systems, and others. To meet this requirement, both project teams worked with consultants to conduct an enhanced commissioning process and thus ensure that the building systems installed would perform according to the design intent and owners' requirements.

Operation Phase

After construction was complete, both hotels activated a range of operational strategies for sustainability. In both buildings, energy and water consumption are monitored to measure and verify energy and water performance of the building. This data is used to measure information on the success of sustainability strategies employed in each project.

In Proximity, the Measurement and Verification (M&V) plan was developed to meet two objectives. The first objective was to collect actual energy-use data and use this data to calibrate the Trane TRACE model (energy simulation model) to ensure proper operation and allow stabilization of the building's performance. The second objective of the M&V plan was to monitor energy use after calibration of the simulation model has been confirmed, in order to verify that the building systems are continuing to operate at maximum efficiency. At the first energy and system analysis (June 2008), a year after completion, the following discrepancies between the predicted energy use and the actual energy use by the following sub-systems were identified:

- The measured energy consumption of the chiller and pump appears to be significantly higher than predicted by the Trane program. In response, additional measurements are planned to confirm measurement accuracy, and Superior, an engineering firm retained by the hotel, will review and adjust the equipment set points and the Trane Trace model as appropriate.

- Data collected which compares chiller output (BTUs per hour) versus electrical energy consumption (kWh) indicates that the supply air temperature from the chilled water coil is colder than specified in the design. In response, the control system will be adjusted to increase the supply air temperature.
- The solar collectors appear to be operating at a significantly lower efficiency than predicted by the supplier. In response, additional performance data will be collected and analyzed to further investigate the situation.

After completing the above calibration process, Superior, the energy modeling company employed by Proximity, will simulate new monthly energy use projections using the Trane TRACE simulation program. These monthly projections can be used as a basis for comparing building and sub-system energy use. To monitor energy use, the project team is collecting the following data:

- Main Building Meter Data—Hotel electrical, Bistro (restaurant) electrical, hotel/Bistro natural gas, hotel water, and Bistro water
- Equipment Sub-metered Energy Data—Main cooling equipment, hydronic heating boilers and pumps, and domestic hot water boilers
- HVAC Equipment Monitoring—Chiller leaving water temperature, hydronic boiler leaving water temperature, domestic hot water supply water temperature, and energy recovery unit coil leaving air temperature
- Building Indoor Environmental Data (Three common area locations)—Space temperature, relative humidity, and carbon dioxide
- Activity Data—Occupancy, laundry loads, restaurant meals, and meeting rooms occupied
- Weather data—Temperature, humidity, and solar isolation.

By monitoring and analyzing this data, it is possible to verify the performance of building systems in terms of both efficiency and their ability to provide high quality indoor environment to hotel guests and restaurant users.

In Bardessono, the project team, led by facility management firm Ecotope, Inc. and a mechanical engineer, also developed an M&V plan that has similar objectives to Proximity. This plan has been implemented to evaluate actual vs. predicted savings and to diagnose potential problems in any areas of operation which are using higher than predicted energy or water.

In addition to the M&V plan, both hotels have also developed green building operating plans, sustainable maintenance plans, and continuous commissioning plans and are implementing them rigorously. Both hotels have developed and implemented sustainable purchasing, an integrated pest management and a green housekeeping program. These strategies limit the ongoing impact each hotel has on the environment. Both hotels have implemented a recycling program to recycle cans, bottles, and paper to reduce the generation of waste in the hotel and recycle materials for new products. Sourcing of green cleaning projects that are Green Seal Certified and reductions in the amount of fertilizers, fungicides, and pesticides used at both hotels minimize the exposure of guests, staff, and the local habitat to harsh chemicals. In addition, both restaurants purchase and use local food including fruits, meats, and vegetables, products, and services from local farmers, makers, and vendors wherever possible to support local communities and businesses. For food waste and its disposal, the Bardessono Hotel organically manages planted areas where food is grown on site, and the vegetable waste from the hotel kitchen is composted in an "Earth Tub" and reused in the planted areas as fertilizer.

Both sets of management teams have also educated their staff in order to improve performance in dealing with and understanding sustainability, promoting the role of each hotel as an education hub for green building design and construction. For example, the Proximity has created displays to describe all green building strategies and technologies implemented in the building (Figure 11) to educate guests and visitors, along with a real-time display that shows energy consumption of the building.

Finally, both hotels regularly schedule environmental and sustainable events to educate and advocate sustainable and environmental practices that change the attitudes of communities and individuals toward sustainability. For example, the Proximity Hotel hosts an annual "E-Recycle Drive" event to provide residents of Greensboro and Guilford County with a safe, free, and environmentally-sound recycling option for electronic waste materials. Finally, the two hotels serve as hubs for sustainability education, teaching green building practices through events such as the "Organic Culinary Tour" at Bardessono Hotel.

End-of-Life Cycle

Achieving the goals of sustainability also requires considering the end of a facility's useful service life. In the Proxmity project, a few strategies have been employed to reduce eventual demolition debris in landfills by using open and exposed ceilings in the hallways and conference rooms and exposed concrete for walls (Figure 12). No such strategies were explicitly noted by interviewees in the Bardessono project during design and construction phase of the hotel development.

FINDINGS ACROSS CASE STUDIES

In striving to achieve sustainability in the hotel industry while providing a luxurious environment for guests, the two hotels in this case study implemented a number of green building practices over the their building's life cycle. Table 7 shows a side-by-side comparison of the strategies used in each project to improve project sustainability while maintaining performance in other areas essential for a luxury hotel. This table provides a basis for the findings of the case study analysis discussed next.

FIGURE 11. Green building strategies and technologies in the Proximity hotel.
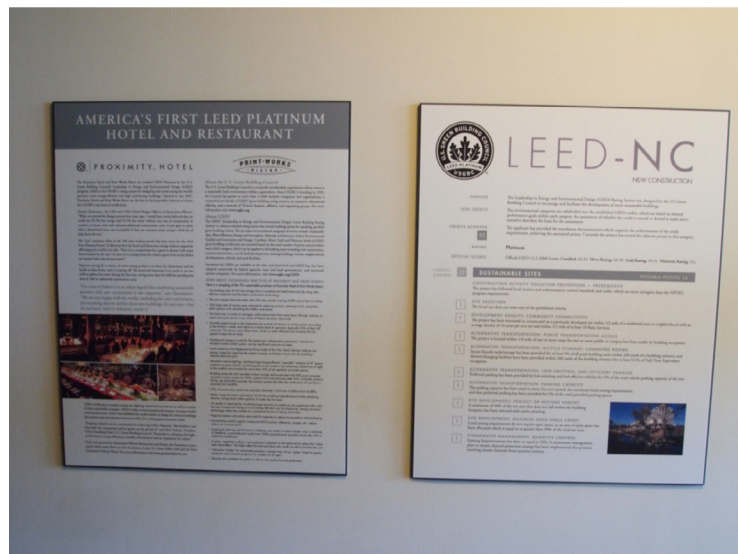
FIGURE 12. Green strategies for the demolition stage at Proximity hotel.

Common Pre-Design Strategies

In both projects at the pre-design stage, it was important to organize an integrated project team with clear project goals, including a focus on sustainability as well as other key factors such as cost and guest experience. In addition, each project team member in these projects had prior knowledge of green building strategies and technologies and understood the integrated project design process within collaborative team environment and decision making process. Based on the established goals, the integrated project teams on both projects held a collaborative meeting, or design charrette, to tackle issues related to green building practices along with other project goals; to set priorities for achieving sustainability, luxury and economic goals; and to identify potential government incentive opportunities and standards related to green building practices. Both projects also used sustainability criteria as part of site selection.

Common Design Strategies

In the design phase, selection of regional materials and the decision to reuse materials harvested from the site must be carefully assessed by the project team in order to provide an appealing and tactile environment for guests. In addition, the design team should attempt to choose building materials that include high percentage of recycled content and are sourced from the region to reduce environmental impacts of deliveries and to help the local economy.

In both projects, a similar integrated design process (Figure 3 and Figure 4) and a systems approach for identifying and evaluating green building strategies and technologies were implemented to select optimal strategies from among the range of green building options available to make each project's overall life cycle more sustainable. Furthermore, it was very important to identify new green building strategies and technologies, such as the regenerative drive elevator in the Proximity Hotel, which can reduce the total cost of ownership over the whole building life despite a first cost premium. The project teams for both hotels also embraced the use of energy modeling to determine the optimal configuration and size of the whole building systems to minimize energy consumption while enhancing the indoor environment. In addition, it was helpful to consider the payback period or life cycle cost for the building, including cost of acquisition, operation, maintenance, and eventual decommissioning.

TABLE 7. Common Sustainability Practices across Case Studies.

Sustainability Strategies	Proximity Hotel	Bardessono Hotel	Target Outcomes
Pre-Design Strategies			
Site selection using sustainability criteria; dense development and community connectivity	X	X	Avoid the development of inappropriate sites; Protect greenfields and preserve habitat and natural resources
Multidisciplinary design team with prior experience	X	X	Find implementable, optimal design solutions at reduced cost
Integrated Design Process and sustainability objectives	X	X	Find implementable, optimal design solutions at reduced cost
Sustainability charrette process	X	X	Find implementable, optimal design solutions at reduced cost
Design Strategies			
Alternative transportation – design for:	X	X	Reduce pollution and land development impacts from automobile use
• Proximity to public transportation (Bus routes)	X	X	
• Bicycle storage and changing rooms	X	X	
• Low-emitting and fuel-efficient vehicles	X	X	
• Limited parking capacity	X	X	
Maximize open space retained on site	X	X	Promote biodiversity; allow for contact with natural systems
Preserve or restore a minimum of 50% of the site to pre-development conditions	X		Conserve existing natural areas and restore damaged areas
Reduce impervious cover, increase on-site infiltration, and implement a stormwater management plan	X	X	Reduce stormwater runoff and eliminate contaminants
Install vegetated roof	X		Reduce the urban heat island effect and manage stormwater runoff
Use reflective roof materials	X	X	Reduce the urban heat island effect; reduce cooling energy needs
Minimize the amount of exterior uplighting	X	X	Limit light pollution and associated negative biological impacts
Use a water efficient landscaping and irrigation system (Drip irrigation system)	X	X	Reduce potable water consumption for landscaping by 64% (526,876 gallons)

Strategy			Goal / Results
Use low flow fixtures:	X	X	Reduce potable water consumption
• Low flow toilets			• Proximity Hotel: 33.5%, total potable water savings of 403,387 gallons/year)
• Low flow faucets and showerheads	X		• Bardessono Hotel: 34%, total potable water savings of 205,218 gallons/year)
On-Site renewable energy		X	Increase levels of on-site renewable energy self-supply to reduce environmental and economic impacts associated with fossil fuel energy use
• Photovoltaic (PV) system			• Proximity Hotel: 100 solar hot water panels, 1,413 MBtu, 60% of the hotel hot water, 8.49% of the building's energy costs
• Solar hot water system	X		• Bardessono Hotel: 940 PV panels, 889MBtu, 26.37% of the energy cost
Optimize energy performance by using:			Reduce energy consumption to minimize negative environmental and economic impacts associated with excessive energy use; Provide optimal indoor environment for guests' comfort and satisfaction
• Daylighting and low-e glass	X	X	
• Reflective materials on the roofs	X	X	• Proximity Hotel: Total energy savings of 42.5% (Energy cost saving of 39.2%), 7,938 MBtu/year
• Sensor technologies	X	X	• Bardessono Hotel: Total energy savings of 31.5% (Energy cost saving of 45.9%), 2,980 MBtu/year
• Geothermal heat pumps	X		
• Geothermal refrigeration system	X	X	
• LED and fluorescent lamps	X		
• Insulated precast concrete building envelope	X		
• Variable speed hoods	X		
• Regenerative elevator	X		
Materials reuse		X	Bardessono Hotel: The hotel has used salvaged, refurbished, or reused materials equal to 10.02% of the total material value (Monterey Cypress, Tufa (limestone), Walnut trees, California Bay trees, etc.)
Use of recycled content materials	X	X	Reduce the use of virgin materials and production energy:
			• Proximity hotel: 22.4% recycled content by value
			• Bardessono Hotel: 11.54% recycled content by value
Use of regional materials	X	X	Reduce negative transportation impacts and enhance local economies:
			• Proximity Hotel: 45.9% of the total building materials value
			• Bardessono Hotel: 30% of the total building materials value
Use of low-emitting materials	X	X	Promote occupant and installer health and reduce exposure to harmful chemicals

Sustainability Strategies	Proximity Hotel	Bardessono Hotel	Target Outcomes
Include outdoor air delivery monitoring system	X		Promote occupant comfort and wellbeing by controlling pollutants
Allow for occupant controllability (Lighting)	X	X	Promote occupant satisfaction, comfort, and well-being
Design for thermal comfort	X	X	Promote occupant satisfaction, comfort, and well-being
Design to preserve views	X	X	Promote occupant satisfaction, comfort, and well-being through providing direct access to views of the outdoors from critical visual task areas: • Proximity Hotel: 97.15% of critical visual task areas • Bardessono Hotel: 97% of critical visual task areas
Construction Strategies			
Commissioning	X	X	Energy-related systems installed and calibrated to perform according to the owner's project requirements, basis of design, and construction documents
Construction waste management	X	X	Divert construction and demolition debris from disposal in landfills and incineration facilities to recover usable material and preserve landfill capacity • Proximity Hotel: 87% of construction waste (1,535 tons of debris) • Bardessono Hotel: 92% of construction waste (1,053 tons)
Construction IAQ management	X	X	Improve indoor air quality and promote occupant and installer well-being
Operational Strategies			
Green power – Purchase Green-e accredited Tradable Renewable Certificates (RECs) equivalent to some portion of energy used	X	X	Reduce negative impacts of electricity generation from fossil fuels • Proximity Hotel: 35% of the electricity used • Bardessono Hotel: 70% of the electricity used
Provide increased ventilation	X	X	Promote occupant comfort and wellbeing through increased fresh air intake

Strategy			Benefit
Undertake measurement & verification of system performance	X	X	Provide ongoing measurement and verification of system performance to identify and resolve problems that could result in poor energy performance
Monitor energy consumption through continuous commissioning	X	X	Reduce energy consumption and carbon emissions and collect data that is useful in managing the hotel
Employ a green cleaning policy	X	X	Minimize exposure of guests and employees to potentially hazardous chemicals
Sustainable purchasing policy - cleaning materials/products	X	X	Minimize exposure of guests and employees to potentially hazardous chemicals
Support local farmers, food makers, and vendors	X	X	Support the prosperity of local community by purchasing locally
Use organic linens and terry cloth		X	Support organic cotton farms and improve guests' satisfaction and comfort
Use electric and bio-diesel vehicles		X	Reduce fossil fuel use and carbon emissions
Sustainable management system – Educate staff on ways to improve performance in dealing with and understanding sustainability	X	X	Change employees' behavior and attitude toward sustainability
Sustainable education for community	X	X	Educate guests and staff about sustainability and encourage them to change their behavior and attitude toward sustainability
Compost food waste (Earth Tub)		X	Minimize waste stream of kitchen and garden vegetables and plant waste
Use local artwork	X		Help local artists and economy
End-of-Life Cycle Strategies			
Maintain exposed ceilings	X		Minimize construction waste at the demolition phase of the facility
Maintain exposed concrete	X		Minimize interior finish materials and construction waste at demolition phase

Common Construction Phase Strategies

During the construction phase of both case study projects, the project teams sought to minimize site disturbance and pollution, and implement erosion and sedimentation control plans, construction waste management plans, and indoor air quality management measures to eliminate potential contaminants into HVAC equipment and ensure worker health and safety. In addition, it was important in both cases to identify and patronize suppliers of local and regional materials and furniture that could replace more conventional exotic or luxury materials such as marble and luxury furniture.

Common Operational Strategies

Throughout the operation phase, the hotels planned to implement a number of green building strategies, including measurement and verification of energy and water consumption, green building operating plans, green building maintenance plans, and continuous commissioning plans. Especially important is measurement and verification to calibrate all systems including HVAC, electrical, and mechanical systems to ensure proper operation and allow stabilization of the building's operations. Measurement and verification also allows the operations staff to verify that systems are continuing to operate at maximum efficiency.

With regard to dining services, both hotels provide top quality food and beverages to their guests and restaurant users using locally grown organic foods and vegetables, and the Bardessono Hotel provides on-site composting of food waste to support its on-site gardens. In addition, both hotels were expected to act as hubs for educating guests, staff and local communities about green building practices that eventually help for the advertisement of hotel.

Based on the experiences in the case study facilities, green luxury hotels should consider implementing the following types of programs to support operational sustainability:

- High-performance green cleaning program to reduce costs and avoid toxic fumes and skin irritants
- Robust recycling and solid waste management program through extensive staff and guest education
- Sustainable purchasing program such as a local organic food purchasing policy
- Comprehensive staff training and guest education on green building practices
- Sustainable operating policies including integrated pest and landscape management
- Green housekeeping program
- Continuous commissioning process for the building.

Common End-of-Life Cycle Strategies

At the end-of-life phase, the Proximity Hotel exposed ceilings in hallways and conference rooms and exposed concrete walls with polished and colored fixtures were used to achieve this end. While no similar measures were noted by the Bardessono project team, such measures could also be considered for other luxury hotel projects in the future.

Project Outcomes

By implementing green building practices throughout the buildings' life cycles, the Proximity and Bardessono Hotels are recognized as being among the most green and luxury hotels in the world. This recognition has helped these hotels to achieve an average occupancy rate that is among the highest in the luxury hotel market. Ninety eight percent of Proximity guests

described their Proximity hotel experience and satisfaction with the hotel as meeting or exceeding their expectations, with well over two-thirds of respondents signifying these exceeded their expectations (Becker 2009). The Bardessono hotel has already been recognized as one of the top five relaxation-hotels in the world, the only hotel so honored in the United States, by the Travelers' Choice website in 2011 (Tripadvisor 2011). In addition, Forbes magazine wrote the article of 'The Nation's Greenest Luxury Resort and Spa Is Profitable' to demonstrate the most environmentally friendly resort & spa on the planet (Forbes 2011). Relative to their first cost premiums, namely the premiums paid by both hotels to incorporate green practices (for the Proximity Hotel this was $2 million and the Bardessono Hotel paid $3 million), these are expected to pay for themselves in a few years due to tax incentives and the energy and water savings achieved. In addition to these financial benefits, the two hotels in this case study not only promote their local economies through local food and art purchases, but also provide a unique experience for their guests by incorporating local culture and art through regional materials and craftsmanship. Both hotels also serve as education hubs for green building practices. Furthermore, these hotels attempt to reduce negative environmental impacts over their entire life cycle. Finally, the hotels examined in this case study demonstrate that green building practices can successfully combine sustainability with a luxurious hotel environment, while at the same time enhancing the hotel's financial position.

CONCLUSIONS

Given growth in interest in green building in the U.S. and elsewhere, it is likely that developers will increasingly consider adopting green building practices in the future to improve the environmental, social, and life cycle economic performance of their hotels. This study identified green building practices common across two case study hotels that can serve as a starting point for future hotel projects. Although not intended to be a comprehensive list, this set of practices has a track record of success so far with the two hotels and should be considered by project teams seeking to develop future green luxury hotel projects.

Study Limitations

At the time of this study, the population of green luxury hotels is quite small: only two projects in the United States met the case study selection criteria of achieving a LEED Platinum rating while being a luxury hotel property. This small number of cases means that it is difficult to generalize findings to other luxury hotel projects. Moreover, the properties developed as case studies in this research had only been in operation for 30 months in the Proximity hotel and 12 months in the Bardessono hotel at the time of the study, so information on mid- to long-term performance outcomes is not yet available. In fact, detailed diagnosis of reasons for observed system performance discrepancies in the first year of operation for the Proximity Hotel has not yet been established. As such, the green building strategies and technologies identified in this study should be considered a starting point for future developers and not a comprehensive set of recommendations.

Areas for Future Research

To address the challenges faced in this research, future research involves expanding the study to include additional case studies as new green luxury hotels are developed. Including additional cases will better enable trends across projects to be identified. Additional research is

also needed in mid- and long-term post-occupancy evaluation of properties to evaluate their ongoing performance, including not only resource efficiency and environmental impact performance, but also stakeholder satisfaction and financial performance. Coupled with a larger population of cases, this data will enable a better understanding of what works and what does not for this population of buildings.

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