YOU SAY YOU WANT A GREEN REVOLUTION, BUT ARE COSTS GREATER THAN ITS BENEFITS?

A CASE STUDY OF 2600 CAPITOL AVENUE, SACRAMENTO, CALIFORNIA

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YOU SAY YOU WANT A GREEN REVOLUTION,
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A Thesis

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Abstract

of

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Proponents of sustainable development argue green buildings provide operational cost savings, resource conservation and recycling, and increased indoor air quality. Industry skeptics argue benefits associated with green buildings don't outweigh the additional upfront costs. This thesis is a cost benefit analysis of Loftworks' decision to pursue LEED certification of 2600 Capitol Avenue in Sacramento, CA.

Additional hard and soft costs totaled 3.10 percent above baseline for the as-built LEED-Gold office building. The quantifiable savings came from an efficient HVAC system and savings average $66,900 per year. Upfront costs and long-term benefits associated with LEED certification of 2600 Capitol Avenue produces a net present value (NPV) of $482,900. The additional LEED investment pays for itself in less than three years and the efficient HVAC system has a 25-year functional life if properly maintained.

_____, Committee Chair
Robert W. Wassmer, Ph.D.

_____
Date

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I would like to thank my primary and secondary advisors Rob Wassmer and Peter Detwiler for helping me put thoughts together and relentless encouragement during my thesis semesters. I am forever indebted to my parents for creating an environment tailored for success. They are the reason why I am the person I am today and owe any success I have in my life to them. Thanks to everyone else who has helped shape me. Thank you Rosemary for your surety of me.

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INTRODUCTION AND BACKGROUND

Introduction

You say you want a revolution; Well, you know; We all want to change the world. You tell me that it's evolution; Well, you know; We all want to change the world.…You say you got a real solution; Well, you know; We'd all love to see that plan. You ask me for a contribution, Well, you know; We all do what we can.

~ John Lennon

The Beatles most likely did not have the built environment in mind when they wrote "Revolution." However, one can apply the thoughts of an uncertain future and calls to action for change in Revolution's lyrics to represent the built environment as we look for my generation's greatest public policy challenge, climate change. What if the ways we build could both help to ease the rate that society is emitting greenhouse gas (GHG) emissions into the atmosphere and simultaneously prove to be a sound investment choice? That would be a "real solution," and thus this thesis is an attempt to offer my "contribution" by offering a cost/benefit analysis of a "plan" that "we'd all love to see."

Specifically, this thesis is a case study that examines the financial desirability of pursuing Leadership in Energy and Environmental Design (LEED) certification for an office building located at 2600 Capitol Avenue in Sacramento, California (see Figure 1.1). This office building is a four-story, certified LEED-Gold building developed by Loftworks. The intent of this thesis is to examine in fine detail whether the decision of Loftworks to pursue LEED-certification pencils out as a better investment choice than a non-certified building. This thesis will place values on energy efficiency measures in the context of a development decision and investment choice. Many argue that LEED projects provide many social benefits such as decreased energy use and consumption of

non-renewable resources, resource conservation and recycling, and increased air quality. These all may be true, but the development community needs a study that looks at sustainable development as an investment choice because the investors and project developers will be the ones that decide if these benefits will come to fruition on a mass scale.

After an initial visioning meeting, Mike Heller, President of Heller Pacific and Partner in Loftworks, agreed to make all of his company's confidential cost and performance data available to me for the purposes of my thesis. I will analyze the development costs and paybacks of two separate buildings: the first being a theoretical "baseline" class-A office building at 2600 Capitol Avenue, and the second being the LEED-Gold building as developed by Loftworks. I need to establish a baseline for comparison and will detail this process in Chapter 3. The difference between the buildings is that the baseline building will not have as many efficiency improvements, but will theoretically still be an attractive building when compared to the built LEED-Gold building. This comparison will help the reader understand different development and investment choices when analyzing a potential development site.

Source: Lionakis
Figure 1.1. 2600 Capitol Avenue

LEED has many different rating systems including New Construction, Existing Buildings: Operation and Maintenance, Commercial Interiors, Core and Shell, Schools, Retail, Healthcare, Homes, and Neighborhood Development. I will detail the history of LEED later in this chapter. Using LEED for Core and Shell version 2.0[1], my sensitivity analysis of additional energy efficiency measures to qualify for LEED-Gold will show the additional costs associated with LEED certification, but also how much the energy savings are worth. The end comparison will look at the net present value of the LEED investment for the as-built building and clearly show if the building is a smart investment. What are the additional features worth, and does it make sense to pursue

[1] See Chapter 3 for an explanation of, and reasoning for using, LEED for Core and Shell.

LEED certification? I look for this case study to clear up myths and apprehensions the Sacramento development community has with LEED certified projects in hopes that smartly designed and energy efficient buildings will soon become the industry norm.

The forthcoming sections of Chapter 1 will explain why examining the costs and paybacks of energy efficient buildings deserve a thesis. The next section “Climate Change” will detail what climate change is, climate change’s damaging effects, and finally what we need to do to help reverse the process. “Building Energy Consumption” will explain how buildings and climate change relate. “What is Green Building?” will define green building and show how green buildings relate to climate change. “California Reacts to Building Inefficiency” will detail the history of energy efficiency and climate change legislation and laws in California. Finally, “Industry Perception of Green Buildings” will give the general consensus and sentiments of the development community as related to green buildings as an attractive investment. The sections in Chapter 1 seek to frame the importance of addressing climate change and show the positive impacts energy efficient buildings can have. However, I will need to further examine the attractiveness of green buildings as a profitable asset.

Climate Change

Climate change is a change in the average weather of the earth. Scientists measure change by change in wind patterns, storms, precipitation, and temperature. The baseline by which scientists measure changes originates in historical records identifying temperature changes that have occurred in the past, such as during previous ice ages. Many recent studies on climate change use these data to extrapolate a level of statistical

significance specifically focusing on temperature records from the last 150 years that differ from previous climate changes in rate and magnitude.

The United Nations Intergovernmental Panel on Climate Change (IPCC) constructed several emission trajectories of GHG needed to stabilize global temperatures and climate change impacts. The IPCC predicted that the range of global mean temperature change from 1990 to 2100, given six scenarios, could range from 1.1°C to 6.4°C (IPCC 2007). Regardless of analytical methodology, the IPCC expects global average temperature and sea levels to rise under all simulated scenarios (IPCC 2007).

The United States cannot continue to conduct "business as usual" when dealing with GHGs. The accumulation of GHGs in the atmosphere regulates the earth's temperature. Without the natural heat trapping effect of GHG, the Earth's surface would be about 34 degrees Centigrade (°C) cooler (CARB 2006). Common GHGs include water vapor, carbon dioxide, methane, nitrous oxides, chlorofluorocarbons (CFC), hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, ozone, and aerosols. However, many scientists believe that GHG emissions from human activities, such as electricity production/consumption and vehicle use, continue to elevate concentration of GHGs in the atmosphere beyond the level of natural occurrence. Production of emissions creates a classic societal negative externality. "Growing Cooler" reports that to reach climate stabilization by 2050; the U.S. would need to cut greenhouse gas emissions by 60 to 80 percent below 1990 levels (Ewing *et al.* 2008). Adding to the challenge, Nelson (2006) reports that society will need to construct 89 million new or replaced homes and 190 billion square feet of new offices, institutions, stores, and other non-residential

buildings through 2050 to meet the needs of 420 million Americans. Two-thirds of the structures on the ground in 2050 will be built from 2007 to 2050 (Ewing *et al.* 2008). Even more frightening, the Energy Watch Group projects that the world will reach peak oil production some time between now and 2020. We are right in the middle of one of the most important time-periods in the history of the United States because we are navigating in uncharted waters. We will not be able to live how we have leading up to today. This thesis is not a scientific analysis of the existence or potential causes of climate change. Rather, I present information on climate change to set a base for the societal problem that climate change causes and show the uncertainty we all face dealing with the problem.

Sprawling Sacramento region land use patters do not help our region in the long run to reduce our carbon footprint. If land use patterns and emission trends persist, heat waves will be more intense, will occur more frequently, and will be sustained for longer periods. Sierra snow pack will decline up to 90 percent. Because more precipitation will fall as rain rather than snow, the risk of winter flooding may increase. Because such of our water storage in California depends on snow pack, water shortages in the summer will increase. Rising sea levels will cause increased saltwater intrusion into the Sacramento-San Joaquin Delta, potentially putting two-thirds of California's water supply in jeopardy. In Sacramento, the number of days per year over 95º F will increase from an average of 18 days/year to as much as 110 days/year (Brown, *et al*. 2008).

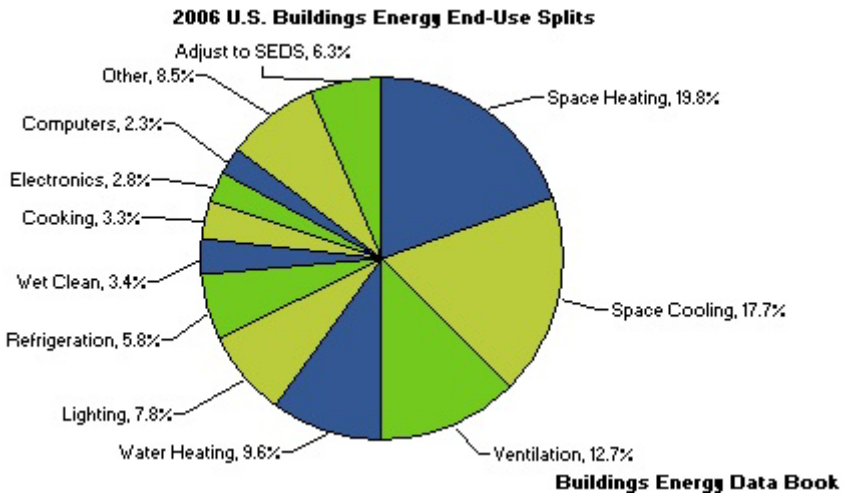
The Sacramento Area Council of Governments (SACOG) (2004) estimates there will be 1.7 million more people in the Sacramento Region in 2050 than in 2000, which will bring the number of residents to over 3.6 million. If present trends persist, residents

will drive many more miles annually and spend more time in their cars, which will have a negative effect on air quality and create increasing rates of GHG emissions. In addition, the increase in energy demand accompanying projected population increases will create the demand for additional power plants, further threatening our air quality. Sacramento growth patterns need to change in coming generations in order to decrease our area-wide GHG emission production. The Sacramento Regional Blueprint (SACOG 2004) advises the greater Sacramento region to grow in a way that reduces vehicle miles traveled by developing near transit as well as building energy efficient buildings. But are energy efficient buildings an attractive investment?

Building Energy Consumption

Roads, buildings, and other constructed surfaces mostly absorb, rather than reflect, the sun's radiation (Ewing *et al.* 2008). On an annual basis, buildings in the United States consume 39 percent of America's energy and 68 percent of its electricity. Furthermore, buildings generate 38 percent of the carbon dioxide (the primary greenhouse gas associated with climate change), 49 percent of the sulfur dioxide, and 25 percent of the nitrogen oxides found in the air. Currently, the vast majority of this energy comes from nonrenewable, fossil fuel resources. With America's supply of fossil fuel supplies dwindling, concerns for energy supply security increasing (both for general supply and specific needs of facilities), and the impact of greenhouse gases on world climate rising, it is essential to find ways to reduce load, increase efficiency, and utilize renewable fuel resources in all facilities.

Buildings are extremely inefficient because they are cooling-dominated places. For example, office buildings have significant energy demand because of lighting, density of people, as well as heating and cooling. Building construction has an enormous direct and indirect impact on the environment. Buildings not only use resources such as energy and raw materials, they also generate waste and potentially harmful atmospheric emissions. The U.S. Department of Energy (2006) produces building energy use data and the Department's data appear in Figure 1.2 below. As the U.S. economy and population continue to expand, designers and builders face an unprecedented challenge to meet demands for new and renovated facilities that minimize their impact on the environment.



Source: U.S. Department of Energy, 2006
Figure 1.2. Buildings Energy Usage Data.

What is Green Building?

Green building is the practice of designing and building structures to be more efficient, and is one characteristic of the much larger notion of sustainable building practices. Sustainability has emerged as one of the most popular buzzwords of the current generation. Environmentally friendly practices and ways of life have even become hip.

But what is sustainable development? The term is so hard to define because it encompasses every aspect of development and how people live. In the broadest sense, sustainable development is the practice of developing to meet the needs of the current generation without compromising the well being of future generations. Many groups around the world use this definition, but it needs to be examined in much greater detail to explain what it actually means.

Sustainable development includes efficient building practices, but also is a part of the much larger notion of Smart Growth. Smart Growth promotes infill development, compact and high-density development, in close proximity to jobs and transit choices, as well as the reuse of underutilized sites. Development patterns in the U.S. have promoted low-density housing and office with large parking lot retail. The United States has not efficiently consumed land. Smart Growth takes those principles and applies them to areas skipped over by previous development, or applies them to sites that are not being used to their highest potential. Smart Growth discourages raw land consumption and challenges developers to be innovative; to provide a place that will benefit the public for generations to come. Smart Growth becomes sustainable development when you apply Smart Growth principles to buildings that are constructed and operate in a resource-efficient manner.

Building efficiency is another important aspect of sustainable development. Sustainable development tries to reduce energy consumption and damage done to the environment. Developers should bring buildings to market that ensure future generations will be able to use the building and not have to tear it down and start over because of

poor construction. Incorporating quality green building practices ensures that buildings and communities will provide long lasting benefits.

In the late 1980s, a group of progressive architects formed the Committee on the Environment within the American Institute of Architects and began to steer the profession towards sustainable design (Yudelson 2008). Yudelson (2008) states the 20th anniversary of Earth Day in 1990 and the Earth Summit held in Rio de Janeiro in 1992 helped facilitate that group of architects to form the United States Green Building Council (USGBC) in 1993. The USGBC is a consensus-based, non-profit group made up of private companies, public agencies, educational institutions, environmental groups, and trade associations and has grown from 150 companies in 1998 to over 7,500 in 2007.

The Kyoto Protocol, of 1997, first attempted to control GHG emission reductions on a global scale and the USGBC saw an opportunity to act. The USGBC originally produced the most recognizable and universally accepted way to rate building efficiency in 2000 (LEED-NC version 2.0). The Leadership in Energy and Environmental Design (LEED) Green Building Rating System awards points for certain aspects of building design, construction, and efficiency. LEED was the first rating system in the United States to hold commercial projects to their effects on energy and water use, resource conservation and recycling, municipal infrastructure, transportation energy use, land use, and indoor environmental quality. The EPA's Energy Star rating program was the other program in existence at the time of USGBC's release of LEED, but only focused on building energy use.

LEED details six rating categories for its certification process and Yudelson (2008) summarizes the categories in Table 2.1 of his book "The Green Building Revolution." They include:

- *Sustainable sites*- develop only appropriate sites, provide for non-auto access, preserve open space, manage storm water, reduce urban heat island effect, and reduce light pollution of the night sky.
- *Water conservation*- reduce the use of potable water for irrigation and for building water use and sewage conveyance.
- *Energy efficiency and atmosphere protection*- reduce building energy use, use less harmful chemicals for refrigerants, generate renewable energy on-site, provide for on-going energy savings, and purchase green power for project use.
- *Materials and resource conservation*- provide for recycling, reuse exiting buildings, reduce construction waste generation, use salvaged and recycled content materials, source materials regionally, and use rapidly renewable (agricultural) materials and certified wood products.
- *Indoor environmental quality*- improve indoor air quality; increase outside air ventilation; manage air quality during construction, use only nontoxic finishes, carpets, and composite wood products; reduce exposure for individual comfort control; maintain thermal comfort standards; and provide day-lighting and views to the outdoors.

- *Encourage innovation and integrated design*- provide for exemplary performance above LEED standards and encourage other innovations; use accredited professionals on the design team.

The rating system assigns points for each component of a project that fits within LEED standards. Projects can obtain a total of 69 possible points in LEED-New Construction (-NC) projects, and projects can achieve different levels of certification depending on how many points USGBC awards. Certifications levels include: Certified-26 to 32 points; Silver-33 to 38 points; Gold-39 to 51 points; and Platinum-52 to 69 points.

The USGBC states "green design not only makes a positive impact on public health and the environment, it also reduces operating costs, enhances building and organizational marketability, potentially increases occupant productivity, and helps create a sustainable community (USGBC, 2005. Pg. 4)." The Whole Building Design Guide describes green building not only by construction methods, but more importantly using the "Whole-Systems" approach. The Whole-Systems approach promotes design and construction integration into the building site; consume less energy and water; are durable and easier to maintain; and are healthier, safer, and more comfortable.

High-caliber design teams will incorporate whole building design concepts regardless of pursuing LEED certification or not. Well-designed buildings can qualify for many LEED credits without changing design or accruing any additional cost. Well-designed buildings make establishing a baseline for comparison difficult and I will detail

this process in Chapter 3. Any developer aiming for LEED certification needs to make it part of the development plan from the start. A smart developer will start the process by taking the entire development team (including architects, engineers, and contractors) through the desired vision for energy efficiency and weigh each credit accordingly.

California Reacts to Building Inefficiency

The California Legislature has long been aware of the harming effects buildings have on the environment. The California Energy Commission (CEC) first established the California Code of Regulations Title 24 Part 6: California's Energy Efficiency Standards for Residential and Nonresidential Buildings in 1978 in response to a legislative mandate to reduce California's energy consumption. The CEC periodically updates the standards as new efficiency technologies become available. The last amendments from 2005 require new homes to use half the electricity they used 10 years ago. Increased energy efficiency results in a decreased creation of greenhouse gas emissions because production of the majority of energy we use comes from high-emitting, non-renewable fossil fuels.

California Governor Arnold Schwarzenegger announced on June 1, 2005, through Executive Order S-3-05, the following GHG emission reduction targets: by 2010, reduce GHG emissions to 2000 levels; by 2020, reduce GHG emissions to 1990 levels; by 2050, reduce GHG emissions to 80 percent below 1990 levels (Schwarzenegger 2005). The California Climate Action Team's Report to the Governor contains recommendations and strategies to help ensure California meets the targets set forth in Executive Order S-3-05.

In 2006, the Legislature passed Assembly Bill 32 (AB 32), the California Global Warming Solutions Act of 2006, and the Governor signed it into law. AB 32 focuses on reducing GHG emissions in California. GHG, as defined under AB 32 include: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. AB 32 requires the California Air Resources Board (CARB), the State agency charged with regulating statewide air quality, to adopt rules and regulations that would achieve greenhouse gas emissions equivalent to statewide levels in 1990 by 2020. AB 32 required CARB to publish a list of discrete early action GHG emission reduction measures that can be implemented by 2010. CARB published the early action measures in late 2007.

One of CARB's early action measures involves California producing guidance and protocols for businesses to reduce greenhouse gas emissions. The strategy includes businesses incorporating efficient building practices, motor vehicle fleet changes, operational changes, fossil fuel switching, and recycling. To be successful, this strategy must convince businesses to embrace new projects and initiatives from both environmental and economic perspectives. Thus, a key element of success in the strategy will be to determine how enhancements of operational efficiencies can result in increased profits for a participating business via savings in energy consumption. Energy efficiency measures associated with green buildings address lighting, heating and cooling, water conservation, refrigeration, and recycling and often lead to a large decrease in GHG emissions. The U.S. Department of Energy states that new energy efficient design can cut

energy usage by 50 percent; renovation of existing buildings can yield savings of up to 30 percent (CARB 2007).

The California Climate Change Proposed Scoping Plan (CARB 2008) calls on State government to set an example in incorporating environmentally friendly principles. CARB (2008) states building energy use and related activities are the second largest contributor to GHG emissions. CARB (2008) quantifies this statistic by taking emission estimates from electricity, natural gas, and water use in homes and commercial buildings. As a large owner-operator of key infrastructure facilities, the State has the ability to ensure designers and contractors use the most advanced, cost-effective environmental performance requirements when designing, constructing, and operating State facilities. Recommended Action #13 calls on the State to "Expand the use of green building practices to reduce the carbon footprint of California's greenhouse gas emissions."

In July 2008, the California Building Standards Commission (CBSC) adopted Green Building Standards Code for all new construction in the state. The current version of the commercial green building code is still voluntary, but the CBSC anticipates adopting a mandatory code in 2011 that will incorporate similar if not the same standards as the LEED certification process. CARB (2008) recommends the 2011 code set a target that 25 percent of all new buildings reduce energy use and water consumption by at least 25 percent beyond the adopted 2011 code.

Signed by Governor Schwarzenegger (2004) on December 14, 2004, Executive Order S-20-04 (the Order) cites that commercial buildings use 36 percent of the State's electricity and account for a large percentage of the State's GHG production. The Order

further states electricity costs for California's institutional and commercial buildings consume more than exceed $12 billion per year, and cost-effective efficiency practices outlined in the Order can save more than $2 billion per year; the State's own buildings consume over $500 million of electricity per year, and the measures outlined in the Order can save California taxpayers $100 million per year. Executive Order S-2-04 requires all new and renovated State-owned buildings to meet LEED-Silver or higher certified buildings and increase energy efficiency 20 percent by 2015.

The Sacramento Business Journal's 2009 Green Business issue lists eleven State-owned buildings currently LEED certified with another 33 seeking certification in Sacramento County. The State needs to be a leader in developing and retrofitting environmentally efficient buildings, but we will not see a true shift in the development industry until the private sector realizes the economic potential of sustainable development because most of the office building stock in Sacramento is and will continue to be privately-owned. Appendix A of the City of Sacramento 2030 General Plan Technical Background Report (City of Sacramento 2005) reports 3,343 acres of office land use designations within the City limits, while the only showing 36 percent of the total (1,197 acres) designated "Office Public" to represent different public agency offices. Sacramento has seen many new office projects built since 2005. The Downtown Sacramento Partnership Strategic Action Plan 2007-2014 (Moore, Iacotono, Goltsman Inc. 2006) reports 10 million square feet of office space in downtown Sacramento with a goal of adding 1 million additional square feet by 2011. Colliers International's Office Overview, Sacramento, 3rd Quarter 2009 (Colliers 2009) reports 18,289,719 square feet

of total office space available in downtown Sacramento. Further, Colliers (2009) reports over 9 million square feet of Class-B or Class-C office space exist in the downtown Sacramento submarket. This statistic is important because Class-B and Class-C offices are usually older structures and not as energy efficient as newly built Class-A structures. Sacramento has an enormous opportunity to increase efficiency given the large office market and relatively older building stock.

Industry Perception of Green Buildings

A developer's number one obligation is to make a livelihood. While some developers are very idealistic, see sustainability as a smart business strategy, and will not involve themselves in projects unless some sustainability standards are met. But for most decision-makers, they focus on the bottom line. How much will it cost and how much do they anticipate to make on the project? Decision-makers have no problem involving themselves in sustainable projects if they can achieve desired returns. The general consensus around the building industry is sustainable building is a good thing and should be practiced, but it simply costs too much. Additional first costs factor in greatly to a decision because construction costs rose 25-30 percent between December 2004 and December 2007 (Cassidy 2007) (However, availability of financing and lack of tenants is the 2009 and 2010 builder's dilemma). Developers agree that they receive benefits from sustainable buildings, but they either don't believe or don't know if the benefits outweigh the costs. Building Design and Construction magazine published "Green Buildings Research White Paper" in 2007 and included the results from 630 real estate industry leaders. Eighty six percent of respondents felt green buildings cost more to build than

similar buildings, and not by just an incremental amount. Most felt green buildings cost more than 6 percent above average and a large group felt green buildings cost more than 15 percent above average.

Fuerst and McAllister (2008) find sustainable building's relatively low proportion of the overall real estate market puzzling given the apparent benefits of certified buildings when compared to non-certified buildings. The authors offer reasons why the industry may be misinformed or underrepresented about the adoption of sustainable features including: imperfect information, split incentives, risk aversion, high discount rates, and skill shortages. Developers may be placing unusually high discount rates (i.e., factoring for risk) on energy saving technologies and investment opportunities because the market is relatively new and may not have the necessary data to make an informed decision.

The Sacramento Business Journal's 2009 Green Business Issue examines the Sacramento industry perception of LEED certification in "Developers Weigh the Need for LEED." The article explains that sometimes developers decide that LEED processing cost is too costly and some developers are betting their buildings can be considered "green" without ever going through the LEED certification process. Some Sacramento developers are betting potential tenants are becoming more aware of environmentally efficient design (e.g., reflective roofs, photovoltaic panels) and therefore find it not necessary to incur the certification costs. In the article "Developers Weight the Need for LEED," architect Etienne Louw, a principal of Lionakis (Sacramento design and planning firm), states "Without LEED certification, a developer's claim of, 'My project

was designed to meet LEED but we decided not to get it certified' rings hollow." Louw goes on to question why a developer would go through the trouble of creating a building to LEED standards and not get the marketing benefit from it. In our current (2009) recession, does a LEED certified building attract tenants that would otherwise lease somewhere else if the building was not certified? Will a LEED certified building lease faster than a non-certified building? What does a LEED certification do to overall building valuation?

Conclusions

This introductory chapter shows the need for change in the building industry given the societal challenges we face in dealing with climate change. The sections to follow will examine what the academic community thinks about the costs and paybacks of green building, an explanation of my research methodology to test if the LEED certification of 2600 Capitol Avenue makes financial sense, results of my analysis, conclusions on LEED certification, and questions and thoughts for further analysis.

Chapter 2

WHAT THE ACADEMIC COMMUNITY THINKS ABOUT GREEN

Costs of Green

Because costs are the underlying factor to build sustainably or not, it is important to understand the costs associated with sustainable development practices. The costs are "hard" and "soft" but the benefits are always "soft." Hard costs include the fundamental materials and labor involved in the building. Developers will consider any work or costs associated with the actual construction as hard costs. Costs of materials are usually pretty fixed and will not vary as much as soft costs. Costs can include: the cost of construction related to the structure itself; and site improvement costs such as grading, sidewalks, drainage, and landscaping. Soft costs are the non-brick and mortar expenses that builders can't physically see. Soft costs include costs associated with the planning, design, and coordination of a construction project. Costs can include: Architects and engineering consultant fees, construction management fees, legal fees, any government fees, LEED fees, and any financial costs such as construction period interest and loan fees.

Yudelson (2008) describes the cost drivers of LEED certification in Table 4.1 of "The Green Building Revolution." The cost drivers include:

- *Level of LEED certification sought*- possible cost increases include zero percent (of total construction costs) for LEED Certified; 1-2 percent for LEED Silver, up to 5 percent for LEED Gold.
- *Stage of the project when the LEED certification decision is made*- after 50 percent completion of construction drawings, things get a lot more costly.

- *Project type*- with certain project types such as science and technology labs, it can be costly to change existing models but models for office buildings are easier to change.
- *Experience of the design team and construction teams in sustainable design and green buildings*- every organization has a learning curve for green projects meaning costs go down with experience.
- *Types of green technologies involved in the project*- Photovoltaics and green roofs are going to add costs no matter what and LEED Gold requires them.
- *Level of direction from the owner in establishing priorities for green measures and a strategy for including them*- every design team thinks of ideas separately without clear leadership from the owner which can lead to huge cost increases.
- *Geographic location and climate*- climate can make certain levels of LEED certification harder for project types such as labs as well as office buildings. Local codes and labor union resistance to change can also add costs.

LEED projects also incur additional "soft" costs for additional design, analysis, engineering, documentation, energy modeling, and building commissioning. Dennis Wilde of Gerding Edlen[2] stated that a lot of soft costs are fixed, and anywhere from $175,000-$250,000 is the cost of doing business. He also stated building commissioning is the largest soft cost. Building commissioning is a large cost because all of the buildings' systems are involved. Contractors build to specifications and all other systems

[2] Gerding Edlen Development Company, based in Portland Oregon, has developed more LEED certified buildings than any company in the world.

need to be aligned with one another. The entire building needs to be modulated and synced to function properly. Historically, the building industry thought this process was a one-time cost, but smart building owners re-commission (i.e., ongoing and sustained maintenance) on a regular basis because systems can drift out of original design specifications relatively easily. It's similar to maintaining a performance car. They perform great, but one needs to make sure they maintain them to function at their highest levels. Building owners commission buildings not only to deliver building systems that work, but also set the stage for ongoing, sustained operational success of these systems. Commissioning can be one of the most cost-effective ways to reduce operating costs.

D'Antonio (2007) examined the LEED certification costs of eleven newly constructed office buildings in Colorado as a part of the Governor's Office of Energy Management and Conservation program looking at building efficiency. The authors state some project teams incorporate certain requirements of LEED, such as commissioning and energy modeling, as business as usual and do not consider them additional costs. The relative cost premiums in the study are exaggerated for such project teams because high quality design will be included regardless of seeking LEED certification or not[3].

D'Antonio (2007) obtained project cost data for eleven State of Colorado-owned office buildings through a survey of the project managers. Among other categories, project managers provided construction costs per square foot and "LEED premium" to categorize the additional costs associated with LEED certification. The cost premium for LEED certification ranged from 1 percent to 6 percent of total construction costs. Soft

[3] I will further explore establishing a baseline building for comparison in the next chapter, Research Methodology.

costs, including LEED registration and certification, LEED documentation, energy modeling and commissioning averaged roughly 0.8 percent of the construction costs or $1 per square foot. Energy modeling averaged roughly $10,000 across nine projects reporting data, with eight projects reporting costs at or below $10,000 and one reporting an energy modeling cost of nearly $35,000. Building commissioning costs averaged $0.55 per square foot, and accounted for roughly 60 percent of total soft costs.

Fuerst and McAllister (2008) categorize two main types of additional costs associated with obtaining LEED certification for commercial and office buildings. The first set of costs are the payments to the certifying body for the rating of the building and the second are the additional production costs associated with meeting the certification standards. The authors don't elaborate on the payments to the certifying body, but do point out a number of studies suggest small construction cost premiums of around 2 percent on average. Fuerst and McAllister (2008) summarize Langdon's (2007) study comparing building costs for LEED certified buildings compared to non-LEED certified buildings. Davis Langdon (2007) compared 83 LEED certified buildings with 138 similar projects without the goal of achieving LEED certification an average cost premium of 1.84 percent for 33 LEED projects. The study found no significant difference (0.66 percent) for projects obtaining a minimum "Certified" status. "Silver" projects had an average cost premium of 2.11 percent, "Gold" projects had an average cost premium of 1.82 percent, and "Platinum" projects had an average cost premium of 6.50 percent. Davis Langdon Company recently (2009) completed a similar study with the Urban Green Council comparing the costs of commercial buildings in New York City. Davis

Langdon (2009) gathered data through surveys on 107 projects in 2008 and 63 of those projects sought LEED certification. Data points included construction costs, design fees, LEED design fees, LEED additional fees, and commissioning fees. The authors found the average construction costs for LEED certified buildings was $440 per square foot and $436 per square foot for non-LEED certified buildings.

Miller *et al.* (2008) reports complete cost data sets for green buildings are very difficult to secure and the USGBC provides most industry-wide cost data as well as anecdotal surveys. Miller *et al.* (2008) reports LEED certification cost premiums from a sample of 26 respondents are three percent for “Certified” projects and 5.5 percent for “Silver” projects.

Kats (2003) also examined the costs of green building and contacted several dozen building representatives and architects to secure the cost data from 33 LEED certified offices and schools from across the United States compared to conventional designs for the same buildings. Kats (2008) states average premium for these green buildings of slightly less than 2 percent, or $3-5 per square foot. Kats (2008) suggests a 0.6 percent cost premium for “Certified” projects, 1.9 percent for “Silver” projects, 2.2 percent for “Gold” projects, and 6.8 percent premium for “Platinum” projects. The majority of the cost is due to increased architectural and engineering design times for improved systems, and modeling costs and time necessary to integrate sustainable building practices into projects. Kats (2008) also states lower project costs are directly correlated with early green building feature incorporation into the design process.

A key issue in sustainable development is whether green buildings in general, and LEED-certified buildings in particular, cost more to build than non-LEED structures. Project budgets are very tight in the current (2009) market and additional project costs can mean the difference between project profit and loss. The research shows that a wide opinion exists in both the academic and private consultant communities on the additional costs for LEED certified buildings. The cost issue will continue to be the main prohibitive factor in the mainstreaming of green building throughout California and the United States. Industry-wide data is not very conclusive. Most agree green buildings do incur additional upfront costs, but the question remains on the worthiness of green building benefits as well as the costs compared to the benefits.

Table 2.1

LEED Certification Cost Increases

Author(s) and Year	Number of observations	Method	Findings
Yudelson (2008)	N/A	N/A	0 % increase for Certified; 1-2% for Silver; up to 5% for Gold.
D'Antonio (2007)	11	Project manager survey	Ranged from 1-6%. Soft Costs averaged 0.8% with building commissioning accounting for 60% of total soft costs.
Langdon (2007)	83 LEED certified and 138 non-LEED buildings.	General cost comparison of LEED v. similar non-LEED buildings	Average cost premium of 1.84%. 0.66% for Certified, 2.11% for Silver, 1.82% for Gold, and 6.50% for Platinum projects.
Langdon (2009)	63 LEED certified and 44 non-LEED buildings in New York City during 2008.	Compared average construction costs for LEED v. similar non-LEED buildings.	Average construction cost of $436 per square foot for non-LEED buildings and $440 per square foot for LEED certified buildings. Equates to 0.01% cost premium.
Fuerst and McAllister (2008)	Multiple studies	Compared findings from multiple studies.	Conclude average cost premium is around 2.0% based on others findings.
Miller *et al.* (2009)	26	Project manager survey	3.0% increase for Certified and 5.5% for Silver projects.
Kats (2003), (2008)	33	Compared project costs to "conventional" design costs	Average premium of slightly less than 2.0% or $3-5 per square foot. 0.6% increase for Certified, 1.9% for Silver, 2.2% for Gold, and 6.6% for Platinum projects.

Quantitative Benefits

The USGBC lists many benefits associated with green buildings. Environmental benefits include: enhance and protect ecosystems and biodiversity, improve air and water quality, reduce solid waste, and conserve natural resources. Economic benefits include: reduce operating costs, enhance asset value and profits, improve employee productivity and satisfaction, and optimize life-cycle economic performance. Health and community benefits include: improve air, thermal, and acoustic environments; enhance occupant

comfort and health; minimize strain on local infrastructure; and contribute to overall quality of life. While these benefits all may be valid, most of these benefits are difficult to quantify and potential green building developers and investors need to see statistics that affect their bottom line. For purposes of this chapter and study, I will examine energy savings, rental premiums, selling premiums, and increased productivity.

Energy Savings

The U.S. Department of Energy (2005) estimates that buildings consume more than 39 percent of all U.S. energy at a cost of over $200 billion per year ($85 billion for commercial buildings). This figure is higher than both the transportation and industry sectors combined! The EPA's analysis of building that earned the ENERGY STAR label showed energy costs were 40 percent lower than an average building (Broughton 2006). The 40 percent lower energy costs means that owners and operators of commercial buildings have a $34 billion annual energy savings opportunity if all buildings operated at ENERGY STAR efficiency! LEED buildings are seeing upwards of 60 percent energy savings using a whole building design approach. Water savings of 20-30 percent are also well documented (Broughton 2006). Broughton (2006) reports 20-25 percent savings in electricity for well-designed day-lighting systems.

Kats (2003) reviewed energy costs for 60 LEED certified buildings in Massachusetts and states the average cost of energy per year is approximately $2.00 per square foot. When compared to similar non-LEED certified buildings, his sample buildings were 25 to 30 percent more energy efficient on average. Specifically, Certified buildings were 18 percent more efficient, Silver buildings were 30 percent more efficient,

and Gold buildings were 37 percent more efficient. Kats (2003) did not observe any Platinum buildings. Kats (2003, p. 4) states, "A reduction, for a 100,000 square foot building, worth $60,000 per year, with a 20-year net present value of expected energy savings at a 5 percent real discount rate[4] is worth about $750,000."

Newsham *et al.* (2009) conducted a re-analysis of data supplied by the New Buildings Institute and the USGBC on measured energy use data from 100 LEED certified commercial and institutional buildings. The researchers compared these data to the general US commercial building stock. The authors also examined energy use by certification level and by energy-related credits achieved in the certification process. They found, on average, LEED buildings used 18 to 39 percent less energy per floor area than their conventional counterparts. However, the measured energy performance of LEED buildings had little correlation with certification level of the building, or the number of energy credits achieved by the building at design time. The authors concluded that green buildings can contribute substantial energy savings on a societal level, but further work needs to be done to redefine green building rating systems to ensure more consistent success at the individual building level.

Turnel and Frankel (2008) conducted the original analysis of these data and looked at actual energy usage compared to, design submittals during the LEED certification process, and to data for the national building stock from more than 5,000 buildings in the 2003 Commercial Building Energy Consumption Survey (CBECS). For office buildings, the most common and easily comparable building type, energy usage

[4] See Chapter 3 (Research Methodology) for all relevant definitions including "real discount rate."

was 33 percent lower in LEED certified buildings when compared to mean energy usage in the CBECS database. Turnel and Frankel (2008) found that energy modeling is actually very similar to actual building performance. In fact, the average ratio between measured and designed energy usage was “remarkably close” at 0.92. Newsham *et al.* (2009) point out the important limitation of Turnel and Frankel’s work is they did not perform any statistical tests on the data. Rather, they were content in drawing conclusions based on trends in average values and suggested that average trends may be spurious. Turnel and Frankel (2008) laid the groundwork for Newsham (2009) to conduct a regression analysis of energy usage and certification level to test the effect more effectively. Newsham (2009) produced outcome variables through statistical tests for all observed buildings including modeled energy savings and percent energy saved in order to draw specific conclusions about the entire sample. Regression analyses are more effective in testing theories because you can see exactly how much “y” affects “x” and enables the researcher to draw general conclusions based on the entire sample instead of noting trends in data.

Diamond *et al.* (2006) examined actual energy use in 21 LEED certified buildings. The authors determined actual energy use from utility billing data. Diamond *et al.* (2006) used the LEED certification documentation submitted to the USGBC to obtain modeled energy data for the as-designed building as well as the baseline building for comparison. The authors found energy use was 1 percent lower than modeled usage and 27 percent below baseline on average. Furthermore, the number of LEED energy credits obtained in the certification process did not correlate with actual energy use per floor

area. The authors called for more research on modeled and actual energy use compared to LEED credits.

Table 2.2

LEED Certified Project Energy Savings

Author(s) and Year	Number of observations	Method	Findings
Broughton (2006)	N/A	N/A	60% energy savings in LEED buildings combined with Whole Building Design approach. 20-30% water savings and 20-25 electricity costs savings for well-designed day-lighting systems.
Turnel and Frankel (2008)	100 LEED certified buildings and 5,000+ non-certified commercial buildings	Compared actual energy usage for 100 LEED certified projects, energy design model submitted in LEED certification process, and energy usage for 5,000+ similar buildings in the 2003 Commercial Building Energy Consumption Survey (CBECS).	LEED certified office building energy usage was 33% lower than mean energy use in the CBECS database. Energy modeling is very close to actual usage at a ratio of 0.92.
Newsham *et al.* (2009)	100 LEED certified buildings and 5,000+ non-certified commercial buildings	Built on Turnel and Frankel (2008) and compared actual energy usage for 100 LEED certified projects, energy design model submitted in LEED certification process, and energy usage for 5,000+ similar buildings in the 2003 Commercial Building Energy Consumption Survey (CBECS).	LEED certified office buildings used 18-39% less energy than their conventional counterparts. Also, energy performance had little to do with the level of certification.
Diamond (2006)	21 LEED certified buildings	Compared utility billing data to modeled energy usage and baseline submitted in LEED certification documents.	Actual energy usage was 1 percent lower than modeled usage and 27% below baseline. Number of LEED credits obtained did not correlate with actual energy use per floor area.

Rental Premiums

Fuerst and McAllister (2008) report that much of the research on pricing effects of sustainable features in commercial property has been normative (i.e., analyzing what the price effect should be rather than what the price effect actually has been). Studies have focused on quantifying expected price effects of sustainable features in commercial real assets rather than measuring observed effects (see Ellison *et al.* 2007). Developers who pay more for energy saving features may assume that they can charge tenants higher rents. The 2009 Sacramento economic and real estate climate may not permit premiums when so much space is vacant. Colliers (2009) reports that total Sacramento-area office vacancy at 20 percent during the third quarter of 2009. The Downtown Class-A market remains somewhat healthy and stable at 8.1 percent vacant. It should be noted that the nature of the lease contract[5] determines whether tenants benefit directly from reduced energy and other utilities. Tenants with net rental contracts pay these costs directly and therefore should be attracted to lower operating costs. Nonetheless, LEED certified buildings should be able to attract increased rents in normal times.

CoStar Realty Group (2007) found that LEED buildings experienced 3-4 percent occupancy rate improvements over non-LEED buildings. They also found LEED buildings experienced $11 rental per square foot premiums, and resale premiums of $181 per square foot. Gerding Edlin's green building presentation states that multiple research efforts show worker productivity increasing from 3-10 percent in LEED buildings. CoStar's interviews with the leading real estate investment trusts (REITs) found green

[5] I will explain and define different lease structures in Chapter 3 (Research Methodology).

building owners can expect an average increase in value of 7.5 percent and average increase of return on investment (ROI) of 6.6 percent when compared to non-LEED buildings.

Fuerst and McAllister (2008) investigated the price differentials between LEED/Energy Star certified buildings and non-certified commercial buildings in the US. The authors tried to provide a theoretical and empirical grounding for the expected rent differential between LEED and non-LEED buildings. The empirical analysis compared certified buildings to non-certified buildings in the same submarket controlling for a set of hedonic building characteristics including age, location, and number of stories.

The consideration that a good is a bundle of characteristics is the basis for hedonic regression modeling. Each characteristic has its own market and the regression determines each characteristic's price independently from the other components. Hedonic regression also incorporates the assumption that the sum of the total prices of characteristics dictates the total price of the "i^{th}" good. In the simplest of terms, regression analysis is a statistical technique used to find relationships between variables to predict values. Essentially, Fuerst and McAllister's (2008) hedonic model measured price differences between certified buildings and randomly selected non-certified buildings in the same submarket controlling for differences in age, height, quality, and submarket. Fuerst and McAllister (2008) ran a rental regression for a sample of 197 LEED and 834 Energy Star buildings as well as over 15,000 comparison buildings. The regression results suggest that LEED certified buildings have an average rental premium of 4-5 percent.

Eicholtz, Kok, and Quigley (EKQ) (2009) used a hedonic regression framework to investigate the effect of certification on the asking rents of 694 LEED certified or Energy Star office buildings. Using Geographic Information Systems (GIS) techniques, they controlled for location effects by identifying other office buildings in the CoStar database within a radius of 0.2 miles of each other. Surprisingly, they found no significant rent premium for LEED certified buildings. However, when they used "effective rents" which reflect the effect of different occupancy levels in the rental income of properties (i.e., nominal asking rent multiplied by the occupancy rate), they found a nine percent premium for LEED certified. These findings indicated that LEED certified buildings might have higher occupancy rates when compared to similar non-certified buildings.

EKQ (2009) model may be flawed because there are likely to be different qualities of location even in the 0.2-mile radius. Furthermore, the study only looked at rent and price premiums and at the costs of development. The study cannot make any findings on what is the better development decision because the authors cannot compare the first costs of development to the benefits. Kats (2003) reports because of cost and rent differences by location, "you really need to compare the costs and benefits of conventional and green designs for the same building only." Kats shows the importance and value of case studies. Buildings need to be approached on an individual basis because every project and market is different.

Sales Price Premium

A number of studies have drawn upon the CoStar database of US properties to identify the effect of certification on sales prices and rents. To control for differences between their sample of 927 certified buildings and a larger sample of non-certified buildings, Miller *et al.* (2009) included a number of control variables such as size, location, and age in their regression framework. Miller at al. (2009) compared sales prices for LEED certified and Energy Star buildings to non-certified buildings using data from the CoStar database and place filters on buildings including only Class-A office buildings, 200,000 square feet or more, five stories or more, built since 1970, and multi-tenanted. The authors reported that the average LEED impact on sales price per square foot is a positive 9.94 percent or roughly 10 percent. A limitation on their model is they failed to control for location. The authors identified rental and sales price premium for certified buildings compared to non-certified buildings in the same metropolitan areas. However, if certified buildings tend to be more likely to be in higher rent areas, observed premiums may include a location as well as a certification premium. EKQ (2009) reported 19 percent sales price premium for Energy Star buildings, but no statistically significant sales price premium for LEED certified buildings.

Fuerst and McAllister (2008) reported a 25 percent sales price premium for LEED certified buildings when compared to similar non-certified buildings. The authors reported median sales price premiums per square foot of $194 for Certified, $252 for Silver, and $232 for Gold projects compared to a sample mean sales price of $113 per square foot. Fuerst and McAllister (2008) offer possible reasons for sales price premium

including effects on capital value of higher rental income, lower operating costs, increased occupancy rates, and a lower risk premium.

Table 2.3

LEED Rental and Sales Price Premiums

Author(s) and Year	Number of observations	Method	Findings
CoStar (2007)	N/A	N/A	$11 per square foot rental premium and **$181 per square foot resale premium** for LEED certified buildings.
Fuerst and McAllister (2008)	197 LEED certified, 834 Energy Star, and 15,000+ comparison buildings.	One regression model with rent per square foot as the dependent variable and one model with sales price per square foot as the dependent.	LEED certified buildings have an average **rental premium of 4-5%** and **sales price premium of 25%**. Specifically, sales price premium (per square foot) of $194 for Certified, $252 for Silver, $232 for Gold projects compared to an average of $113 per square foot.
Eicholtz, Kok, and Quigley (2009)	694 LEED certified and Energy Star buildings from the CoStar database.	Captured all similar buildings in a 0.2-mile radius (using GIS) of a LEED certified building and compared rents and sales price.	No significant premium for base rent but **9% premium when looking at "effective rents."** Shows higher occupancy rates in LEED certified buildings. No statistically significant sales price premium for LEED certified buildings.
Miller *et al.* (2009)	N/A	Filtered similar buildings to only Class-A, over 200,000 sq. ft., 5-stories or more, built after 1970, and multi-tenanted.	Average sales price premium is roughly 10%.

Other Benefits

A harder component of sustainable design to quantify is improved air quality. Employees seem to be more productive and miss fewer days of work when they are located in naturally lit and well-ventilated environments. A 2003 study by the Lawerence Berkeley National Laboratory found that improving indoor air quality could save US businesses up to $58 billion in time lost due to illness each year, with another $200 billion earned in increased worker performance. Fewer sick days lead to more

productivity. Four attributes of green design – increased ventilation, increased daylight, improved temperature controls, and improved lighting controls have been positively and significantly linked with increased productivity. Increased productivity because of increased indoor environmental quality is not surprising considering Americans spend 90 percent of their time indoors. EPA (2003) reports indoor concentration of pollutants can be 10 or even 100 times higher than outdoor concentration. Lawrence Berkeley (2003) report increases in tenant control over ventilation, temperature, and lighting each provide measured benefits from 0.5 percent up to 34 percent. Average measured workforce gains include 7.1 percent for lighting control, 1.8 percent for ventilation control, and 1.2 percent for thermal control.

Kats (2003) reported all LEED certified buildings address some combination of measures that help reduce the pollutants that cause sickness and increase health care costs; improve air quality of lighting and increase use of day lighting; and increase tenant control and comfort. Gold and Platinum level buildings are more comprehensive in applying indoor air quality-related measures and therefore should provide larger productivity and health benefits than Certified or Silver level green buildings.

Yudelson (2008) also examined tax benefits that green projects can receive. Many states offer tax incentives for green projects. For example, Oregon and New York offer state tax credits and Nevada offers property and sales tax abatement for green projects. A 100,000 square foot LEED Platinum building in Oregon can receive a net-present-value credit of up to $2 a square foot. New York projects meeting state environmental goals can claim up to $3.75 per square foot against their state tax bill. LEED Silver projects in

Nevada can abate up to 50 percent of their property tax bill. Assuming the tax is 1 percent of value, the savings can be up to 5 percent of the building's value, which is much higher than the cost of achieving LEED Silver (Yudelson 2008). The 2005 Federal Energy Policy Act entices green development by offering two major tax incentives. Owners can receive up to a 30 percent federal tax credit for both solar thermal and electric systems; and owners can also receive a federal tax deduction of up to $1.80 per square foot for projects that reduce energy use for lighting.

Fuerst and McAllister (2008) reported that LEED certified buildings could also experience decreased regulatory risk for investors. That is, LEED certified buildings appear to be less risky than a non-certified building and can receive insurance benefits that non-green buildings cannot. Novato, California based Fireman's Fund Insurance Company has pledged that if a fire occurs in a building that has been selling energy back to the grid, the insurer will pay for the loss of income. This policy supporting sustainable development could amount to hundreds of thousands of dollars for larger operations. The policy amendments guard against specific exposures not covered by traditional policies for new green buildings under construction and existing buildings undergoing green renovations, including the previously mentioned loss of earnings. Fireman's Fund broadened reimbursements of soft costs to cover reasonable building commissioning expenses and other costs associated with certification. The company also broadened the definition of "loss of rental value" to include additional time needed to match the level of green certification incorporated into the building prior to the loss. Green buildings will usually have lower insurance costs than non-LEED buildings because health-related

liabilities are lower, and these lower costs are especially important to self-insured businesses (Fireman's Fund 2008).

Conclusions

Unfortunately, comprehensive and conclusive studies do not exist that compare the costs and benefits of LEED certified buildings on a mass scale. The studies mentioned above show LEED certified buildings typically cost 0-10 percent more than a comparable non-certified building. The studies indicate LEED certified buildings commonly save 20-30 percent in energy costs. Studies also show LEED certified commonly command 0-10 percent higher rents and 10-25 percent higher selling prices when compared to similar non-certified buildings. Other benefits include improved air quality, employee productivity, tax benefits, and lower risk assessments. But what does this all mean? How does a developer make a decision to build a LEED certified building or not? The research indicates too much variability exists between markets and individual buildings to place a one-size-fits-all model on assessing green buildings. The next chapter will introduce my model for testing the attractiveness of LEED certification of 2600 Capitol Ave.

Chapter 3

RESEARCH METHODOLOGY

Introduction

This chapter describes the process I used to develop a test for the attractiveness of LEED certification for 2600 Capitol Avenue. I will give a brief background behind my reason for developing a case study, define key terms associated with my study, define the LEED-Core and Shell rating system, describe my data collection process, and finally show the reader how I will conduct the test to show the attractiveness (or lack there of) for LEED certification of 2600 Capitol Avenue.

Justification of Case Studies

I originally wanted to conduct a regional study of LEED certified buildings that would compare the costs and benefits of certified buildings to non-certified buildings in Northern California. I soon realized a study of such magnitude would nearly be impossible for many reasons. Building cost and performance data are extremely hard to obtain. Project owners are usually not willing to share construction costs and associated levels of return to the public. In addition, every building is different, so it would be very difficult for me to establish some sort of broad baseline for comparison.

As the previous chapter explains, many studies show the benefits of LEED certified buildings and many studies show the costs of LEED certified buildings. However, not many studies show LEED certification as a “ground up” investment decision. So how would I be able to show LEED certification as an investment decision? Showing a “ground up” approach to LEED certification from the project owner’s

perspective is necessary because project owners either pursue LEED certification for newly constructed buildings or perform retrofits for existing buildings. The development community and public should see the entire process that goes into the decision to pursue LEED certification. I am not aware of any studies that look at LEED certification as an investment decision in the greater Sacramento region.

Key Terms

Before I detail my data collection process, I feel it is necessary for me to define key terms that are fundamental to understanding the real estate development and LEED certification processes, as well as my test method.

The concept of present value reflects the reality that money has time value. Time value of money simply means that a dollar today is worth more than a dollar tomorrow. If an investor can chose between receiving $1 today or receiving $1 in the future, the proper choice will always be to receive the $1 today because the investor can invest the dollar in some opportunity that will earn interest for the investor. Investors would rather have cash immediately than having to wait and therefore must be compensated by borrowers for not having cash on hand for other investments.

When determining how much a borrower should pay today for an investment that the borrower expects to produce income in the future, the borrower must discount the income received in the future to reflect the time value of money. The discounted cash flow (DCF) model is the most widely used and reliable method of simulating the performance of a real estate investment over a determined number of years (i.e., holding

period). The DCF model takes all future cash flows and discounts them to reflect their present values. Applying the correct discount rate (e.g., real discount rate) to an investment can be a difficult task, and usually represents two different things. The real discount rate must first represent the time value of money as well as a risk premium. The risk premium reflects the extra return investors demand for the risk that the cash flow might not materialize at all. Higher risk premiums correlate with riskier projects. Another way to look at the discount rate is to choose a rate that would earn the company a similar return if the company invested the money elsewhere. For example, if an investment of $100,000 will earn 5 percent interest somewhere else, the company should use 5 percent as the discount rate.

Net present value (NPV) is total present value of a time series of discounted cash flows. The NPV method provides a decision-making tool for investors because it measures the present value excess or shortfall of cash flows, once financing or return requirements are met. NPV is an indicator of how much an investment adds to a firm. Strictly from a financial perspective, the general rule of thumb for NPV is to accept a project with a positive NPV and reject a project with a negative NPV. A firm should invest in the project that produces the highest NPV. Many other factors go into an investment decision but the NPV method is a good starting point to understand the real estate investment decision-making process.

LEED for Core and Shell

Speculative development is exactly what the name implies because it is speculative. Developers build buildings speculating a demand for a certain use and do not

have leases on tenants ready to move in. The incoming tenants will have the final say on the floor plans and the LEED for Core and Shell Rating System (LEED-CS) provides a certification process for speculative development. LEED-CS acknowledges the limited influence a developer can exert in a speculatively developed building and encourages the implementation of green design and construction practices in areas where the developer has control (USGBC 2006). Interior space layout, interior finishes, lighting, mechanical distribution, and other tenant related systems are often outside the direct control of the developer. Thus, the scope of a LEED for Core & Shell project is limited to those aspects of the project over which the developer has direct control (USGBC 2006). It is the responsibility of the developer/owner to identify which LEED rating system to use for the LEED building certification. The 2600 Capitol Avenue project team chose to pursue LEED-CS because it did not know who would be occupying the building when the team started the planning and design process.

Data Collection

The first thing I needed to do was locate cost and performance data for a LEED certified building (preferably in Sacramento) and find data for a similar non-certified building. I stumbled upon the opportunity by chance in an unrelated meeting. Bob Chase, LEED Accredited Professional (LEED AP) and former Chief Building Official of the City of Sacramento, informed me that Mike Heller just completed a LEED certified office building and Mike made his cost data available to him. Mike is a native Sacramentan and started Heller Pacific Inc. in 1997. Heller Pacific is a real estate development firm specializing in office, retail, and mixed-use development. Loftworks is

an urban development partnership between Mike Heller and Mark Friedman (President of Fulcrum Property).

Bob told me that Mike estimated the LEED-Gold building cost 1.6 percent above baseline. I told Bob that I was looking for data to conduct a case study on the costs and benefits of a LEED certified building compared to a standard Class-A office building for my thesis. Bob told me he would help me set up a meeting with Mike to discuss the idea.

Source: Lionakis
Figure 3.1. 2600 Capitol Avenue Site Plan

The beauty of 2600 Capitol Avenue (for purposes of a case study) is Loftworks developed the building from the ground-up. Loftworks looked at different development options and efficiency improvements before the construction crews started work. Loftworks went through the exact exercise (before they made the investment decision) that I was looking to examine in my thesis. What are the costs and benefits of a LEED

certified building? Do the benefits outweigh the costs when compared to a similar non-certified building?

I met with Bob Chase and Mike Heller in August 2009 to discuss my thesis idea. I told Mike that I was having an extremely difficult time locating reliable green building data and was interested in making his building the focal point of my thesis. Mike reiterated what I thought previously about the Sacramento development community's thoughts towards green building. He said many builders think the costs of LEED certification are substantially higher than they really are, and Sacramento as a whole would benefit from a study that shed light on the real costs and benefits of LEED certification.[6]

Mike told me his company and all associated building data would be at my disposal for purposes of my thesis. He sent an email to Patrick Malloy of Heller Pacific, A.P. Thomas Construction, Rob Jensen of EMCI Engineering, and Nick Dokis of Lionakis Building Design Group informing them I would be analyzing 2600 Capitol Avenue for my thesis, and to please make all data and resources available to me. Mike thought it would be a good idea for me to meet with the project development team as a whole to discuss the development and LEED certification process for 2600 Capitol. Nick Dokis very graciously offered the Lionakis conference room as a meeting place for all of us. I must point out the rarity of the opportunity Mike Heller gave me. Most developers

[6] This may be obvious to many, but I must note that higher costs and unknown benefits are not solely responsible for green building not reaching the masses in Sacramento. The greater economic climate is the over-riding reason why developers are not developing more LEED certified buildings. Project financing is nearly impossible to secure today and vacancy rates are rising every quarter in the commercial and office markets. As a whole, new commercial and office development does not make financial sense today.

do not share their investment decision data with anyone but their paid consultants and internal staff. This case study is a truly unique opportunity to go back and analyze a green building investment decision.[7]

I met with part of the 2600 Capitol project team including Bob Chase (who was the Chief Building Official for the City of Sacramento at the time of construction), Patrick Malloy from Heller Pacific, as well as Nick Dokis and Jeffrey Justice from Lionakis on October 1, 2009. The team explained to me the process they went through when exploring LEED certification for 2600 Capitol Avenue.

The key to a successful LEED certification process is to define the sustainability goals before the design process begins. The entire project team including developer, architect/designer, engineers, and contractor meet for an "eco-charette." The interactive meeting may last multiple days and gives the developer a chance to explain the project vision and define sustainability goals to the entire project team. The architect designs a building concept and the project team goes through and evaluates each LEED credit. The 2600 Capitol team went through each credit and marked "yes", "no", or "maybe." The team identified how much each credit would cost (including hard and soft costs) and then made a final decision. The project team identified total costs for different levels of certification. The project team gave me the LEED checklist with additional costs associated with each credit, a summary matrix for LEED certification, and a cost sheet that separates baseline costs and additional LEED costs (see Appendix). They key to my

[7] It is not everyday a graduate student has a meeting with highly paid development company staff and consultants to recreate the development and decision-making process for academic purposes. I commend Mike Heller and the entire project team for their commitment to educating the public on the benefits of green building, and making confidential company resources available to me for educational purposes.

study is to place present values on additional costs incurred due to LEED certification as well as cost savings due to greater efficiencies.

Present Values of LEED Costs

Some developers only assess first costs when considering a sustainable development, especially if the project developers do not retain ownership over the long term. Nevertheless, the first-costs approach, although essential to any financial analysis, can be misleading because many sustainable practices often show their value through savings over time. I needed to aggregate cost savings related to a green component over time and calculate a net present value for the component.

The project team informed me that establishing a baseline for comparison is always a difficult task. Smart design teams will incorporate design measures that earn LEED credits and may not necessarily incur additional costs. The project team suggested that I use the initial designed building as my baseline comparison. This building represents a high-quality Class-A office building and A.P. Thomas provided an estimate of how much this building would have cost to build, and EMCI provided me with an estimate of how much this building would cost to operate.

I will use a discounted cash flow (DCF) model to test the costs and benefits of 2600 Capitol's LEED certification. My process includes the following steps:

- I will use a 25-year holding period and assume 2600 Capitol Avenue is a long-term investment.

- I will first identify each LEED credit that incurred an additional cost to the baseline project budget.
- I will next identify if the cost has an associated monetary benefit. I define a monetary benefit as any cost savings because of increased efficiency when compared to baseline machinery and design.
- I will take the up-front hard and soft costs associated with each credit and use that number as my “initial investment” cost. I will use the cost savings as my cash flow inputs over a 25-year life cycle.
- I will then total all present values, and then I will compare all additional costs to all associated monetary benefits to give me a net present value for LEED certification of 2600 Capitol.

The next chapter will show a detailed analysis of each LEED credit and associated present values when compared to the designed baseline Class-A office building. The chapter will also provide reasons why the tenants of 2600 Capitol Avenue chose to lease the building.

Chapter 4

LEED CERTIFICATION COST/BENEFIT ANALYSIS

Introduction

This chapter provides the results of my cost/benefit analysis of pursuing LEED certification at 2600 Capitol Avenue. This investment decision lends itself for a case study because the project team already gathered the cost and performance data. I have the luxury of plugging in real cost and performance data to a discounted cash flow model, and do not have to make false or unrealistic assumptions about upfront costs or energy savings. I am not claiming my analysis has the same level of financial detail as a developer's would. I know much more goes into a site analysis and *pro forma* of a building. However, my analysis does capture additional upfront costs associated with LEED certification as well as cost savings over time due to greater efficiencies. I will first detail the A.P. Thomas cost sheet and compare the first costs of a proposed Class-A office building and the LEED-Gold building as built. Next, I will detail the energy savings associated with the building's efficient HVAC system when compared to a standard HVAC system of a comparable sized building. Finally, I will present the results of my discounted cash flow (DCF) model and detail the tenant's sentiments of why they chose the building.

Upfront Costs

Whether a green feature adds a construction cost premium depends on the starting point. Green premiums diminish when project teams start the design process with a whole building approach. After the project team discussed project goals and design, A.P.

Thomas developed a construction cost sheet for an office building at 2600 Capitol Avenue. The cost sheet details hard costs for a Class-A office building and also additional hard costs for the LEED-Gold designed building (see Table 4.1).

Table 4.1

2600 Capitol Avenue Construction Costs

CSI Code	Description	Total Value	LEED Costs	Notes
1-01000	GENERAL CONDITIONS	$ 243,470	$12,000	Recycling Program/Documentation
2-02000	SITE WORK	195,506	13,250	SWPPS
3-02800	LANDSCAPING	27,240	4,500	Low water use planting/Added hardscape
4-03000	CONCRETE	494,580	-	
5-04000	MASONRY	10,962	-	
6-05000	STEEL	1,402,624	-	Recycled content in steel is standard
7-06200	CARPENTRY	129,322	-	
8-06400	CABINETRY	16,116	-	
9-07200	INSULATION	27,090	-	
10-0790	WATERPROOFING	235,811	-	
11-0810	DOORS, FRAMES, & HARDWARE	117,976	-	
12-0880	GLASS & GLAZING	1,012,100	20,000	Premium glazing for energy savings
13-0925	EXTERIOR FINISHES	517,318	-	
14-0930	CERAMIC TILE & STONE	106,830	-	
15-0950	ACOUSTIC TREATMENT	-	-	
16-0968	FLOORING	44,390	2,250	Walk-off mat
17-0990	INTERIOR FINISHES	29,800	2,500	No VOC paints
18-1000	SPECIALITIES	75,510	-	
19-1145	SPECIAL EQUIPMENT	-	-	
20-1250	WINDOW TREATMENT	-	-	
21-1300	SPECIAL ROOMS & SYSTEMS	-	-	
22-1400	LIFTS & ELEVATORS	216,000	-	
23-1540	PLUMBING	145,402	12,200	Two showers and two low-flow fixtures
24-1550	FIRE SPRINKLERS	116,435	-	
25-1580	HVAC	448,578	60,000	Premium HVAC unit and controls
26-1600	ELECTRICAL	283,670	23,000	Lighting controls/Premium fixtures

SUBTOTAL		$ 5,896,730	$ 149,700	
LIABILITY INSURANCE	0.9%	53,071	$ 1,347	
OVERHEAD	2.8%	165,108	$ 4,192	
PROFIT	1.0%	58,967	$ 1,497	
TOTAL PROJECT COST		$ 6,173,876	$ 156,736	
OTHER COSTS				
PERMITS & FEES		$ -	$ -	
ARCHITECTURAL FEES		$ -	$ -	
TOXIC REMOVAL		$ -	$ -	
TESTING		$ -	$ -	
PRECONSTRUCTION SERVICES		46,000	-	
SUBTOTAL		$ 46,000	$ -	
LIABILITY INSURANCE	0.9%	$ 414	$ -	
OVERHEAD	2.8%	$ 1,288	$ -	
PROFIT	1.0%	$ 460	$ -	
TOTAL OTHER COSTS		$48,162	-	
TOTAL ALL COSTS		$ 6,222,038	$ 156,736	2.52% above baseline for LEED certification

Source: A.P. Thomas and Heller Pacific (2009)

Table 4.1 shows the hard costs to build a Class-A office building as well as the as-built LEED-Gold building. I added all of A.P. Thomas' construction cost line items for a total of $6,222,038 to construct a Class-A office building. Each line item had a corresponding LEED cost if applicable. Additional costs for LEED totaled $156,736, which is 2.52 percent above baseline construction costs. However, I also added additional LEED fees and other soft costs associated with LEED certification design, engineering, and consulting to my total. Table 4.2 shows all additional costs associated with LEED certification for a total of $192,611 above the $6,222,038 baseline[8]. Using the numbers that Lionakis and Heller Pacific provided me, upfront LEED costs (i.e., the green

[8] It should be noted that the baseline design was a Class-A office building intended to reach above average levels of energy efficiency and natural light. I cannot make assumptions after the fact, but additional costs to get to LEED certification may be higher with less experienced design teams.

premium) for 2600 Capitol Avenue is 3.10 percent above baseline. Now that I have my additional upfront investment calculated, I will next show how I developed my energy savings cash flow to test if the additional upfront investment makes sense.

Table 4.2
Total Project Costs

	LEED Costs	Class-A Office
HARD COSTS		
A.P. THOMAS	$ 156,736	$ 6,222,038
SOFT COSTS		
Lionakis	$ 29,000	$ -
Cunningham Engineering	1,500	$ -
EMCI	3,000	$ -
Subtotal	$ 33,500	$ -
LEED FEES		$ -
Registration	$ 450	$ -
Submittal Review	1,925	$ -
Subtotal	$ 2,375	$ -
TOTAL COSTS	$ + 192,611	$ 6,222,038
Percent above baseline		3.10%

Source: Lionakis and Heller Pacific (2009)

Associated Savings

Each line item in A.P. Thomas' cost sheet does not have an associated operating cost savings. Here is a summary of the additional costs and associated operational savings:

- $12,000 for recycling and documenting construction materials earns two LEED credits but does not provide an operational savings;
- $13,250 for Stormwater Pollution Prevention Plans for Construction Activities (SWPPPS) earns one LEED credit but does not provide an operational savings;

- $4,500 for low-water landscape earns one LEED credit and provides operational savings, but water use data was not available for this study;
- $20,000 for premium window glazing earns one LEED credit and provides operational savings that I will detail in the next paragraph;
- $2,250 for a walk-off mat at the building's entrance earns one LEED credit but does not provide an operational savings;
- $2,500 for using interiors paint without volatile organic compounds (VOC) earns one LEED credit but does not provide operational savings.
- $12,200 for two showers (for bike commuters to bathe) and low-flow fixtures earns two LEED credits and provides operational savings, but water use data was not available for this study;
- An additional $60,000 (base system of $448,578) for an efficient HVAC system earns three LEED credit and provides operational savings that I will detail in the next paragraph;
- $23,000 for lighting controls and premium fixtures earns one LEED credit and provides operational savings that I will detail below.

Given that office buildings are heating and cooling dominated places, electricity costs from heating and cooling usually represent an office building's largest operating expense. My initial meeting with the project team shed light on how efficient 2600 Capitol Avenue really is. I knew the financial attractiveness of this project hinged upon

the energy savings from an efficient HVAC system and who received the benefit of the savings.

Rob Jensen of EMCI Engineering designed 2600 Capitol Avenue's HVAC system and provided me with operating cost modeling data. I met with him to discuss how I should set my baseline energy costs and associated savings due to a high-efficient HVAC system. Rob told me that a standard Title 24 HVAC system in a 60,000 square foot building costs $1.85 to $2.38 a square foot per year. Energy costs range from $111,000 to $142,800 per year given Sacramento's climate, user preferences, and SMUD's electricity rates. My energy cost baseline is the standard HVAC system at $111,000 to $142,800 per year.

Rob informed me that he designed the system to reduce energy consumption, increase net positive cash flow, and increase tenant comfort while maintaining a competitive cost. After one year of data collection and management, Rob told me his efficient system at 2600 Capitol Avenue cost $0.90 to $1.10 per foot, or $54,000 to $66,000 per year. Energy savings due to an efficient HVAC system average $66,900 per year (see Table 4.3).

Table 4.3

Energy Savings

	Cost per Foot Range		Cost per Year Range		Average Savings per Year
Title 24 HVAC Syetm	$1.85	$2.38	$111,000	$142,800	
2600 Capitol Efficient System	$0.90	$1.10	$54,000	$66,000	
Savings			$57,000	$76,800	$66,900

Source: EMCI (2009)

I used the $66,900 in energy savings as my cash flow input for my DCF model because of how Loftworks structures its leases. Most office project owners structure full service gross leases for their tenants. The property owner is responsible for the payment of taxes, maintenance, insurance, and utilities in full service gross leases. The base rent figure includes all of these costs. The tenant is typically responsible for his or her own property insurance, taxes, and any excess utility consumption beyond building standards. The tenant is typically responsible for their proportionate share of any increase in base operating expenses over a base year or expense stop. Meaning, the project owner (Loftworks) realizes the energy savings overtime because it pays the utility costs.

Discount Cash Flow Model of LEED Costs and Benefits

My discount cash flow model is a financial analysis of pursuing LEED certification. The reader should not look at this model as a representation of pursuing development of an office or not. This model is not a representation of the highest and best use of the property. This model assumes that Loftworks previously decided to develop an office building and had a choice between developing a Class-A office building or the LEED-Gold office building as built.

I identified a total upfront cost premium of $192,611 (3.10 percent above baseline) for LEED-Gold certification. The efficient HVAC system saves $66,900 per year in electricity costs and has a 25-year life cycle. I chose an eight percent discount rate because an eight percent return on investment is industry standard in normal times[9]. Upfront costs and long-term benefits associated with LEED certification of 2600 Capitol Avenue produces a net present value (NPV) of $482,900, and an internal rate of return (i.e., required percentage of return to break even or expected level of return on an investment) of 34.7 percent. Not factoring for the time value of money, Loftworks' LEED certification investment should pay for itself in less than three years. Given today's economic climate and real estate market, pursuing LEED certification at 2600 Capitol Avenue makes sense financially and includes many other benefits.

Table 4.4

Discount Cash Flow Model Summary

Total LEED Investment (Upfront Costs)	Cost Savings per Year	Holding Period (years)	Discount Rate	Net Present Value (NPV)	Internal Rate of Return (IRR)
$ (192,611)	$ 66,900	25	8.00%	$ 482,900	34.7%

Why Did Tenants Choose 2600 Capitol Avenue?

I initially wanted to test for increased rents due to LEED certification. I found this task extremely difficult given the declining commercial and office real estate market. Many tenants are re-negotiating current leases and many new office buildings sit empty today. I asked Patrick Malloy of Heller Pacific if 2600 Capitol Avenue achieved above-

[9] See Appendix for the complete discount cash flow model and multiple discount rates.

market rents. He replied “No,” but he also told me they are receiving rent, as opposed to owning a new empty building. Sacramento region office vacancy hovers around 20 percent and close to 10 percent in the Downtown Sacramento market (Colliers 2009). Demand for new office projects remains relatively low and new projects obviously need a way to set them apart from the pact. I decided to ask the current tenants of 2600 Capitol Avenue why they chose the building.

Source: Lionkais
Figure 4.1. 2600 Capitol Avenue Terrace

I sent out an email to the tenants with multiple questions about why they chose the building. Coleen A. Paul, Vice President of Business Development for NORR Architects, and Holly K. Wilson, Environmental Specialist for Science Applications International

Corporation (SAIC), very graciously provided me with details on why they chose the building. I listed my questions and corresponding tenant responses below.

- Why did you choose 2600 Capitol Avenue?
    - *Paul: "The location was very convenient and the architectural design was unique."*
    - *Wilson: "We liked the location in midtown and good parking as we have lots of client meetings. The aspect of the building being green while not the original reason is very much a plus for us. Personally I love all the windows!"*
- Is indoor air quality and energy efficiency important to you and your organization (e.g., is "green building" important to you)? If yes, please explain.
    - *Paul: "The health and well-being of our employees is paramount. Studies have shown that indoor air quality reduces absenteeism and can have a positive effect on the work environment. Our employees like coming to work here everyday!"*
    - *Wilson: "These are very important to our staff, especially from an environment and health perspective. Our business is natural resources planning so concern and benefit to the environment is always at the forefront. In addition, our company at a corporate level has instituted an internal environmental sustainability initiative."*
- Would you pay higher rents for a LEED certified building (when compared to a Class-A office) under normal market conditions? If yes, please explain.
    - *Paul: "Having worked in this building now, which is LEED certified, for nearly six months, I would say absolutely we would pay more for rent."*

- *Wilson: "We are paying the highest rent for any of the offices we considered when anticipating our move last year. In some cases, twice as much."*

- If rents are equal, which is more important to you - a Class-A office building with a prestigious address (Capitol Mall) or an energy efficient building?

  - *Paul: "Because we are an architectural and engineering firm, energy efficiency is more important to us than a prestigious address. If we are to be good stewards of the environment and encourage our clients to be, we have to "practice what we preach.'"*
  - *Wilson: "We are less concerned with a prestigious address like Capitol Mall. Although, we do consider this a prestigious office because of the LEED certification."*

- What will you require out of an office space in the future?

  - *Paul: "We'll want many of the same amenities we have in the 2600 Capitol building now, including LEED certification (silver minimum) for indoor air quality and energy efficiency. We'll also want a quality landlord like Heller Pacific. They have been outstanding to work with and genuinely care about the quality of their buildings and taking excellent care of their tenants."*
  - *Wilson: "Having worked in this green building our sensitivities have been raised significantly, so there is expectation that future office space address similar environmental considerations."*

The responses shed light on how important green building is for environmentally conscious companies. Sustainability is emerging as a major initiative for corporations across the United States. I found a few answers very intriguing. Coreen A. Paul stated

that indoor air quality is very important because it leads to decreased absenteeism and higher productivity. She even said her co-workers enjoy working in the building everyday. Holly stated her company is paying the most in rent out of any building they considered, and twice as much as other considered buildings. I also found both responses interesting when discussing future office space requirements. Both respondents conveyed that sustainable and energy efficient features will be at the forefront of future lease decisions.

Chapter 5

SUMMARY, CONCLUSIONS, AND RECOMENDATIONS

Introduction

This chapter provides a summary of the first four chapters, my conclusions on LEED certification of 2600 Capitol Avenue, policy implications, and provides recommendations for further research and future sustainable development decisions.

Report Summary

The United States needs to cut greenhouse gas (GHG) emissions. Assembly Bill 32 requires California to reduce GHG emissions statewide to 1990 levels by 2020. Four hundred and twenty million Americans will need 190 billion square feet of offices, institutions, stores, and other non-residential buildings in 2050 (Ewing *et al*. 2008). Buildings consume nearly 40 percent of US energy and emit nearly 40 percent of US GHG emissions. The built environment continues to have increased demand for energy capacity each year. The US' largest GHG emission reduction opportunity is through an energy efficient built environment coupled with smart growth land use patterns to reduce vehicle miles traveled. Incorporating green building practices in the built environment slows the rate at which we emit GHG emissions and provides other societal benefits. However, developers and investors need to see sustainable development as an investment decision because they are the ultimate decision makers on what to build.

Costs remain the overriding consideration for project developers not building LEED certified buildings when markets are normal. Some in the industry perceive that the hard and soft costs associated with LEED certified buildings to be substantially

higher than non-certified buildings. The research shows upfront costs increase with higher levels of certification. Research shows a “green premium” ranging from 0 to 6.6 percent above conventional design and construction costs. However, the research shows a minimal cost increase for LEED Certified projects, 0 to 2 percent for Silver, 1 to 5 percent for Gold, and usually above 5 percent for Platinum. Most builders agree that LEED certified buildings cost more to build than conventional buildings, but many also agree that LEED certified buildings provide operational cost savings, environmental benefits, increased productivity, and other societal benefits.

Research shows that US commercial building owners would have a $34 billion energy savings opportunity if all buildings operated at Energy Star efficiency (Broughton 2006). Research also shows LEED buildings use 18 to 39 percent less energy than their conventional counterparts. Further, LEED buildings achieved up to 60 percent energy savings when coupled with the Whole Building Design approach.

LEED certification requires energy usage modeling data. The research shows that energy modeling data is actually very close to building performance data, which should put some skepticism to rest. In fact, the ratio between measured and designed energy usage for more than 5,000 buildings was very close at 0.92 (Turnel and Frankel 2008). However, Newsham *et al*. (2009) points out a very important fact about the LEED certification rating system. Measured energy performance of 100 LEED certified buildings had little correlation with certification level of the building. Meaning, buildings with lower certification levels have achieved energy savings similar to higher-level

certified buildings. The USGBC needs to continue to refine the rating process to ensure consistent metrics for each certification level at the individual building level.

Developers who pay more for energy efficient features most likely assume they can charge tenants higher rents because the investment in energy efficiency is creating a more desirable asset than a conventional building. I think my previous statement is true under normal market conditions, but not today given the recession. The research shows that LEED certified buildings achieved 0 to 10 percent higher rents than conventional buildings and sold for 10 to 25 percent more than conventional buildings. Also, employees seem to be more productive and miss fewer days in well-lit and well-ventilated buildings.

Cost/Benefit Analysis

Chapter 3 presented the process I went through to develop my test for the attractiveness of LEED certification at 2600 Capitol Avenue. I chose a case study approach because every building is different, so researchers should not generalize systems that work in a certain building for buildings across the board. I found out what exactly went into the design and decision-making process. The development community and public should see the entire decision-making process for sustainable development. Recreating the investment decision process showed me that the key to a successful LEED certification process is to define sustainability goals before the team starts work on design.

A.P. Thomas provided a cost sheet to construct an attractive Class-A office building as well as the additional incremental cost for the desired LEED certification. Additional hard and soft costs totaled 3.10 percent above baseline for the as-built LEED-Gold office building. The quantifiable savings came from an efficient HVAC system and savings average $66,900 per year. The additional LEED investment pays for itself in less than three years and the HVAC system has a 25-year functional life if properly maintained. The operational cost savings stay with the project owner given the full service gross lease structures.

Future Research

Researchers should focus future efforts on energy efficiency retrofits for existing buildings. The owner of the Empire State Building is embarking on a multi-million dollar energy efficiency retrofit and is a good starting point for future research. New development will continue to be more and more energy efficient as time goes on. Green building will become the rule and not the exception. The challenge will be enticing owners of existing structures to reduce GHG emissions significantly while simultaneously not putting them out of business.

New federal and state programs try to help existing building owners make energy efficiency improvements with minimal upfront costs. Congress is considering two rebate programs for energy efficiency improvements – Home Star for residential owners, and Building Star for non-residential owners. Without getting into too much detail, the federal government would rebate up to 50 percent of energy efficiency improvement costs from a pre-approved list of improvements. Future research could focus on the cost of rebates

compared to the resulting economic stimulation and GHG reductions. Property Assessed Clean Energy (PACE) financing districts also enable property owners to make energy efficiency improvements with little upfront cost. While not a rebate, PACE financing districts enable property owners to make efficiency upgrades with little upfront cost and payback loans through their property taxes. Both programs have significant potential to both stimulate the stagnant construction industry as well as significantly reduce GHG emissions. Research should also focus on the additional upfront costs of the 2009 LEED v3. New construction will have to follow these more stringent guidelines and the early industry perception is it will cost more than previous LEED rating systems. Research could also focus on how building code revisions make green building more accessible and affordable to all. Research could focus on if the new CalGreen Code helps reduce costs of green building as well as promotes GHG emission reductions.

Conclusions

Sustainable office development makes sense now more than ever. Vacancy rates continue to rise and access to credit is very difficult. As the case with any project, developers need projects that set them apart from the rest of the pack. Sustainable development provides real value and will reshape the United States office market. Because profit margins are so tight, project owners and tenants need to save money through reduced operating costs. LEED certification promotes owners and tenants saving money through reduced operating costs, but is not the final answer.

LEED certification is now pop-culture. LEED certification is a selling point. LEED certification opens the door to prospective tenants and the tenant responses

detailed in Chapter 4 proves it. 2600 Capitol Avenue has tenants today because the building is LEED certified. LEED certification is easily identifiable to tenants and project owners should continue to leverage its fame because certifications help tenants to sign leases. Tenants rightfully feel that they are working in a healthy building and can therefore be more productive and enjoy the building. However, LEED certification alone is not saving money. In fact, LEED certification actually costs more than a conventional building. The additional upfront costs are one-time but the cost savings last for many years.

Project owners really do not need LEED certification to save money. All an owner needs is an efficient building. Developers need energy savings to get their buildings LEED certified, but the certification is simply certifying that their building is performing better than others are. The real value comes in defining sustainability goals early in project design, designing energy efficient and well-sealed buildings, modeling energy usage for efficient HVAC systems, and maintaining those systems. As shown in Loftworks' development of 2600 Capitol Avenue, energy savings from a well-designed building and efficient systems payback all additional LEED costs in a very short time and the certification acts as a recognizable selling point to tenants. Holistic office design usually translates to increased net operating income, which translates into a higher asset class, and the market needs to realize the facts. Sustainable development should become the industry norm.

I think that sustainable office development has not become the industry norm yet because of holding periods. Many project developers have not viewed offices as long-

term assets for quite some time. I asked Rob Jensen of EMCI why all developers are not installing efficient systems in their building. He told me that many developers frankly did not care about efficient systems or their operating costs but they installed what was the cheapest. Project owners would pass the operating costs onto their tenants through triple net leases, build the building and sell it immediately, or sell the building within two years. Commercial and office projects faced the same false-appreciation that residential projects faced during the last unfathomed real estate cycle. Developers were interested in building and selling because the next buyer would not blink an eye at the operating costs.

Energy efficiency is now at the forefront of the national policy agenda and the State of California is ensuring non-residential building owners focus more attention on operating costs and energy usage. California Assembly Bill 1103 from 2007 requires after January 1, 2010, a nonresidential building owner disclose Energy Star Portfolio Manager benchmarking data and ratings, for the most recent 12-month period, to a prospective buyer, lessee, or lender. The law requires electric and gas utilities to maintain records of the energy consumption data of all nonresidential buildings to which they provide service for at least the most recent 12 months. However, The California Energy Commission (CEC) is now tasked with implementation and the CEC will start implementing the law in stages starting January 1, 2011.

My study and policy agendas show tenants and policy makers are now showing more interest in sustainable development and energy usage. I cannot say exactly when, but sustainability will be at the top of prospective office tenants' requirements. Developers will not be profitable over the long haul if they don't recognize the coming

market shift. Developers should focus on building sustainable energy efficient buildings. LEED certification is a result of an efficient building. I'm not saying every building needs to be LEED certified, but I am saying the built environment needs to be energy efficient to meet the needs and wants of future Americans. The way we build will help ease the rate society is emitting GHG emissions into the atmosphere and simultaneously be a sound investment choice. Sustainable development is a real solution, a plan we'd all love to see, and this study is my contribution.

APPENDIX

Table A1

2600 Capitol Avenue Discount Cash Flow Model

	DESCRIPTION	INVESTMENT	NOTES	SAVINGS PER YEAR
HARD COSTS				
(A.P. THOMAS)	General Conditions	$(12,000)	Recycling Program/ Documentation	$ -
	Site Work	$(13,250)	SWPPS	$ -
	Landscaping	$(4,500)	Low water use planting/Added hardscape	N A
	Glass & Glazing	$(20,000)	Premium glazing for energy savings	N/A
	Flooring	$(2,250)	Walk-off mat	$ -
	Interior Finishes	$(2,500)	No VOC paints	$ -
	Plumbing	$(12,200)	Two showers and two low-flow fixtures	N/A
	HVAC	$(60,000)	Premium HVAC unit and controls	$66,900
	Electrical	$(23,000)	Lighting controls/ Premium fixtures	N/A
	Subtotal	$(149,700)		
SOFT COSTS				
(A.P. THOMAS)	Liability Insurance	$(1,347)		$ -
	Overhead	$(4,192)		$ -
	Profit	$(1,497)		$ -
(LIONAKIS)	LBDG	$(29,000)		$ -
(Cunningham Engineering)		$(1,500)		$ -
(EMCI)		$(3,000)		$ -
	Subtotal	$(40,536)		$ -
LEED FEES				$ -
	Registration	$(450)		$ -
	Submittal Review	$(1,925)		$-
	Subtotal	$(2,375)		$-
TOTAL COSTS		$(192,611)		

Table A1 continued

Year	1	2	3	4	5	6	7	8
Savings	$66,900	$66,900	$66,900	$66,900	$66,900	$66,900	$66,900	$66,900

Table A1 continued

Year	9	10	11	12	13	14	15	16
Savings	$66,900	$66,900	$66,900	$66,900	$66,900	$66,900	$66,900	$66,900

Table A1 continued

Year	17	18	19	20	21	22	23	24	25
Savings	$66,900	66,900	66,900	66,900	66,900	66,900	66,900	66,900	66,900

Table A1 continued

TOTAL COSTS	$(192,611)					
	Discount Rate	1%	2%	3%	4%	5%
	NPV	$1,268,058	$1,091,675	$944,008	$819,717	$714,547

TOTAL COSTS	$(192,611)					
	Discount Rate	6%	7%	8%	9%	10%
	NPV	$625,090	$548,611	$482,900	$426,165	$376,948

Table A2

2600 Capitol Avenue LEED Checklist

Credit		Yes	?	No	Lead	Support	Needed	Comments - 7/25/07 LEED Charrette	Hard Cost	Incentives/Comments
Sustainable Sites		9	1	5						
SS p1	Construction Activity Pollution Prevention	Y			APT			7/25/07 LEED Charrette - Local codes meet this requirement.	NAC	APT required to provide Construction Pollution Management Plan per County requirements - included in Bid.
SS c1	Site Selection	1			LBDG			7/25/07 LEED Charrette - Chosen site location meets this requirement.	NAC	Site meets LEED criteria for credit - LBDG to submit documentation for Certification.
SS c2	Development Density & Community Connectivity	1			LBDG			7/25/07 LEED Charrette - Chosen site location meets this requirement.	NAC	Site meets LEED criteria for credit - LBDG to submit documentation for Certification.
SS c3	Brownfield Redevelopment			1				7/25/07 LEED Charrette - Project will not meet requirements.		
SS c4.1	Alternative Transportation, Public Transportation Access	1			LBDG			7/25/07 LEED Charrette - Chosen site location meets this requirement.	NAC	Site meets LEED criteria for credit - LBDG to submit documentation for Certification.
SS c4.2	Alternative Transportation, Bicycle Storage & Changing Rooms	1			LBDG			9/25/07 - LW Transportation Plan will have 8 bicycle parking spaces of which 3 will be Class 1 spaces (bike lockers). LW's Transportation plan earns this credit because it provides more bike parking spaces and lockers than LEED or City Zoning Requirements 7/25/07 LEED Charrette - Space for 7 bikes and 2 showers is required for LEED. City Zoning requires space for 6 bikes (at least 3 of which must be Class I). Therefore only one additional bike space must be provided for LEED over what is required by the City.	N/A	9/25/07 - Cost for bike lockers is not a LEED cost since LW is providing them as part of the Transportation plan required by the EIR.
SS c4.3	Alternative Transportation, Low-Emitting and Fuel-Efficient Vehicles			1	LBDG			9/25/07 - LW decided NOT to dedicate 1 parking space for low-emitting or alternative fuel vehicle pakring. 7/25/07 LEED Charrette - 1 parking space along alley would need to be reserved for low-emitting vehicles.	N/A	
SS c4.4	Alternative Transportation, Parking Capacity	1			LBDG			7/25/07 LEED Charrette - Within LEED project boundary, only seven new parking spaces are being created which is well below minimum local zoning requirements.	NAC	LBDG to submit documentation for Certification.
SS c5.1	Site Development, Protect or Restore Habitat			1				7/25/07 LEED Charrette - Project will not meet requirements.		
SS c5.2	Site Development, Maximize Open Space	1			HLA	LBDG		7/25/07 LEED Charrette - Landscape plan meets credit requirements.	NAC	Landscape plan meets LEED criteria for credit - HLA to submit documentation for Certification.
SS c6.1	Stormwater Design, Quantity Control			1				7/25/07 LEED Charrette - Project will not meet requirements.		
SS c6.2	Stormwater Design, Quality Control		1		CE	HLA	X	9/25/07 - This credit stays in the "?" column until LW meets with the City to determine what, if any, financial assistance can be provided to the project. LW will also check to see if Filterra would be willing to provide "preferred" pricing to LW as a pilot project. 9/17/07 - Contech system has been installed elsewhere in the City and has been approved by Public Works. Filterra is in process of getting their system approved by City. 7/25/0 LEED Charrette - Stormwater Biorentention Filtration System by Filterra is a possible strategy for meeting this credit. Cunningham estimates that 2 units would be needed. Cunningham to coordinate with HLA to work into landscape plan. (Another manufacturer offering a similar product is Contech.)	TBD	Filterra - approx. $25K -- Contech - approx. $16K; Contech is self contained underground system with filtration devices that will require maintenance. Filterra is visible at grade and doubles as a tree planner, using tree roots as part of the filtration system. Requires lower maintenance than the Contech system.
SS c7.1	Heat Island Effect, Non-Roof	1			HLA	LBDG		7/25/07 LEED Charrette - HLA to combine the efforts of selecting high-albedo paving materials with providing shade from trees to make up or cover at least 50% of site hardscape.	NAC	Project will earn credit based on using standard gray concrete.
SS c7.2	Heat Island Effect, Roof	1			LBDG			7/25/07 LEED Charrette - LBDG to choose roofing materials that have an SRI value greater than 78.	NAC	LBDG's standard spec for roofing - light colored TPO single ply roofing will qualify the projec for this credit
SS c8	Light Pollution Reduction			1	HYA			9/17/07 - Desire for ample and safe lighting levels in alley and along building perimeter in conflict with this credit's requirements. 7/25/07 LEED Charrette - Exterior lighting must be carefully designed to meet credit requirement.		
SS c9	Tenant Design and Construction Guidelines	1			LBDG			7/25/07 LEED Charrette - LBDG to assemble information about building's sustainable features and controls to serve as guidance for TI work.		LBDG will prepare guidellines for tenant improvements to meet this requirement. LW must supply the guidelines to potential tenants. Tenants are not required to do LEED Interiors.

Table A2 continued

Credit		Yes	?	No	Lead	Support	Needed	Comments - 7/25/07 LEED Charrette	Hard Cost	Incentives/Comments
Water Efficiency		3	0	2						
WE c1.1	Water Efficient Landscaping, Reduce by 50%	1			HLA			7/25/07 LEED Charrette - HLA to select planting species that will meet credit requirements.	NAC	HLA's design for the irrigation system will meet LEED requirement for this credit.
WE c1.2	Water Efficient Landscaping, No Potable Use or No Irrigation			1				7/25/07 LEED Charrette - Project will not meet requirements.		
WE c2	Innovative Wastewater Technologies			1				7/25/07 LEED Charrette - Project will not meet requirements.		
WE c3.1	Water Use Reduction, 20% Reduction	1			Turley			9/25/07 - LW decides that project will use plumbing fixtures noted below to earn Water Efficiency Credits WE c3.1 & c3.2 and ID c1 - Exemplary Performance 40% Reduction. 9/17/07 - By using dual flush water closets (20 total), low flow urinals (4) and water efficient faucets (16) the project can be up to 48% more efficient than the EPA Water Consumption Baseline Calculation. 7/25/07 LEED Charrette - Turley to investigate the feasibility of using dual flush toilets, 1/8 gallon urinals, low flow shower fixtures, sensored faucets, etc.	9,000	The hard cost is a net cost - $12,000 estimated upcharge for water efficent fixtures less $3,000 estimated savings that water efficient fixtures will generate: smaller domestic water booster pump and smaller water line sizes.
WE c3.2	Water Use Reduction, 30% Reduction	1			Turley			9/24/07 - See WE c3.1. 7/25/07 LEED Charrette - See WE c3.1.	see WE c3.1	
Energy & Atmosphere		4	1	9						
EA p1	Fundamental Building Systems Commissioning	Y			Turley			9/25/07 - LW asked LBDG to get a scope and fee proposal from Turley & Associates. 7/25/07 LEED Charrette - Turley to submit fees/proposal for Commissioning Services.	4,000	The cost is a net cost - $9,000 estimated fee by Turley for Cx less $5,000 Cx incentive from SMUD.
EA p2	Minimum Energy Performance	Y			EMCI			7/25/07 LEED Charrette - Codes meet this requirement.	NAC	By designing to Title 24 baseline standards for energy efficiency, the project meets this requirement.
EA p3	CFC Reduction in HVAC&R Equipment	Y			EMCI			7/25/07 LEED Charrette - Codes meet this requirement.	NAC	Per EMCI, no CFC's will be used on the project.
EA c1	Optimize Energy Performance	3		5	EMCI			7/25/07 LEED Charrette - EMCI to run energy models for new HVAC system (low temperature, dual duct).	NAC	Cost for high efficiency, low temp/velocity dual duct HVAC system by EMCI included in APT Bid amount. EMCI estimates that $30,000 in incentives (see summary tabulation at end of report) can be got from SMUD & PG&E through Savings by Design. EMCI to apply for incentives.
EA c2	On-Site Renewable Energy, 1%			1				7/25/07 LEED Charrette - Project will not meet requirements.		
EA c3	Enhanced Commissioning			1				7/25/07 LEED Charrette - Project will not meet requirements.		
EA c4	Enhanced Refrigerant Management	1			EMCI			7/25/07 LEED Charrette - EMCI to determine feasibility of not using HCFC's in refrigerant equipment.	NAC	Per EMCI, the HVAC system that will be provided will meet LEED requirements for enhanced refrigerant management.
EA c5.1	Measurement & Verification - Base Building			1				9/25/07 - It was agreed and determined by all, with input from EMCI, that this credit, while obtainable, is cost prohibitive to pursue. 9/17/07 - EMCI to provide input on cost of providing measurement and verification systems. Generally, this is an expensive cred to obtain. 7/25/07 LEED Charrette - Review feasibility of requirements.	N/A	
EA c5.2	Measurement & Verification -Tenant Sub Metering			1	EMCI	HYA		9/17/07 - Since no electrical submeters will be provided for tenants, project cannot meet this requirement. 7/25/07 LEED Charrette - Review feasibility of requirements.		
EA c6	Green Power		1		LBDG	HYA	X	9/25/07 - LW will contact SMUD to inquire about the cost for a 2 year contract for Gree Power. Building electrical loading is listed on the SMUD application. This credit will remain in the "?" column until LW decides whether the additional operational costs for Green Power will be incurred. 9/17/07 - SMUD to provide clarification on Green Power rates - typically they are 1/2 to 1 cent per kilowatt hour. Once SMUD provides clarification, load and usage calcs will be used to generate an annual cost for Green Power. 7/25/07 LEED Charrette - LBDG to get price quote from SMUD to enroll this project in their Commercial Greenergy program. 35% Green Power with 2 year contract is needed to meet requirement. Can purchase 70% green power for 2 years to get innovation point.	TBD	This is an annual operating cost that can be included in the lease rate with the tenants.

Table A2 continued

Credit		Yes	?	No	Lead	Support	Needed	Comments - 7/25/07 LEED Charrette	Hard Cost	Incentives/Comments
Materials & Resources		1	6	4						
MR p1	Storage & Collection of Recyclables	Y			LBDG			7/25/07 LEED Charrette - Project will meet requirements.	NAC	LW will need to develop a building recycling plan.
MR c1.1	Building Reuse, Maintain 25% of Existing Walls, Floors & Roof			1				7/25/07 LEED Charrette - Project will not meet requirements.		
MR c1.2	Building Reuse, Maintain 50% of Existing Walls, Floors & Roof			1				7/25/07 LEED Charrette - Project will not meet requirements.		
MR c1.3	Building Reuse, Maintain 75% of Existing Walls, Floors & Roof			1				7/25/07 LEED Charrette - Project will not meet requirements.		
MR c2.1	Construction Waste Management, Divert 50%		1		APT			9/25/07 - This credit remains in the "?" column until APT determines that the construction waste stream will be recycled by Waste Management (WM) even the additional fees are not paid for sorting and tracking. The $7,000 cost is for 1) not having the room at the site for multiple bins and 2) for WM to track the % of recycled waste and providing the documents for LEED certification. If the waste stream will be recycled by WM anyway, LW may not pursue this credit due to it's cost. APT pointed out, however, that WM has indicated that they feel that up to 85% of the construction waste can be recycled - a point bolstered by LBDG by noting that the type of construction waste from the project will primarily be recyclable materials. If this were the case, the project *could* reap up to 3 credits for this effort - MR c2.1, MR c2.2 and a potential Innovation in Design Credit for Exemplary Performance. 7/25/07 LEED Charrette - APT to manage construction waste recycling efforts.	TBD	$7,000 Additional cost per APT to pay service to cart away recyclin because there is not enough room to store and separate materials on site, and to track and document construction waste recovery necessary for LEED certification.
MR c2.2	Construction Waste Management, Divert 75%		1		APT			7/25/07 LEED Charrette - APT to manage construction waste recycling efforts.	TBD	Depending on the volume of construction waste diverted from the landfill stream, this credit may be achievable. This will not be known until construction has been completed. Management and quantification of waste diversion will be part of MR c2.1.
MR c3	Materials Reuse, 1%			1				7/25/07 LEED Charrette - Project will not meet requirements.		
MR c4.1	Recycled Content, 10% (post-consumer + ½ pre-consumer)	1			LBDG	APT		7/25/07 LEED Charrette - Steel will likely meet requirements. LBDG to consider recycled content in finish selections.	NAC	LBDG and APT will garner documentation required to achieve this credit throughout the design and construction process.
MR c4.2	Recycled Content, 20% (post-consumer + ½ pre-consumer)		1		LBDG	APT		7/25/07 LEED Charrette - See above	TBD	Depending on the dollar value of the materials with recycled conten as compared to the total dollar value of construction materials, this credit could be achieved. This will not be known until all materials have been purchased.
MR c5.1	Regional Materials, 10% Extracted, Processed & Manufactured Regionally		1		LBDG	APT		7/25/07 LEED Charrette - LBDG to consider local material manufacturers. Using local wood for the exterior would contribute to this credit.	TBD	As rule of thumb, USGBC allows for 45% of total construction cost for material value. To earn this credit, LW must show that 10% of the material value comes from sources that are extracted, processed and manufactured regionally (500 mile radius from project site). This will not be known until all materials have been purchased.
MR c5.2	Regional Materials, 20% Extracted, Processed & Manufactured Regionally		1		LBDG	APT		7/25/07 LEED Charrette - See above	TBD	See above
MR c6	Certified Wood		1		LBDG	APT		7/25/07 LEED Charrette - LBDG to consider FSC Certified wood for exterior wood products.	TBD	To earn this credit, 50% of the wood used on the project must be from forests certified by the Forest Stewardship Council. It will not be known if the project can achieve this credit until all wood products have been purchased. Most of the wood on the project will be on the exterior elevations and IF this wood comes from FSC certified forests, the project would earn this credit.

Table A2 continued

Credit		Yes	?	No	Lead	Support	Needed	Comments - 7/25/07 LEED Charrette	Hard Cost	Incentives/Comments
Indoor Environmental Quality		7	3	1						
EQ p1	Minimum IAQ Performance	Y			EMCI			7/25/07 LEED Charrette - Codes meet this requirement.	NAC	EMCI to prepare and submit documentation for Certification.
EQ p2	Environmental Tobacco Smoke (ETS) Control	Y			LBDG			7/25/07 LEED Charrette - Codes meet this requirement. Signage is required at entries.	1,000	Designing to State of California Non-Smoking requirements earns this LEED credit for the project. The hard cost is for signage.
EQ c1	Outdoor Air Delivery Monitoring	1			EMCI			9/25/07 - Per EMCI input, the HVAC system will earn this credit. 7/25/07 LEED Charrette - EMCI to determine cost vs. benefit	NAC	
EQ c2	Increased Ventilation			1	EMCI			9/26/07 - Per Rob Jensen, in order to meet this credit, tonnage would need to be added which adds to both construction and operating costs. 7/25/07 LEED Charrette - EMCI t determine if this approach is feasible/desirable.	NAC	EMCI to advise that the HVAC system meets this LEED requirement.
EQ c3	Construction IAQ Management Plan, During Construction	1			APT			7/25/07 LEED Charrette - APT to manage Construction IAQ.	NAC	APT will develop and implement a Construction IAQ plan as part o their Bid. APT will prepare and submit documentation for Certification.
EQ c4.1	Low-Emitting Materials, Adhesives & Sealants	2	1		LBDG	APT		7/25/07 LEED Charrette - Project will meet requirements.	NAC	LBDG will specifiy low emiting adhesives and sealants. These are typically available at no added cost over standard adhesives and sealants. APT to track and manage cut sheets and information regarding VOC content of adhesives and sealants.
EQ c4.2	Low-Emitting Materials, Paints & Coatings				LBDG	APT		7/25/07 LEED Charrette - Project will meet requirements.	NAC	LBDG will specifiy low emiting paints and coatings. These are typically available at no added cost over standard paints and coatings. APT to track and manage cut sheets and information regarding VOC content of paints and coatings.
EQ c4.3	Low-Emitting Materials, Carpet Systems				LBDG	APT		7/25/07 LEED Charrette - Project will meet requirements.	NAC	LBDG will specifiy low emiting carpet systems. These are typically available at no added cost over standard carpet systems. APT to track and manage cut sheets and information regarding VOC conten of carpet systems.
EQ c4.4	Low-Emitting Materials, Composite Wood & Agrifiber Products				LBDG	APT		7/25/07 LEED Charrette - Project will meet requirements.	NAC	LBDG will specifiy low emiting composite wood. These are typically available at no added cost over standard composite wood. APT to track and manage cut sheets and information regarding VOC content of composite wood.
EQ c5	Indoor Chemical & Pollutant Source Control	1			LBDG			7/25/07 LEED Charrette - LBDG will work to make sure walk-off mat requirement fits into overall lobby design.	1,500	LBDG will specify a walk-off mat outside the front entry. This item was not included in the scope of work in the Bid Set.
EQ c6	Controllability of Systems, Thermal Comfort		1		EMCI		X	*9/26/07 - Per Rob Jensen, what is required to earn this credit is the expansion of the base EMS system he is providing with the HVAC system. The number of zones that would need to be added to the EMS would be twice what is now included in the scope of work. The additional cost to earn this credit would be approximately $5,000.* 9/25/07 - At LEED meeting, LW instructed LBDG to get "real" costs from EMCI. 9/25/07 - Per Rob Jensen, he feels that LW can get this credit. He estimates that soft costs would be updwards of **$11,300**. 7/25/07 LEED Charrette - Project will not meet requirements.	TBD	5,000
EQ c7	Thermal Comfort, Design		1		EMCI		X	*9/26/07 - To earn this credit, per Rob Jensen, all we need do is add a humidifier to the HVAC unit. However, in this climate, it will get used only minimally…perhaps 3 times a year, per Rob, given Sacramento's climate. Additionally, in this climate, buildings are not humidified…the climate is not that harsh or dry.* 9/25/07 - At LEED meeting, LW instructed LBDG to get "real" costs from EMCI. 9/25/07 - Rob Jensen feels that LW ca earn this credit but that there will be soft costs of**$6,500**. 7/25/07 LEED Charrette - EMCI to verify that project will meet requirements.	TBD	5,500
EQ c8.1	Daylight & Views, Daylight 75% of Spaces	1			LBDG			9/17/07: LBDG has completed daylight calculations and has confirmed that the project, as designed with full height glazing at the north and east, will achieve this credit. 7/25/0 LEED Charrette - LBDG to determine if requirements are met.	NAC	LBDG to submit documentation for Certification.
EQ c8.2	Daylight & Views, Views for 90% of Spaces	1			LBDG			7/25/07 LEED Charrette - LBDG to determine if requirements are met.	NAC	Design meets this requirement - LBDG will prepare and subimt documentation for Certification.

Table A2 continued

Credit		Yes	?	No	Lead	Support	Needed	Comments - 7/25/07 LEED Charrette	Hard Cost	Incentives/Comments
Innovation & Design Process		5	0	0						
ID c1.1	Innovation in Design - Chemical-free Water Treatment System	1						9/25/07 - Per Rob Jensen/EMCI this work is in the scope of HVAC and he feels LW can get this credit. 9/17/07 - Dolphin Water Treatment System	NAC	Chemical-free water treatment system for HVAC unit part of EMCI's scope. This is in the maybe column because using the Dolphin system is becoming a standard practice. EMCI to prepare and submit docuemntation for Certification.
ID c1.2	Innovation in Design - EMCI's "Energy Reclaim Wheel"	1						9/26/07 - The "Heat Wheel" in EMCI's HVAC System saves 20Kw in cooling capacity and 1/2 million Btu's for heating.Rob Jensen feels that this is an achievable credit. 9/25/07 - At LEED meeting, LW instructed LBDG to get "real" costs from EMCI. 9/25/07 - Per Rob Jensen/EMCI the use of the "Heatwheel Energy Recorvery" for both heating and cooling is in the scope of HVAC and he feels that LW can get this credit. He also feels that his soft costs would tally about**$5,500**. 9/17/07 - Energy Reclaim Wheel	NAC	Per EMCI, the wheel recovers energy from air that otherwise would have been exhausted to the atmosphere. The wheel also saves on installed compressor horsepower and reduces gas use. EMCI to prepare and submit docuemntation for Certification.
ID c1.3	Innovation in Design - TBD	1						9/17/07 - Select one of the alternates listed below.		
ID c1.4	Innovation in Design - TBD	1						9/17/07 - Select one of the alternates listed below.		
Alt	Innovation In Design - Green Housekeeping								TBD	LW and LBDG to work w/ Property Management Vendor to develop and implement green housekeeping procedures.
Alt	Innovation in Design: IAQ Management Plan for Tenant Build Out								TBD	LBDG and APT to develop an Indoor Air Quality Management Plan for Tenants when they are constructing their interior spaces.
Alt	Possible Exemplary Performance - Recycled Materials								NAC	It is possible given the value of the structural steel relative to the tot cost of the core & shell construction materials that the value of the total recycled content could reach the exemplary performance level of 30%. We must wait until the end of the project to determine if this will be the case. It is highly possible and if it bears out, exemplary performance for recycled content is a NO COST credit to pursue.
Alt	Possible Exemplary Performance - Recycled Materials								TBD	9/25/07 - Randy Boehm brought up the idea of presenting the fact that the basement was not torn out and refilled with recycled aggregate is a "good" story for an ID Credit. Jeffrey Justice noted that it could go into the Construction Waste Management diversion credits (MR c2.1 & c2.2)
Alt	Fan Energy Savings								TBD	9/26/07 - Per EMCI, 50% fan energy reduction is realized by using 45 degree discharge air. This is achieved through fan static (energy) control based on VAV Box position: In a conventional office building the fan has an imaginary pressure it wants to control over a 24 hour period. Under this operating procedure, the worst point in the building (usually where the most cooling is needed at any given time) governs the whole HVAC system. This is an extremely inefficient way to run a the system. EMCI's system looks at every VAV so that *any* VAV can drive the system and fan use is based only on demand, not the hottest spot in the building. As fan static (energy) goes down, the discharge temperature goes up and thus the system uses less compressorized energy to maintain a higher discharge temperature.
ID c 2	LEED™ Accredited Professional	1			LBDG			7/25/07 LEED Charrette - All members of LBDG team are LEED AP.	N/A	
		Yes	?	No						
	Project Totals (Pre Certification Estimates)	29	11	21						

Certified 23-27 points **Silver** 28-33 points **Gold** 34-44 points **Platinum** 45-61 points

Hard Costs		
Total Estimated Hard Costs	$15,500	Note - This amount does not include any credits in the "?" column.
LEED Fees		
LEED Registration Fee	450	Paid when Project is Registered
LEED Submittal Review Fee	1,925	Does not need to paid until USGBC review has been completed.
Total Estimated LEED Fees	$2,375	
Soft Costs		
LBDG	29,000	LBDG has already spent $5,000 in LEED support and assessment for LW – fees are based, on average of $1,000 per credit
Cunningham Engineering	1,500	
EMCI	3,000	
Total Estimated Soft Costs	$33,500	
Total Estimated LEED Costs	$51,375	

NAC = No Additional Cost

Table A3

2600 Capitol LEED Summary Matrix

Lionakis Beaumont Design Group

LEED CS v 2.0 Point Summary for LoftWorks 2600 Captiol

Credit		Yes	?	No	Team Lead	Team Support	Action Needed	Comments - 7/25/07 Charrette	Cost Hard	Cost Soft	Incentives
Sustainable Sites		9	3	3							
SS p1	Construction Activity Pollution Prevention	Y			APT			Local codes meet this requirement.			
SS c1	Site Selection	1			LBDG			Chosen site location meets this requirement.	N/A		
SS c2	Development Density & Community Connectivity	1			LBDG			Chosen site location meets this requirement.	N/A		
SS c3	Brownfield Redevelopment			1				Project will not meet requirements.			
SS c4.1	Alternative Transportation, Public Transportation Access	1			LBDG			Chosen site location meets this requirement.	N/A		
SS c4.2	Alternative Transportation, Bicycle Storage & Changing Rooms	1			LBDG			Space for 7 bikes and 2 showers is required. Both of those requirements have been included in the design.			
SS c4.3	Alternative Transportation, Low-Emitting and Fuel-Efficient Vehicles		1		LBDG		X	1 parking space along alley would need to be reserved for low-emitting vehicles.	minimal signage costs		
SS c4.4	Alternative Transportation, Parking Capacity	1			LBDG			Within LEED project boundary, only seven new parking spaces are being created which is well below minimum local zoning requirements.	N/A		
SS c5.1	Site Development, Protect or Restore Habitat			1				Project will not meet requirements.			
SS c5.2	Site Development, Maximize Open Space	1			HLA	LBDG		Landscape plan meets credit requirements.	No additional cost		
SS c6.1	Stormwater Design, Quantity Control			1				Project will not meet requirements.			
SS c6.2	Stormwater Design, Quality Control		1		CE	HLA	X	Stormwater Bioretention Filtration System by Filterra is a possible strategy for meeting this credit. Cunningham estimates that 4 units would be needed. Cunningham to coordinate with HLA to work into landscape plan. (Another manufacturer offering a similar product is Contech.)	approx. $5K per unit x 4 = $20K + Installation Costs of around $4-6K		
SS c7.1	Heat Island Effect, Non-Roof	1			HLA	LBDG	X	HLA to combine the efforts of selecting high-albedo paving materials with providing shade from trees to make up or cover at least 50% of site hardscape.	No additional cost		
SS c7.2	Heat Island Effect, Roof	1			LBDG		X	LBDG to choose roofing materials that have an SRI value greater than 78.			
SS c8	Light Pollution Reduction		1		HYA		X	Exterior lighting must be carefully designed to meet credit requirements. Interior lighting must be placed on controlled shut-off after business hours.			
SS c9	Tenant Design and Construction Guidelines	1			LBDG		X	LBDG to assemble information about building's sustainable features and controls to serve as guidance for TI work.			
Water Efficiency		2	1	2							
WE c1.1	Water Efficient Landscaping, Reduce by 50%	1			HLA		X	HLA to select planting species that will meet credit requirements.	No additional cost		
WE c1.2	Water Efficient Landscaping, No Potable Use or No Irrigation			1				Project will not meet requirements.			
WE c2	Innovative Wastewater Technologies			1				Project will not meet requirements.			
WE c3.1	Water Use Reduction, 20% Reduction	1			Turley		X	Turley to investigate the feasibility of using dual flush toilets, 1/8 gallon urinals, low flow shower fixtures, sensored faucets, etc.			
WE c3.2	Water Use Reduction, 30% Reduction		1		Turley		X	See above			
Energy & Atmosphere		3	4	7							
EA p1	Fundamental Building Systems Commissioning	Y			Turley		X	Turley to submit fees/proposal for Commissioning Services.			SMUD offers 55K for Commissioning Plan.
EA p2	Minimum Energy Performance	Y			EMCI			Codes meet this requirement.			

Table A3 continued

Credit		Yes	?	No	Team Lead	Team Support	Action Needed	Comments - 7/25/07 Charrette	Cost Hard	Cost Soft	Incentives
EA p3	CFC Reduction in HVAC&R Equipment	Y			EMCI			Codes meet this requirement.			
EA c1	Optimize Energy Performance	3		5	EMCI		X	EMCI to run energy models for new HVAC system (low temperature, dual duct).			EMCI estimates incentives from SMUD & PG&E of around $30K.
EA c2	On-Site Renewable Energy, 1%			1				Project will not meet requirements.			
EA c3	Enhanced Commissioning			1				Project will not meet requirements.			
EA c4	Enhanced Refrigerant Management		1		EMCI		X	EMCI to determine feasibility of not using HCFC's in refrigerant equipment.			
EA c5.1	Measurement & Verification - Base Building		1		EMCI	HYA	X	Review feasibility of requirements.			
EA c5.2	Measurement & Verification -Tenant Sub Metering		1		EMCI	HYA	X	Review feasibility of requirements.			
EA c6	Green Power		1		LBDG	HYA	X	LBDG to get price quote from SMUD to enroll this project in their Commercial Greenergy program. 35% Green Power with 2 year contract is needed to meet requirement. Can purchase 70% green power for 2 years to get innovation point.	approx. 1/2 cent per kilowatt hour		
Materials & Resources		2	5	4							
MR p1	Storage & Collection of Recyclables	Y			LBDG			Project will meet requirements.	N/A		
MR c1.1	Building Reuse, Maintain 25% of Existing Walls, Floors & Roof			1				Project will not meet requirements.			
MR c1.2	Building Reuse, Maintain 50% of Existing Walls, Floors & Roof			1				Project will not meet requirements.			
MR c1.3	Building Reuse, Maintain 75% of Existing Walls, Floors & Roof			1				Project will not meet requirements.			
MR c2.1	Construction Waste Management, Divert 50%	1			APT			APT to manage construction waste recycling efforts.			
MR c2.2	Construction Waste Management, Divert 75%		1		APT			APT to manage construction waste recycling efforts.			
MR c3	Materials Reuse, 1%			1				Project will not meet requirements.			
MR c4.1	Recycled Content, 10% (post-consumer + ½ pre-consumer)	1			LBDG	APT		Steel will likely meet requirements. LBDG to consider recycled content in finish selections.			
MR c4.2	Recycled Content, 20% (post-consumer + ½ pre-consumer)		1		LBDG	APT		See above			
MR c5.1	Regional Materials, 10% Extracted, Processed & Manufactured Regionally		1		LBDG	APT		LBDG to consider local material manufacturers. Using local wood for the exterior would contribute to this credit.			
MR c5.2	Regional Materials, 20% Extracted, Processed & Manufactured Regionally		1		LBDG	APT		See above			
MR c6	Certified Wood		1		LBDG	APT		LBDG to consider FSC Certified wood for exterior wood products.			
Indoor Environmental Quality		7	3	1							
EQ p1	Minimum IAQ Performance	Y			EMCI			Codes meet this requirement.			
EQ p2	Environmental Tobacco Smoke (ETS) Control	Y			LBDG			Codes meet this requirement. Signage is required at entries.			
EQ c1	Outdoor Air Delivery Monitoring	1			EMCI		X	EMCI to determine cost vs. benefit			
EQ c2	Increased Ventilation		1		EMCI		X	EMCI to determine if this approach is feasible/desirable.			
EQ c3	Construction IAQ Management Plan, During Construction	1			APT			APT to manage Construction IAQ.			
EQ c4.1	Low-Emitting Materials, Adhesives & Sealants				LBDG	APT		Project will meet requirements.			
EQ c4.2	Low-Emitting Materials, Paints & Coatings	3			LBDG	APT		Project will meet requirements.			
EQ c4.3	Low-Emitting Materials, Carpet Systems				LBDG	APT		Project will meet requirements.			

Table A3 continued

Credit		Yes	?	No	Team Lead	Team Support	Action Needed	Comments - 7/25/07 Charrette	Cost Hard	Cost Soft	Incentives
EQ c4.4	Low-Emitting Materials, Composite Wood & Agrifiber Products				LBDG	APT		Project will meet requirements.			
EQ c5	Indoor Chemical & Pollutant Source Control		1		LBDG		X	LBDG will work to make sure walk-off mat requirement fits into overall lobby design.			
EQ c6	Controllability of Systems, Thermal			1				Project will not meet requirements.			
EQ c7	Thermal Comfort, Design	1			EMCI			Project will meet requirements.			
EQ c8.1	Daylight & Views, Daylight 75% of Spaces		1		LBDG		X	LBDG to determine if requirements are met.	N/A		
EQ c8.2	Daylight & Views, Views for 90% of Spaces	1			LBDG		X	LBDG to determine if requirements are met.	N/A		
Innovation & Design Process		1	4	0							
ID c1.1	Innovation in Design: Exemplary Performance - 40% Water Use Reduction		1								
ID c1.2	Innovation in Design: Exemplary Performance - 70% Green Power		1								
ID c1.3	Innovation in Design: Exemplary Performance - 30% Recycled Content		1								
ID c1.4	Innovation in Design: Green Education Program		1								
Alt	Innovation In Design: Green Housekeeping										
Alt	Innovation in Design: Low Temp/Dual Duct HVAC System										
Alt	Innovation in Design: IAQ Management Plan for Tenant Build Out										
ID c 2	LEED™ Accredited Professional	1			LBDG			All members of LBDG team are LEED AP.	N/A		
		Yes	?	No							
	Project Totals (Pre Certification Estimates)	24	20	17							

Certified 23-27 points **Silver** 28-33 points **Gold** 34-44 points **Platinum** 45-61 points

Table A4
2600 Capitol Avenue Energy Usage Summary

EMC INCORPORATED CONTRACTOR MECHANICAL ENGINEER

1495 NICHOLS DRIVE
ROCKLIN, CA 95765-1306
PHONE 1-916-408-6600
FAX 1-916-408-6606
CONTRACTOR'S LICENSE# 698122

DATE: 11/20/09

TO: HELLER PACIFIC

ATTENTION: MICHAEL J. HELLER

PROJECT: 2600 CAPITOL 60,000 FOOT OFFICE BUILDING UTILITY USE WHY SO GOOD

Michael a standard Hvac system in today's market for a small building is running for a very good system $ 1.85 to $ 2.38 afoot for an average system or in other terms $ 111,000.00 to $ 142,800.00. Here is the good news our super energy efficient systems have been running at $ 0.90 to $ 1.10 a foot or in other terms $ 54,000.00 to 66,000.00 a year. From your current energy bills that I have reviewed you are on track for the 66,000 a year bill or a savings of $ 45,000.00 to $ 76,800 in budgeted operating cost per year. The title 24 energy model shows the base building at the $ 142,800.00. Your current energy bills are running at $ 0.77 a foot and with this new tenant coming on line the first of next year you should hit our design target.

This 41% reduction in energy cost should change the cap rate on this project. The description below is how we can save the money in operating cost and also provide a 25 year life cycle for the Hvac system.

This project has a few green building features that I would like to quickly high light; the first is there is no harmful CFC refrigerant this project. We using 407c HFC **green refrigerant**, which provides 1 LEED, point. This helps by protecting the ozone layer. We use an energy reclaim wheel to capture energy that would be exhaust out of the building to meet the indoor air requirements this save on installed compressor horsepower and gas requirements for heating. The wheel also provides a constant out side air source for a health building and provides 1 LEED point. We also use no chemicals in the treatment of the water in the evaporative cooling section of the unit this is done be using a "Dolphin" that treats the water with an low electrical charge that kills of the organisms that live in the water. This help to **reduce water use** and good for the environment since there are no chemicals that have to be treated in the sewer system. We get 1 LEED point for this feature. The building HVAC is a systems approach, which with the building envelope help it **to better title 24 by 17.9%** which is worth 3 LEED points. Below is a more detailed systems description of the HVAC system for this project and how it works.

The low temperature dual duct change over hvac system has many advantages to a conventional hvac dual duct or hot water reheat systems. A conventional hvac system is designed for a 55 degree supply air discharge or higher; the low temperature system is designed for a 45 degree supply air discharge. This 10 degree difference will allow the low temperature system to use 50% less supply fan horsepower. The hvac fan is the second highest user of electricity in an office building; the first being lighting. This reduced fan horsepower means less air is required to meet the load due to the colder supply air temperature; this means less noise (duct rumble) in the office space.

The second area is the use of energy recover for indoor air quality. We use a heat wheel to recover the energy that would be lost due to the out side air that needs to be brought into the building to meet ventilation standards. The heat wheel works in the summer and the winter, in the summer the out side air (104 degree) is drawn through one half of the wheel and building air (76 degrees} is exhausted past the other half, the wheel absorbs the cold temperature air leaving the building and as the wheel turns into the out side air stream it cools the air from 104 degrees to 84 degrees; these 20 degree difference will save 30 tons of compressor on a 100,000 square foot bldg. and allows it to meet the indoor air quality standards . We also use an airflow station to monitor the quantity of air being brought into the building so you always know you are in compliance with indoor air quality. In the winter the wheel work the same way. The out side air (30 degrees) is drawn through one half of the wheel and building air (72 degrees} is exhaust past the other half, the wheel absorbs the warm temperature air leaving the building and as the wheel turns into the out side air stream it heats the air from 30 degrees to 60 degrees, these 20 degree difference will save heat required in the perimeter office and stop over cooling in the inter space which is a big problem due to the fact these spaces have to meet the min. ventilation standard. We use an economizer for free cooling, as the building requires it.

Table A4 continued

The low temperature air system due to the lower air volumes required to meet the hvac load has a higher percentage of out side air (45% min.) in the supply air; a conventional hvac system has a lower percentage of out side air (15% min.) in the supply air. This means that the low temperature system will be a cleaner smelling and better ventilated office space due to the high percentage of out side air in the supply air and the constant air change rate due to the use of the energy recover heat wheel.

There is no reheat in the dual duct system. This has great energy saving over hot water or electric reheat systems that take cold supply air (55 degree) and heats the supply air up to 110 degrees to meet the heating requirements.

The low temperature dual duct change over system as three modes of operation. The first is the HEAT COOL MODE; this mode is a traditional dual duct system with cold air in one duct and hot air in the other the air is mixed at a vav box to provide min ventilation (cold duct) and heating (hot duct) in a perimeter office. The second mode of operation is VENT COOL MODE; the cold duct fills it traditional roll and the hot duct carries neutral plenum (74 degree) air to the vav box, which will provide a variable air quantity to increase air movement and prevent over cooling by adding heat that is in the plenum that would be wasted. The third mode of operation is PEAK COOL MODE; the cold duct fills it traditional roll and the hot duct now carries cold air to meet the summer load that drives the hvac system. This mode is activated when the out side air temperature is 78 degrees or the DDC system called for itThis system uses the hot duct all year round and by using it for peak cooling it saves on fan horsepower by using the hot duct fan that would sit ideal in the summer. We size the main cooling system to handle 70% of the total cooling load and install 30% in the heat / cooling unit. This saves on the fan sizes in the main cooling unit and ductwork; this with the lower temperature air is the real reason for the big energy savings.

The roof top units are custom built for each project. The units are DX cooling with evaporative condensing. The supply fans are a plug type and controlled by a variable frequency drive with premium efficiency motors. 100% modulating economizer for free cooling, power exhaust for building pressurization controlled by a variable frequency drive and gas fired heaters for heat. The unit's standard filters are 4" pleated 35% filtration this can be increased as desired. The units DDE controls are factory mounted. The Energy recovery system for out side air loads combined with the low temperature dual duct change over system provides the most energy efficient system that is on the market for a competitive price.

The hvac system is controlled by a DDC energy management system (wattmaster). This controls all of the hvac modes of operation, the rooftop units and vav boxes it is a windows based system that has password protection for user. The system has a computer on site for direct access and a modem for off site monitoring and alarm call out. The shell system is set up for 90 vav boxes per floor for a total of 180 vav boxes per building, this can be expanded .The system can have a option that can control site and office lighting and can have a system that will track hvac and or lighting after hours use; this is very valuable with multi tenant building.

Table A4 continued

The zoning will run on perimeter zone 100 to 1200 square foot and inter zones will be sized at 100 to 2000 square foot this will all depend on office configuration. Corner offices, conference rooms, break rooms, etc will all be independent zones. Open office will have larger zones then independent office. The high pressure duct to the vav boxes is spiral to the box inlet (hard connection) all down stream (low pressure) duct work is spiral with flex the last 7'-0" to the low temperature slot diffusers. We use a linear low temperature slot diffuser for all of the tenant improvement space,

The concept behind the variable opening slot diffuser (VSD) is to deliver a variable volume of air at near constant discharge face velocity to the occupied space. The design of the VSD incorporates a movable vane and a fixed curved surface within the body of the slot diffuser. The geomertric center of gravity of the moveable vane forces the vane to the closed position when airflow is absent. Additional closure force is placed on the movable vane by the aerodynamic design of the swinging vane and the fixed airfoil. Airflow across the curved surfaces induces a low-pressure area between the two airfoils. This low pressure varies exponentially as a function of the air volume and tends to drive the free moving airfoil closed. Duct static pressure acts in opposition to the closure forces on the movable vane. Thus a stable, repeatable vane position directly proportional to the volume of air moving through the VSD is established by the dynamic balance of the gravitational and aerodynamic forces on the movable vane. In turn discharge velocity at the face of the VSD remains high and relatively constant throughout the published operational range of the diffuser due to the relationship between the slot opening and the air volume.

The owner will gain many benefits from this system. The first is lower electrical installed cost due to the reduced (30% of conventional hvac systems) electrical demanded; second there is more available space in the main service for the tenant improvements. Heating is reduced by 40% due to the heat wheel and no reheating of conditioned air reducing the gas demand and piping. There are fewer units and these save on structural costs. The system will save $0.03 to $0.06 cents per square foot per mouth this will increase the cap rate and salability of the building.

The bottom line is this we have invested 18 years into this hvac system with project running from 1992 we have 1,563,000 feet running and 80% are repeat customers. We have 325,000 feet permitted and or under construction. We have projects from 45,000-200,000 feet, two to six story. The system is the best bang for the buck for features, comfort and operational costs.

Sincerely,

Rob S. Jensen
President

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