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The *Journal of Sustainable Real Estate* (1949-8276) is published annually by the American Real Estate Society at Clemson University, School of Business and Behavioral Science, Department of Finance, 424 Sirrine Hall, Clemson, SC 29634-1323. Periodicals postage paid at Clemson, SC and at additional mailing offices. Postmaster, please send address changes to: Diane Quarles, Clemson University, College of Business and Behavioral Science, Department of Finance, 424 Sirrine Hall, Clemson, SC 29634-1323. Changes of address, claims and all correspondence dealing with subscriptions should be sent to Diane Quarles, Manager of Member Services, Clemson University, School of Business and Behavioral Science, Department of Finance, 424 Sirrine Hall, Clemson, SC, 29634-1323. Phone 864-656-1373, Fax 864-656-7519 or email equarle@clemson.edu. For more information, visit our website: www.ARESnet.org.
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The quotes below by leaders like Al Gore and Barack Obama set the tone for why we need more research in the area of sustainability, particularly as applied to the field of real estate. We must get it right and we must refrain from biases that serve particular agendas. This independent journal, the *Journal of Sustainable Real Estate*, the first of its kind in the United States, calls upon those interested in fostering truth surrounding the myriad questions of how to become more efficient, healthier, and more productive while recognizing that economics and regulation will drive the market, not environmental evangelists. Those of us focused on real estate, which encompasses where we live, work, shop, and recreate, may not be able to determine if ideas like clean coal are realistic but we can and should investigate the economics driving the market, the true costs, direct and indirect, the management strategies that will support better user and owner decisions, and the state-of-the-art in terms of best practices. These are the types of questions we hope to address in this inaugural issue of the *Journal of Sustainable Real Estate*.

Norm Miller
Editor
*Journal of Sustainable Real Estate*

“By making buildings and homes more efficient, ramping up renewable energy generation, constructing a unified national smart grid, and transitioning to clean and affordable plug-in cars, we can address our country’s economic and national security challenges....In nation after nation, leaders have concluded that they must design a green stimulus and build the infrastructure for renewable sources of energy and put people to work retro-fitting homes and buildings with CO₂ reducing insulation and windows and lighting and more efficient technologies.

We can revitalize our economy, increase our energy security, and do our part to cut global warming pollution, all at the same time.
We’re committed to changing not just light bulbs, but laws. And laws will only change with leadership.” Al Gore, 2007, Nobel Peace Prize Winner.

“For our economy, our security, and the future of our planet, I will set a clear goal as President: in ten years, we will finally end our dependence on oil from the Middle East. Washington’s been talking about our oil addiction for the last 30 years...Now is the time to end this addiction, and to understand that drilling is a stop-gap measure, not a long-term solution. As President, I will tap our natural gas reserves, invest in clean coal technology, and find ways to safely harness nuclear power. I’ll help our auto companies re-tool, so that the fuel-efficient cars are built in America. I’ll invest 150 billion dollars over the next decade in renewable energy—an investment that will lead to new industries and five million new jobs that pay well and can’t ever be outsourced.” August 27, 2008, Barack Obama.

“... to truly transform our economy, to protect our security, and save our planet from the ravages of climate change, we need to ultimately make clean, renewable energy the profitable kind of energy. So I ask this Congress to send me legislation that places a market-based cap on carbon pollution and drives the production of more renewable energy in America. And to support that innovation, we will invest
$15 billion a year to develop technologies like wind power and solar power, advanced biofuels, clean coal, and more efficient cars and trucks built right here in America.” February 24, 2009, President Barack Obama.
Acknowledgements

We thank the CoStar Group and the support its CEO Andrew Florance for funding this journal in full including prizes. We want to make it clear that while CoStar has provided funding to us and data to many researchers, they have always provided total independence and never asked to see any results prior to publication. I am also deeply indebted to Myla Lorenzo-Wilson, who has worked tirelessly on all the communication with authors, provided content and cover designs, and otherwise managed the entire journal and to the Burnham-Moores Center for Real Estate for their support of this journal. Melissa Sharick, a University of San Diego Master of Science in Real Estate student, also provided valuable research support.

This is the first of many issues until such time that sustainable real estate becomes so mainstream that a separate journal is not needed. While it is a peer-reviewed academic journal, we may on occasion accept summaries of prior work or papers published elsewhere in order to disseminate work or perspectives we feel are important. In this vein, there is an Industry Insight section of un-reviewed work that provides some industry perspective.

We know that ambitious academics must work hard to publish in the most well known and respected journals and, as such, a few colleagues whom I had hoped would contribute to this journal have sent their work to more traditional economic and real estate outlets. We recognize it will take time to become known and cited via the traditional economic literature route, but we expect more viral circulation of papers accepted here and will post all accepted papers on our website www.josre.org, which is also generously hosted by CoStar. So thank you to all who have contributed and to those whose papers were not accepted, please keep submitting your papers for review, and we will try and provide constructive feedback. In this regard, we want to thank our Editorial Board, who reviewed papers, as well as the Advisory Board that provides support and encourages submissions from those engaged in applicable research.

On Behalf of CoStar Group

On behalf of CoStar Group, I am very pleased to welcome the publication of the first issue of the Journal of Sustainable Real Estate, and to congratulate the authors whose original research is presented in this inaugural issue.

CoStar Group continues to be an active supporter of academic research involving the built environment. As part of our ongoing efforts to increase awareness of energy efficiency and sustainability issues in real estate, CoStar has joined with the American Real Estate Society (ARES) to sponsor the Journal of Sustainable Real Estate, with the goal of provoking thought and encouraging discussion by publishing a collection of research papers addressing sustainable real estate issues.

Of all the core categories of energy consumption in the United States, the built sector is the least efficient and has the largest potential for cost-effective improvement. Addressing the impact that sustainability practices can have on this major business sector is critical.

And yet, businesses and public sector organizations face a daunting task in confronting the fundamental challenges presented by climate change, population
growth, and resource constraints. If successful, their decisions may lead to the
development of market-leading innovations and technologies and drive changes in
business practices and consumer behavior needed to integrate sustainability on
a large scale and achieve the economic rewards and long-term viability that
sustainable principles offer. However, if we are unsuccessful in meeting those
challenges, we collectively face increased costs, diminished opportunities, and a
very real threat to our future.

Above all, confronting what I believe to be one of the greatest challenges of our
time requires innovative thinking and fundamentally questioning the accepted
status quo in our real estate and business practices. It requires careful consideration
of alternatives, clear-eyed analysis of risks, and thoughtful debate on the merits
of pursing different strategies for securing our future and achieving our long-term
goals.

That is why CoStar is proud to sponsor independent research into sustainable real
estate. In doing so, our goal is to help in a small but meaningful way those
investors, developers, appraisers, lenders, asset managers, government officials,
and land use regulators gain a better understanding of the issues associated with
sustainable real estate practices.

As more and more providers and occupiers of business real estate integrate
sustainability into their business strategies, we believe there will be competitive
advantages for innovative companies to unlock opportunities and capture profitable
growth. Through our support for this journal, our hope is that independent research
in this area can spur additional interest and provide the insight and recognition
that helps bring about those needed changes.

In addition to sponsoring academic research, CoStar offers qualified university
professors and their students access to CoStar’s comprehensive online information
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can be found at www.CoStar.com/JOSRE.

Andrew Florance
Chief Executive Officer
CoStar Group

From the Director of Research at USGBC

Buildings represent a nexus of impacts and opportunities for people and the
environment. We have ample documentation of the far-reaching consequences of
buildings for energy use, water consumption, greenhouse gas emissions, human
health, occupant productivity, and myriad other factors. The magnitude of these
impacts means that the design, construction, and operation of buildings also
provide far-reaching opportunities to reduce negative impacts and ultimately
strive to make active, positive contributions. This convergence of impacts and
opportunities means that buildings must be central to any effort to address the
sustainability of human activities.
Understanding this confluence of impacts and opportunities requires new interdisciplinary approaches and strong connections between theory and practice. As with so many new fields of study, the issues associated with green buildings and real estate do not fit neatly into existing academic categories. Rather, the most pressing and potentially rewarding intellectual challenges are arising at the boundaries and interfaces between disciplines. This new journal provides an urgently needed vehicle for rigorous, peer-reviewed communication for the growing green building research community that strives to bridge these boundaries and create novel scholarship at the confluence of disciplines. Over time, this journal has the potential to become a critical outlet for new work and, consequently, an essential part of the intellectual foundation for this rapidly growing research community.

This journal can fulfill this potential by providing a forum for the rigorous exchange of ideas and seeking an editorial balance that blends concepts and empirical observations to advance both the theory and practice of green building. In this inaugural issue, the editors and contributors have demonstrated this balance with an exceptional collection of papers. Going forward, I encourage the research community to reflect on the example set in this issue and the broader goals and aspirations of this new publication. For me, this reflection leads to a belief that this journal will provide an important outlet for findings that will help shape the future of green building. I am looking forward to working together to fill its pages for years to come.

Chris Pyke
Director of Research
US Green Building Council
Introduction

This issue of the Journal of Sustainable Real Estate begins with a paper by Richard Reed, Anita Bilos, Sara Wilsinson, and Karl-Werner Schulte that compares international sustainable rating tools. While Leadership in Energy and Environmental Design (LEED), developed by the United States Green Building Council (USGBC), is well known in the United States and utilized in over 55 countries, there are many other measurement systems. We can all learn from each other and any model, LEED, CASBEE, BREEAM or Green Star and so forth should be considered works in progress. For example, while LEED is fairly easy to understand and fairly transparent, it may not sufficiently weigh factors that are of most importance in different geographies and climates. Over time, based on the kind of discussion and dialogue presented here and elsewhere, we expect these measurement systems to adapt and improve for their intended purpose.

The second paper, by Sofia Dermisi, is on the effect of LEED rating on office assessed values. It is not clear that appraisers, yet alone assessors, understand much about sustainable real estate features and at the same time some jurisdictions are exempting from property taxes sustainable property improvements, so this will remain an important topic for some time. The third paper is by Franz Fuerst and Patrick McAllister on occupancy rates for eco-labeled office property in the U.S. It is an extension of some of their prior work and continues to support the notion that greener property achieves greater occupancy and in turn supports higher values relative to peer property. The fourth paper is a preliminary effort to understand the role of environment on productivity by Norm Miller, David Pogue, Quiana Gough, and Susan Davis. Using a large data set, this study provides some support for an economic payoff for tenants in buildings with better light and ventilation.

Next we have a paper by Jerry Jackson on the risk of sustainable real estate projects. We then have a series of papers that touch on the challenges inherent in green development. The first, by Jennifer Wang, discusses removing barriers to green development. A second is by Robert Simons, Eugene Choi, and Donna Meister Simons on state and city green policies and market penetration. The third paper is by John Goering on sustainable real estate market penetration. Finally, a paper by Kwame Addae-Dapaah, Liow Kim Hiang, and Neo Yen Shi, Sharon on the sustainability of sustainable real property development. The last paper is by Christoph Rohde and Thomas Lutzkendorf on sustainable investment products, which is a natural follow-up to the four previous papers.

The Industry Insight section contains two pieces that provide some initial industry-based evidence of the impact of green building. We hope this first issue of JOSRE is the springboard for further research and exploration of the green building environment.

Norm Miller
Editor
Journal of Sustainable Real Estate
International Comparison of Sustainable Rating Tools

Authors
Richard Reed, Anita Bilos, Sara Wilkinson, and Karl-Werner Schulte

Abstract
This paper undertakes an international comparison of global sustainability tools and examines their characteristics and differences. Most importantly, it focuses on which tools from different countries can be directly compared with each other (i.e., is a five-star building with one rating system directly comparable with a four-star rating of another rating system?). The results are designed to provide some clarification of the assessment tools for sustainable buildings, which in turn will assist investors, developers, tenants, and government bodies in making informed decisions about green buildings. In addition, it is envisaged that removing some of the uncertainty associated with sustainable buildings will increase transparency for stakeholders and facilitate their acceptance.

There is little dispute now that buildings are substantial CO₂ emitters and contribute substantially to climate change (Reed and Wilkinson, 2008; Wilkinson, Reed, and Cadman, 2008). This argument is based on the large environmental footprint of buildings, especially when considering the high reliance on resources due to an increased reliance on air conditioning and heating. At the same time it has been demonstrated that the value of a building can be linked to the building’s perceived level of sustainability (Myers, Reed, and Robinson, 2008), where the stakeholders include building owners, tenants, and property appraisers or valuers. The problem therefore lies with how to distinguish the level of sustainability in a building, which will facilitate a direct comparison between each building. This is where sustainability rating tools can potentially play a major role.

Many countries have introduced new rating tools over the past few years in order to improve the knowledge about the level of sustainability in each country’s building stock. On one hand, it can be argued that the individual characteristics of each country, such as the climate and type of building stock, necessitate an individual sustainability rating tool for that country. The downside is that to varying degrees the rating tools for different countries are constructed on different parameters. This in turn has created complications for stakeholders, including property investors, who purchase buildings in different countries; an understanding of the many differences between each market has been increasingly harder to understand (Dixon et al., 2008). This paper investigates the evolution of global building rating tools, with a concentration on office buildings. Consideration is given to the different rating tools for sustainable buildings in each country. Furthermore, it examines how rating tools have evolved over time and which
countries and their respective rating tools have contributed to their global uptake. This paper analyses the development of rating tools over time and seeks to provide insight into their positive and negative attributes.

**International Rating Tools**

While it is accepted that there are no identical parcels of land in the world (Australian Property Institute, 2007), in a similar manner every country is also unique. However, there are common approaches to appraising or valuing land/buildings and analyzing property values in each country, although it appears that rating tools have not followed this trend (Exhibit 1). On appearance, they are relatively complex.

While it is possible to directly compare the value of an office building in New York City, Berlin, London or Melbourne using a ten-year discounted cashflow approach (after allowing for exchange rate variations), making a similar direct comparison of the sustainable features and rating of the same building is quite complex. In the past it appears there has been an unwillingness to compromise or admit a particular rating system may not be the possible best tool, which in turn has been a barrier to developing a global rating system (Exhibit 2). The unwillingness to compromise or admit that a rating system may be deficient in certain areas may be due to a lack of knowledge and understanding on the part of those valuing or marketing buildings. A starting point is to reflect on the current development status of rating tools internationally (Exhibit 3). It can be noted that most countries with existing or emerging rating tools have developed economies
Exhibit 2 | Main Rating Tools

<table>
<thead>
<tr>
<th>U.K. and Europe</th>
<th>Americas</th>
<th>Rest of the World</th>
</tr>
</thead>
<tbody>
<tr>
<td>BREEAM (inc Eco-homes)</td>
<td>LEED (U.S. &amp; Canada)</td>
<td>Green Star (Australia)</td>
</tr>
<tr>
<td>Office Scorer</td>
<td>WBDG (Whole Building Design Guide) (U.S.)</td>
<td>LEED (China and India)</td>
</tr>
<tr>
<td>ENVEST</td>
<td>HOK Sustainable Design Guide (U.S.)</td>
<td>Greenmark (Singapore)</td>
</tr>
<tr>
<td>Sustainability Checklists (e.g. SEEDA; BRE)</td>
<td>BREEAM Canada (Canada)</td>
<td>GBTool (South Africa)</td>
</tr>
<tr>
<td>Environmental Impact Assessment (EIA)</td>
<td>Green Globes (U.S. &amp; Canada)</td>
<td></td>
</tr>
<tr>
<td>Strategic Environmental Assessment (SEA)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The sources are RICS (2007) and Green Globes (2009).
and most often there is also a property market where information is readily available. The diverse range of countries and associated climates can be clearly observed.

The next step is to also identify countries that have expressed interest according to the World Green Building Council (WGBC) data (Exhibit 4). In this diagram, it can be observed that these countries predominantly include the Middle East, Africa, and Asia, which are located relatively close to the equator.

Often a rating tool can be linked back to common aspects with other systems, depending largely on the particular influences on each property market. Many rating tools have been modified and adopted from earlier models that were originally developed in other countries. For example, it is possible to trace many systems back to the Leadership in Energy and Environmental Design (LEED) and BRE Environmental Assessment Method (BREEAM) building rating systems (Exhibit 5). The benefits of having a common foundation with LEED and BREEAM may assist with moving towards an internationally-accepted rating tool, especially when there are recent signs of change and compromise. For example, it is reported that three of the most common rating tools, namely BREEAM, LEED, and Green Star, are seeking to develop common metrics that will help international stakeholders compare buildings in different cities using an ‘international language’ (Kennett, 2009).

While there has been fragmentation of rating systems as shown in Exhibit 1, it can be argued that the World Green Building Council has the largest global
coverage (Exhibit 6). There are common links in the United States and Canada, some parts of Europe, Japan, Australia, and South Africa.

The Need for Global Rating Tools

The importance of sustainable development has been mooted for many years since the Bruntland Report (Bruntland, 1987) and has gathered momentum, partly as a result of major economic reports to governments in developed countries, such as the Stern Report to the government in the United Kingdom (Stern, 2005) and the Garnaut Report to the Australian Federal Government (Garnaut, 2007). Both reports, written by leading economists, concluded that a ‘business as usual’ approach with respect of greenhouse gas emissions would lead to global economic and environmental catastrophe in the long term. With Stern and Garnaut accepting the IPCC predictions on climate change, the impetus to the adoption of sustainability within the built environment gathered pace. It is now the case that a majority of professionals and scientists accept that action is needed to mitigate climate change through the reduction of greenhouse gas emissions in particular and the adoption of sustainability practices generally (Reed and Wilkinson, 2008).

The importance of sustainable development for the built environment professions is a point that has been targeted in prominent task forces internationally (DETR, 1999a; Egan, 2004; and Dixon et al., 2008). In addition, the U.K. Government’s Sustainable Development Educational Panel set a target of achieving the inclusion of sustainable development criteria within all course accreditation requirements for the professions and industry lead bodies by 2010 (DETR, 1999b). In response, the major professional body representing land, construction, and property globally,
the Royal Institution of Chartered Surveyors (RICS), adopted sustainability policy principles with the “intention to place sustainability at the heart of all its activities,” (RICS, 2007). Not only do built environment professionals need to learn the rationale for sustainable development and to appreciate the key issues, they need to learn how and when to apply the many environmental assessment tools.

Earlier studies (Upstream, 2003; Pett et al., 2004; and Sayce, Ellison, and Smith, 2004) suggested that there is an increasing focus on providing a ‘business case’ for sustainable development as a result of the emergence of planning policies and EU directives [e.g., the Energy Performance of Buildings Directive (IPF, 2007)]. This is linked with internal corporate drivers, such as the demand for improved risk management and better governance structures to deal with environmental risk in the real estate sector (Ellison and Sayce, 2007). But what assessment tools are at hand for built environment professionals to use to support advice to clients? In addition, what areas do the tools cover and omit? EPSRC (BRE, 2004) found approximately 600 tools that measured or evaluated the social, environmental, and economic dimensions of sustainability. In professional practice, many of these tools can be used with regards to the use and management of rural and natural resources, as well as across the whole lifecycle of buildings from inception and design, construction, and development through to the operation phase and post occupancy-monitoring. As an example, one commonly-used tool in Australia is Green Star, which is equivalent to the LEED and BREEAM rating systems. All of these tools provide a broad ranging assessment of the environmental impact of a building. Each features a suite of tools developed for different land uses such
as commercial, industrial, retail, and educational and health buildings. The issues covered include those relating to the global, local, and internal environments, focusing on design stage assessments (i.e., new build and refurbishment) and also to the ongoing operation and management of the building. Each tool leads to a rating of the building, which is used to market the building. Green Star adopts a star rating from 1 to 6; LEED uses a scale of platinum, gold, silver, and bronze to indicate a higher or lower rating; whereas BREEAM adopts a scale from pass to excellent. The questions therefore include: Are the tools equal or are the standards embraced by one tool markedly different to those adopted by others? Is a 6-Star Green Star rating equal to a Platinum LEED or an Excellent BREEAM score? Furthermore, with increasingly global financial and property markets, do the tools need to be benchmarked in a clear and transparent way? Clearly, some regional variation is appropriate; for example, the ongoing Australian drought implies that water economy measures are of high importance locally, whereas in the northern region of the U.K. where higher rainfall is a result of climate change to-date and water economy is not such an important environmental measure in contrast to arid countries.

Many of these tools measure sustainability of the built environment and have been developed to determine if any capacity exists for further development, or whether a development is sustainable, or whether progress is being made towards sustainable development. ‘Indicators’ are also an important part of the range of the tools available and relate mainly to parameters that can be measured to show trends or sudden changes in a particular condition. It is important to distinguish between those tools used for measurement (identifying variables measuring sustainable development and collecting relevant data), and those used for assessment (evaluating performance against criteria), as well as those tools that can be used to effect a move towards sustainable development by changing practice and procedures (BRE, 2004; Therivel, 2004). In general, the tools are attempting to: achieve continuous improvement to optimize building performance and minimize environmental impact; provide a measure of a building’s effect on the environment; and set credible standards’ by which buildings can be judged objectively.

There are numerous benefits of using assessment tools and also variations between ease of use. For example, the ‘Green Globes’ assessment tool used in Canada and the U.S. is an on-line assessment tool actively promoted as using a ‘streamlined on-line approach’ using an on-line questionnaire that generates a report (Green Globes, 2009). The overall goal is to have a common set of criteria and targets, and these are typically embodied in design guides, which help professionals to design, construct, and manage property in a more sustainable way. One benefit is raising awareness of environmental issues and standards is that the assessment tools recognize and encourage best practice and stimulate the market for sustainable construction and property. This is apparent in the marketing and rental levels achieved by sustainable buildings (PCA, 2008). A further benefit of the tools is that they provide a verifiable method and framework for professionals to use. In many cases, the tools set criteria and standards that go beyond the building codes and regulations in the countries in which they are used. However, it is also
possible to link the tools to government policies and regulations, such as certification and labels and incentive initiatives. The EU Energy Performance Directive is a good example of this in practice. Finally, on an individual building level, the adoption of assessment tools improves property management and prioritization of maintenance and operational needs to enhance sustainability.

Despite the many positive aspects, arguably there are perceived shortcomings with different tools. One of the developers of the LEED tool (Schendler and Udall, 2005) stated that LEED was ‘broken’ and needed to be fixed. The authors argued that there was a disconnect between the concept of LEED and the reality of the tool in use. Firstly, the assessment was prohibitively expensive as designers and owners were increasingly driven by scoring points and not designing sustainable buildings for a particular site and use; a phenomenon term ‘LEED brain.’ The energy modeling adopted by the tool was ‘fiendishly complicated’ and the assessment process crippled by bureaucracy. However, of more concern was Schendler’s observation relating to the “overblown claims for green buildings.” Thus, was it possible that buildings having high LEED ratings were not actually that sustainable? Furthermore, BRE claimed for many years that BREEAM accounted for 40% of all new buildings. When one realizes that only 1%–2% of new stock is added to the total stock each year, it will be many decades before the entire stock is ‘sustainable.’ To-date, the overall building assessment tools, such as BREEAM, LEED, and Green Star, have been voluntary and not mandatory schemes. While the 2003 EU Energy Performance Directive is compulsory, it requires disclosure of energy performance rather than attainment of stringent performance targets. The intention with these tools is to benchmark some key sustainability standards and then over time to increase the standards, so while some are weak in certain areas, changes will occur in future. In summary, evidence suggests that built environment professionals have embraced the SD agenda across many developed countries and are looking to the increased use of assessment tools. As yet, however, we know relatively little about the equivalence of the tools used internationally.

The Development of Rating Tools from an International Perspective

It is generally accepted the current era of rating tools commenced in 1990 with the introduction of the BREEAM rating tool (Exhibit 7). This was followed by the French system HQE and then by the U.S. LEED in 2000. Further analysis of this diagram confirms that the evolution of rating systems into different countries is largely based on the initial rating systems [e.g., BREEAM (Netherlands), LEED (Emirates), and Green Star (South Africa)]. Many of these tools and their relevant websites are listed in Appendix A.

Listed in Exhibit 2 is a summary of rating tools based on a global report of sustainability titled “A Greener Profession” (RICS, 2007) and Green Globes (2009). This has three broad groups: U.K. and Europe, Americas, and Rest of the World. There have also been attempts to classify rating tools on the triple bottom
line criteria—economic, environmental, and social criteria—as per the U.K./Europe Example in Appendix B. Exhibit 8 follows on from the initial concept in Exhibit 2 and therefore groups the existing 38 rating tools based on five distinct geographical regions.

An International Comparison of BREEAM, LEED, Green Star, and CASBEE

BRE undertook a comparison of the four key environmental assessment tools in 2008 and Exhibit 9 illustrates the key comparisons made. The assessment criteria were: launch date, rating scales, information gathering, assessment, third-party validation, certification and labeling, update process, governance, required qualification of assessors, assessor AP CPD requirements, compound annual growth rate, assessment fee, certification fee, cost of appeals, credit interpretation request costs, number of units certified, number of domestic and non-domestic building already certified, and availability of assessment information. Exhibit 8 highlights the considerable variation across the four tools. When the process of certification was evaluated, differences existed. For example, CASBEE has a six-stage process from start to finish, whereas Green Star has nine steps to certification, LEED has eight, and BREEAM has six (BRE, 2008).

Exhibit 10 shows that when BREEAM, LEED, Green Star, and CASBEE are compared across a number of sustainability issues, there is variation in the standards of each scheme. For example, BREEAM sets higher standards for building management compared to LEED and Green Star. LEED and BREEAM score equivalent scores for energy and transport while Green Star falls behind. In terms of health and well-being issues, BREEAM again exceeds the other schemes.
# Existing Rating Tools

<table>
<thead>
<tr>
<th>Continent</th>
<th>Labeling</th>
<th>Country</th>
<th>Web Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>America</strong></td>
<td>LEED*</td>
<td>USA</td>
<td><a href="http://www.usgbc.org/">http://www.usgbc.org/</a></td>
</tr>
<tr>
<td></td>
<td>Green Globes*</td>
<td>USA</td>
<td><a href="http://www.greenglobes.com/">http://www.greenglobes.com/</a></td>
</tr>
<tr>
<td></td>
<td>LEED Canada*</td>
<td>Canada</td>
<td><a href="http://www.ccgbc.org/">http://www.ccgbc.org/</a></td>
</tr>
<tr>
<td></td>
<td>AQUA</td>
<td>Brazil</td>
<td><a href="http://www.vanzolini.org.br/">http://www.vanzolini.org.br/</a></td>
</tr>
<tr>
<td><strong>Europe</strong></td>
<td>Green Building</td>
<td>Europe</td>
<td><a href="http://www.eu-greenbuilding.org/">http://www.eu-greenbuilding.org/</a></td>
</tr>
<tr>
<td></td>
<td>DGNB*</td>
<td>Germany</td>
<td><a href="http://www.dgnb.de">http://www.dgnb.de</a></td>
</tr>
<tr>
<td></td>
<td>PromisE</td>
<td>Finland</td>
<td><a href="http://www.vtt.fi/">http://www.vtt.fi/</a></td>
</tr>
<tr>
<td></td>
<td>LiderA</td>
<td>Portugal</td>
<td><a href="http://www.obedgroup.com">http://www.obedgroup.com</a></td>
</tr>
<tr>
<td></td>
<td>BREEM Netherlands</td>
<td>Netherlands</td>
<td><a href="http://www.dgnb.nl/">http://www.dgnb.nl/</a></td>
</tr>
<tr>
<td></td>
<td>Protocollo Itaca</td>
<td>Italy</td>
<td><a href="http://www.itaca.org/">http://www.itaca.org/</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Italy</td>
<td><a href="http://www.gbciitalia.org">http://www.gbciitalia.org</a></td>
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<tr>
<td></td>
<td>Minenergie*</td>
<td>Switzerland</td>
<td><a href="http://www.minergie.ch/">http://www.minergie.ch/</a></td>
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<td></td>
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<td>Poland</td>
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<td></td>
<td>VERDE</td>
<td>Spain</td>
<td><a href="http://www.energycertification.org">http://www.energycertification.org</a></td>
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<tr>
<td><strong>Asia</strong></td>
<td>LEED Emirates*</td>
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<td><a href="http://www.escool.gohsphere.com/default.aspx">http://www.escool.gohsphere.com/default.aspx</a></td>
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<td>LEED India*</td>
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<td><a href="http://www.cgbci.org/">http://www.cgbci.org/</a></td>
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<tr>
<td></td>
<td>TGBRS India</td>
<td>India</td>
<td><a href="http://www.terlin.org/">http://www.terlin.org/</a></td>
</tr>
<tr>
<td></td>
<td>CASBEE*</td>
<td>Japan</td>
<td><a href="http://www.ibec.or.jp/CASBEE/">http://www.ibec.or.jp/CASBEE/</a></td>
</tr>
</tbody>
</table>

30.05.2009 not verified

*Certification Systems / Rating Tool
### Exhibit 9 | Comparison of BREEAM, LEED, Green Star, and CASBEE

<table>
<thead>
<tr>
<th></th>
<th>BREEAM</th>
<th>LEED</th>
<th>Green Star</th>
<th>CASBEE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Launch Date</strong></td>
<td>1990</td>
<td>1998</td>
<td>2003</td>
<td>2004</td>
</tr>
<tr>
<td><strong>Ratings</strong></td>
<td>PASS / GOOD / VERY</td>
<td>Certified / Silver / Gold / Platinum</td>
<td>One Star / Two Star / Three Star / Four Star / Five Star / Six Star</td>
<td>C / B+ / A / S</td>
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<tr>
<td><strong>Weightings</strong></td>
<td>Applied to each issue category (consensus based on scientific/open consultation)</td>
<td>All credits equally weighted, although the number of credits related to each issue is a de facto weighting</td>
<td>Applied to each issue category (industry survey based)</td>
<td>Highly complex weighting system applied at every level</td>
</tr>
<tr>
<td><strong>Information Gathering</strong></td>
<td>Design / management team or assessor</td>
<td>Design / management team or Accredited Professional</td>
<td>Design team</td>
<td>Design / management team</td>
</tr>
<tr>
<td><strong>Third-Party Valuation</strong></td>
<td>BRE</td>
<td>N/A</td>
<td>GBCA (Green Building Council of Australia) nominated assessors</td>
<td>Third-party agencies e.g., JSBC (Japan Sustainable Building Consortium)</td>
</tr>
<tr>
<td><strong>Certification labeling</strong></td>
<td>BRE</td>
<td>USGBC (United States Green Buildings Council)</td>
<td>GBCA</td>
<td>JSBC</td>
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<tr>
<td><strong>Update Process</strong></td>
<td>Annual</td>
<td>As required</td>
<td>Annual</td>
<td>As required</td>
</tr>
<tr>
<td><strong>Governance</strong></td>
<td>UK Accreditation Service (UKAS)</td>
<td>USGBC</td>
<td>GBCA</td>
<td>JSBC</td>
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<tr>
<td><strong>Required qualification</strong></td>
<td>Competent persons scheme</td>
<td>Passed exam</td>
<td>Training scheme and exam</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Assessor / AP CPD requirements</strong></td>
<td>Carry out at least one assessment per year</td>
<td>No CPD requirements</td>
<td>Status renewed every three years</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Comparison of BREEAM, LEED, Green Star, and CASBEE

<table>
<thead>
<tr>
<th></th>
<th>BREEAM</th>
<th>LEED</th>
<th>Green Star</th>
<th>CASBEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment Collation Fee*</td>
<td>£2000–£10000 ($3971–19857)</td>
<td>Up to £37,770 ($75000)</td>
<td>£2015–4030 ($4002–8004)</td>
<td>Unknown</td>
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<tr>
<td>Certification fee</td>
<td>£740–£1500 ($1469–2979)</td>
<td>£1133–£11331 ($2250–22500)</td>
<td>£2550–£7185 ($5063–14268)</td>
<td>Unknown</td>
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<tr>
<td>Cost of credit appeals</td>
<td>Free</td>
<td>£252 ($500)</td>
<td>£403 ($800)</td>
<td>Unknown</td>
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<tr>
<td>Credit interpretation requests</td>
<td>Free/unlimited number</td>
<td>£111 ($220) unlimited number</td>
<td>Free/Maximum of two</td>
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<tr>
<td>cost/allowance</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Number of units certified**</td>
<td>110808</td>
<td>1823</td>
<td>50</td>
<td>23</td>
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<tr>
<td>Domestic</td>
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<td>Non-Domestic</td>
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<td>1283</td>
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<td>23</td>
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<tr>
<td>Availability of assessment</td>
<td>Estimator tools are available free of charge. Guidance is currently only available to people who attend the training courses</td>
<td>The tools are available free of charge and technical guidance is available for £100 ($200)</td>
<td>The tools are available free of charge and the technical manual is available for £224 ($444)</td>
<td>The assessment tool and guidance is available free of charge in Japanese and English.</td>
</tr>
<tr>
<td>information</td>
<td></td>
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</tbody>
</table>

Notes: The source is (BRE, 2008). Amounts are in £ and U.S.$ using these exchange rates: £0.50360 = US$1; £0.40311 = AUS$1; US$0.80445 = AUS$1.

*Assessment costs for different schemes may include varying tasks. This makes a direct comparison difficult.

**As of February 2008.
Exhibit 10 | Issue Weightings Comparison Table

<table>
<thead>
<tr>
<th>Category</th>
<th>BREEAM</th>
<th>LEED</th>
<th>Green Star</th>
<th>CASBEE&lt;sup&gt;a&lt;/sup&gt;</th>
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<tbody>
<tr>
<td>Management</td>
<td>15</td>
<td>8</td>
<td>10</td>
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<td>Energy</td>
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<td>25</td>
<td>20</td>
<td></td>
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<tr>
<td>Transport</td>
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<td>Water</td>
<td>5</td>
<td>5</td>
<td>12</td>
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<td>Materials</td>
<td>10</td>
<td>19</td>
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<tr>
<td>Landuse</td>
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<tr>
<td>Ecology</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pollution</td>
<td>15</td>
<td>11</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Sustainable Sites</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The source is BRE (2008).

<sup>a</sup>It is not possible to calculate the value of each category as the value is dependent on the final score.

Not surprisingly, when considering the record-breaking drought conditions in Australia, the water conservation standards in Green Star are the highest compared to the other schemes. BREEAM in the U.K. has the highest standards with respect to land use and ecology where the density of the population is highest. Overall, the schemes promote standards reflecting local sustainability issues and environmental conditions.

When BRE assessed each of the schemes under a normalized set of conditions across all the rating criteria, the following results were found, as shown in Exhibit 11 (BRE, 2008). From the outset it is clear that LEED, Green Star, and CASBEE assessments are not equivalent to BREEAM. In a hypothetical scenario, a six-star Green Star building (the highest Green Star rating possible) is less sustainable than a platinum LEED building (the highest LEED rating possible) and approximately equal to a ‘very good’ BREEAM-rated building.

Lack of Consistency in Baseline Assumptions

Building code or building regulation standards vary from country to country and one of the assumptions in comparisons has been that all countries are starting from the same baseline standard. This is not always the case however; for example, building code standards in the U.S. are lower than those found in the U.K. Building Regulations (BRE, 2008). The reliance on local building standards as a
minimum starting point for the systems means that the ratings they subsequently award are affected. Therefore, the LEED system sets lower standards than the U.K. BREEAM system. The Australian Green Star system also has lower standards than the U.K. BREEAM system. This is an issue for businesses wishing to set global standards across their property portfolios, because choosing any one standard may lead to lower rating for their properties in some countries than if they followed the local system.

The Difficulties with Comparing Rating Tools

So far this analysis has focused on the different countries and their respective rating tools, as well as the characteristics of each tool. The next step is to consider a direct comparison of the eleven rating tools based on fifteen different assessment criteria, as shown in Exhibit 12. A notable observation from this matrix confirms that every assessment criteria is considered by at least one rating tool, although importantly no single rating tool addresses all fifteen criteria. It can be argued that this is due to the differences between climate zones as previously noted, although the lack of flexibility here can also be argued.
### Exhibit 12 | A Broad Comparison of Rating Tools

<table>
<thead>
<tr>
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</tr>
<tr>
<td>Economy</td>
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<td>X</td>
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<td></td>
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<td>Health and Wellbeing</td>
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<td>?</td>
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<td>?</td>
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<td>X</td>
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<td>X</td>
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<td>X</td>
<td>X</td>
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<td>?</td>
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<td></td>
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<td>?</td>
<td>X</td>
<td>X</td>
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<td>X</td>
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<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: The source is King Sturge (2009).

? Data for DGNB-Seal, HQE, and Protocol ITACA is not exhaustive and additional criteria may be included in the assessment.

*a Code for sustainable homes.
Conclusion

A study by BRE (2008) concluded that there are high levels of variation between the systems for the same ‘grade’ or ‘rating’ than might be expected. For example, BREEAM Excellent, LEED Platinum, and a 6-Star Green Star office building are not equivalent in terms of sustainability features or environmental impact (BRE, 2008). Both Green Star and LEED, when applied to U.K. buildings, rated those buildings higher than the U.K. BREEAM assessment method. Overall, BRE stated that none of the systems they examined (BREEAM, CASBEE, LEED, and Green Star) traveled well in terms of comparison.

For the market of international assessment to mature, additional transparency is required between the various assessment methods. While some tools are promoted as complex and are relatively expensive, others are wholly on-line and cost substantially less; such differences between rating tools increases the level of confusion with users who are not 100% familiar with or perhaps new to global rating tools. Transparency should lead to increased competition among the rating tools, and produce an environment that tends towards improvement of standards as owners compete to demonstrate their commitment to the environment and the highest possible standards of performance. Standards markets work more effectively if common metrics are agreed upon for key issues, such as greenhouse gas emissions for example. Common standards are a pre-requisite for the next stage of development. Eventually a market may emerge where licensing, cross certification, and multiple labeling occurs. Such a system would allow owners to buy into local market standards, as well as regional and international standards (BRE, 2008).

This paper has conducted an investigation into the international evolution of sustainable rating tools for buildings, predominantly office buildings. While it has now been widely acknowledged that buildings are a major contributor to CO₂ emissions, the focus is on how to use rating tools from a global perspective. In an era of international property investment where it is possible to directly compare values of individual buildings in different countries with a view to potential acquisition, unfortunately rating tools do not exhibit the same level of comparability due to their unique characteristics and focus. This in turn may hinder the take-up rate of sustainable rating tools and also be a barrier to increasing the knowledge about sustainability and buildings.

There are some key recommendations for this discussion as follows:

A global set of ‘benchmark’ parameters should be established for building rating tools in order to reduce the barriers between international markets and associated confusion. It is suggested a starting point is zero net emissions, which would allow buildings to be compared within each country and also between each country.

The individual characteristics of each country must not be overlooked when seeking to standardize rating tools. For example, water is a climate change issue in the U.K. (due to too much water hence flooding) and also in Australia (but due
to lack of water or drought). Accordingly, it is not possible to use the same rating tool in each country.

Consideration should be given to all buildings, not just new high-profile trophy buildings. The largest offenders to sustainability are older buildings (Reed and Wilkinson, 2006).

Further research should be conducted into global rating tools from an objective perspective for the betterment of international stakeholders. While there are positive and negative characteristics associated with each rating tool, it is important to continue to monitor their success with regards to their take-up rate and implementation. After considering all of the efforts to increase sustainability in the built environment, it is critical that the goal of more sustainable buildings is not hindered by the absence of a truly international rating system.

### Appendix A

#### Websites of Relevant Sustainability Tools

<table>
<thead>
<tr>
<th>Rating Tool</th>
<th>Website</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>BREEAM (Building Research Establishment Assessment Method)</td>
<td><a href="http://www.breem.org">www.breem.org</a></td>
<td>Created in the UK in 1990.</td>
</tr>
<tr>
<td>Canada Green Building Council</td>
<td><a href="http://www.cagbc.org">www.cagbc.org</a></td>
<td></td>
</tr>
<tr>
<td>Colombia Green Building Council</td>
<td><a href="http://www.cccs.org.co">www.cccs.org.co</a></td>
<td></td>
</tr>
<tr>
<td>DGNB (Germany)</td>
<td><a href="http://www.dgnb.de">www.dgnb.de</a></td>
<td>Commenced in 2008.</td>
</tr>
<tr>
<td>Emirates Green Building Council</td>
<td><a href="http://www.emiratesgbc.org">www.emiratesgbc.org</a></td>
<td></td>
</tr>
<tr>
<td>Germany Green Building Council</td>
<td><a href="http://www.gesbc.org">www.gesbc.org</a></td>
<td></td>
</tr>
<tr>
<td>Green Building Council of Brazil</td>
<td><a href="http://www.gbcbrazil.org.br">www.gbcbrazil.org.br</a></td>
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</tr>
<tr>
<td>Green Building Council of South Africa</td>
<td><a href="http://www.gbcsa.org.za">www.gbcsa.org.za</a></td>
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<tr>
<td>India Green Building Council</td>
<td><a href="http://www.igbc.in">www.igbc.in</a></td>
<td></td>
</tr>
<tr>
<td>Japan Sustainable Building Consortium</td>
<td><a href="http://www.jgbc.com">www.jgbc.com</a></td>
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</tbody>
</table>
## Appendix A (continued)

### Websites of Relevant Sustainability Tools

<table>
<thead>
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<th>Rating Tool</th>
<th>Website</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mexico Green Building Council</td>
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<td>Province of Ontario</td>
<td><a href="http://www.gov.on.ca">www.gov.on.ca</a></td>
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</tr>
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<td>Toronto and Regional Conservation Authority</td>
<td><a href="http://www.trca.ca">www.trca.ca</a></td>
<td></td>
</tr>
<tr>
<td>UK Green Building Council</td>
<td><a href="http://www.ukgbc.org">www.ukgbc.org</a></td>
<td></td>
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<tr>
<td>U.S. Green Building Council</td>
<td><a href="http://www.usgbc.org">www.usgbc.org</a></td>
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</tr>
<tr>
<td>Vietnam Green Building Council</td>
<td><a href="http://www.vsccan.org">www.vsccan.org</a></td>
<td></td>
</tr>
</tbody>
</table>
## Appendix B

### Main Tools Used in the U.K. and Europe: ‘Mind the Gap’?

<table>
<thead>
<tr>
<th>Tool/Technique</th>
<th>Checklist, Toolkit/Other</th>
<th>Property</th>
<th>Environmental</th>
<th>Social</th>
<th>Economic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BRE Sustainability Checklist for Developments</td>
<td>Checklist/toolkit</td>
<td>Commercial and residential</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>This Checklist provides practical tools and indicators to measure the sustainability of developments (both buildings and infrastructure) at site or estate level.</td>
</tr>
<tr>
<td>BRE Office Scorer Rating system</td>
<td>Rating system</td>
<td>Commercial</td>
<td>Present</td>
<td>Absent</td>
<td>Present</td>
<td>The tool compares major or complete refurbishment with complete redevelopment, and redevelopment within an existing facade.</td>
</tr>
<tr>
<td>BREEAM</td>
<td>Rating system</td>
<td>Commercial and public</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>BREEAM stands for the Building Research Establishment Environmental Assessment Method. BREEAM is a method for assessing the environmental quality of buildings. It considers design issues that affect the global environment, local environment and the health and well being of building occupants.</td>
</tr>
</tbody>
</table>
## Appendix B (continued)

**Main Tools Used in the U.K. and Europe: ‘Mind the Gap’?**

<table>
<thead>
<tr>
<th>Tool / Technique</th>
<th>Checklist, Toolkit / Other</th>
<th>Property</th>
<th>Environmental</th>
<th>Social</th>
<th>Economic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EcoHomes</td>
<td>Rating system</td>
<td>Residential and public</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>EcoHomes is the homes version of BREEAM. It provides a comprehensive rating for new, converted or renovated homes, and covers both houses and apartments.</td>
</tr>
<tr>
<td>Envest 2</td>
<td>Software tool / toolkit</td>
<td>All</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
<td>Envest 2 is a software tool that simplifies the otherwise very complex process of designing buildings with low environmental impact and whole life costs.</td>
</tr>
<tr>
<td>Environmental Impact Assessment (IAIA)</td>
<td>Set of techniques</td>
<td>All</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>International Association for Impact Assessment is a forum for advancing innovation, development and communication of best practice in impact assessment.</td>
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<tr>
<td>SEEDA Sustainability Checklist</td>
<td>Checklist / Toolkit</td>
<td>All</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>This Checklist is designed to be used by those involved in planning or building sizeable developments from estates to urban villages and regeneration projects.</td>
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<tr>
<td>Strategic Environmental Assessment</td>
<td>Set of techniques</td>
<td>All</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>A website with a variety of tools and useful links for SEA.</td>
</tr>
</tbody>
</table>

Note: The source is RICS (2007).
References


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Effect of LEED Ratings and Levels on Office Property Assessed and Market Values

Author Sofia V. Dermisi

Abstract This study examines the effect of Leadership in Energy and Environmental Design (LEED) ratings and certification levels on Assessed (AV) and Market Values (MV), while controlling for a property’s characteristics and its location. The overall dataset was developed by combining information from CoStar Group, U.S. Green Building Council (USGBC), and local Assessors/Treasurer. The results indicate that ENERGY STAR designation increases AV and MV substantially. The effect of LEED rating/level on both of these values (AV and MV) can be differentiated based on the level of geographic aggregation. LEED-Existing Building (EB) designation at the Gold level has a strong positive effect on AV, while LEED-EB at the Silver level has a similar effect on both AV and MV. This effect is absent among all LEED-EBs, when controlling only for MSAs. LEED-New Construction at the Gold level has a strong positive effect on MV, while LEED-Core & Shell at the Gold and Silver levels almost doubles that effect on AV, when controlling for MSAs.

Scientists raised their concerns over the environment for many years, but climate changes (IPCC, 2007) and improved green technologies have increased the top-down political and bottom-up civic engagement in enhancing the protection of our planet. Real estate is among the many industries increasingly pursuing green technologies, because it affects both the environment (natural and built) and the occupants it houses. The real estate industry in the United States currently uses three primary sustainable rating systems, with the goal of decreasing the environmental impact of a facility through improved efficiency: ENERGY STAR (launched by the U.S. Environmental Protection Agency and the Department of Energy in 1992), Leadership in Energy and Environmental Design—LEED [launched by U.S. Green Building Council (USGBC) in 1998], and Green Globes (initiated by the Canadian Standards Association and evolved through time with the participation of multiple private and public organizations).

The interest of property owners and managers on environmentally-friendly interventions for existing buildings and green development of new buildings is mushrooming throughout the U.S., due to the cost savings realized in the short and long run Return On Investment (ROI) (Denise, 2007; Burr, 2008; IBT, 2008; Turner 2008). The growing professional interest combined with the data availability is leading to a growing amount of academic research in this area.
(Eichholtz, Kok, and Quigley, 2009; Fuerst and McAllister, 2008; Miller, Jay, and Florance, 2008). Departing from other studies, this paper analyzes assessor determined values (market values and assessed values) of LEED office buildings based on their certification rating (New Construction, Existing Building, Core & Shell, and Commercial Interior) and levels (Platinum, Gold, Silver, and Certified). The only restrictions imposed on the dataset were on the building size (above 50,000 sq. ft. of rentable building area) and classification (only A or B). This new perspective on the performance of LEED office buildings as evaluated by a third party (assessor) will provide an additional benchmark for the evaluation of their future performance.

Literature Review

The combination of publicly accessible information on both ENERGY STAR and LEED certified buildings, along with the establishment of a critical data mass for research purposes, has led to an increasing volume of academic research on the effect of ENERGY STAR rating and LEED on property rents and sales prices. A series of three recent studies in the U.S. focused on controlled experiments with a “green” group of LEED and ENERGY STAR buildings and a controlled group of buildings with similar, but “non-green” characteristics. Eichholtz, Kok, and Quigley (2009) find that rents/sq. ft. and sales prices were roughly 3% and 16% respectively higher for their “green” group. Miller, Jay, and Florance (2008) find similar trends on average rent/sq. ft. levels (control group $28, LEED $42.15, and ENERGY STAR $30.5) and building values (LEED 9.9% and ENERGY STAR 5.3%). Fuerst and McAllister (2008) derive similar results on the significance of their “green” group for rent/sq. ft. (control group $24.68, LEED $27.07, and ENERGY STAR $29.34) and sales price.

In addition to the academic research field, a number of organizations are surveying executives on sustainability and green development. A global survey by Jones Lang LaSalle and CoreNet Global (JLL, 2008) in 2008 clearly shows the increasing interest in sustainable buildings, which will eventually pressure buildings currently not pursuing green technologies to reevaluate their future strategy to remain competitive. Two key findings were that: “a) three-quarters of companies consider energy and sustainability issues as a “major” or “tie-breaker” factor in making location decisions; b) corporate tenants report greater scarcity of green space that meets their needs today than a year ago.” Turner Construction (2008) interviewed commercial real estate executives after the credit market crises began and the results of their survey showed a sustained interest in the benefits of green buildings even in this difficult economic environment, because of the “lower ongoing costs (energy, operating costs)” and market performance (values, rents). The vast majority of executives also indicated their interest to pursue LEED certification for new construction. IBT’s (2008) survey of financial institution executives had similar results for new construction as the Turner survey. They also highlighted a number of sustainable initiatives currently in place by the executives’ organizations (e.g., energy efficient lighting, recycling, etc.) leading to decreased
operating costs. Among the cases highlighting the LEED effect on Return on Investment (ROI) by USGBC is that of Adobe Towers, with an ROI of 120% and a 9.5-month payback (Denise, 2007). A more general reference on a survey conducted by the Building Owners & Managers Association (BOMA/International), USGBC, and the Real Estate Forum found that 65% of respondents acknowledged a 5% increase in their ROI compared to the year before due to their green investments (Burr, 2008).

Data

This study uses assessor-generated values (total assessed values\(^2\) and market values\(^3\)) of LEED office buildings throughout the U.S. for three reasons. The first is the difficulty in obtaining the actual transaction prices of properties throughout the U.S. with certain characteristics. In addition, properties constructed recently might have not transacted at all. The use of assessor-generated values is, therefore, the closest proxy one can use for a property’s valuation. The third reason this route was chosen was the lack of any work we are aware of on this area and the creation of a benchmark to which future studies can compare their results to and evaluate changes in the way properties are assessed.

The study’s focus on assessors’ valuations required information gathering from multiple sources. Although some aggregations were available on LEED ratings, levels and general property information, market values, and assessed values required extensive research of local (county and city) assessor/treasurer offices throughout the U.S. The sources of information included:

- **CoStar Group:** This was the first source used to extract information on buildings with rentable building area of 50,000 sq. ft. or more with Class A & B classification and LEED designation throughout the U.S. The data fields gathered included: the building’s geocoding (longitude and latitude), number of stories, building class (A or B), Rentable Building Area (RBA), year built, type of tenant (single vs. multi), owner (private or public (government or educational), ENERGY STAR status, and LEED certification. Information was partially available and gathered on property valuation and it was compared with the information gathered from the local assessors’ records.

- **U.S. Green Building Council (USGBC):** The second source verifying and enriching the CoStar Group data with specific information on the LEED rating\(^4\) and certification\(^5\) levels achieved by each building.

- **County/City Assessors and Treasurers websites across the U.S.:** They provided information on property assessment levels for 2008. Total Assessed Values (AV) were available in most cases, as well as Fair Market Values (MV). In the cases where AVs\(^6\) were available without MVs, additional research was done to identify the appropriate assessment ratio used and backtracked to the MV. In forty-two cases, the property was tax exempt, but the MV was recorded by the assessor and, therefore, the dataset with MVs are slightly larger from the one with AVs.
It should be noted that a number of states, counties, and cities offer a variety of property and other tax-related incentives (Nellen and Miles, 2007) promoting green development and renovation. The Database of State Incentives for Renewables & Efficiency (DSIRE) offers the most comprehensive aggregation of all incentives at the state and local level throughout the U.S. As of July 2009, DSIRE reported state-related property tax exemptions or special assessments for renewables in 24 states. Local governments in three states (Virginia, New Hampshire, and Vermont) are authorized to offer exemptions and five states (Colorado, Iowa, Maryland, New York, and Rhode Island) offer state level exemptions or special assessments and local government options. In addition to DSIRE, USGBC publishes a quarterly report named “Summary of Government LEED Incentives,” which provides updates on LEED incentives in counties, cities and towns throughout the U.S.

The data were gathered from February of 2009 through the summer of 2009 with the overall dataset reaching 351 office buildings across 36 states (Exhibit 1). This overall dataset was then divided into two subgroups: MVD included properties with available market values (275, also shown broken down in Exhibit 1 in parentheses) and AVDs included other properties with assessed values (266). Regardless of overall dataset or subgroup, Class A properties dominate the data gathered (Exhibit 1). The vast majority of property is privately owned (mainly due to CoStar Group, which concentrates on private properties) (Exhibit 1). The distribution among the different LEED designations shows that 200 buildings were LEED-New Construction, 85 were LEED-Existing Buildings, 51 were LEED-Core & Shell, 6 were LEED-Commercial Interiors, and 9 were not specified. The certification level of the 351 buildings ranged from Platinum (highest) to Certified (lowest), with 24 Platinum properties, 120 Gold, 124 Silver, one Bronze (not currently used by USGBC), and 82 Certified.

**Methodology**

The main goal of this study is to examine the effect of certain property characteristics (ENERGY STAR designation, rentable building area, year built, property class, type of tenant, and owner) and LEED designations (rating and level) on their assessed and market values. The initial overview in Exhibits 1–10, which allocates selected property characteristics and LEED designations (rating and level) by state, is complemented with Exhibits 11–13, which provide the average values of: rentable building area, year built, assessed, and market values by LEED rating and level.

A few regression models were considered, but three were finally used: a robust OLS regression (Equation 1, Exhibit 14), a maximum likelihood spatial error regression (Equation 1-1), and a fixed effects regression (Equation 2, Exhibit 14).
## Exhibit 1 | Overview of Key Data by U.S. State

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## Exhibit 1 | (continued)
Overview of Key Data by U.S. State

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Notes: Values in parenthesis represent the count of properties with available market values. If a property was tax exempt and did not have a market value it was excluded. An additional 34 properties were excluded because of the lack of market value information.

NA = Not Available.
Exhibit 2 | LEED-NC Distribution

Exhibit 3 | LEED-EB Distribution
Exhibit 4 | LEED-CS Distribution

Exhibit 5 | LEED-Platinum Distribution
Exhibit 6 | LEED-Gold Distribution

Exhibit 7 | LEED-Silver Distribution
Where:

- \( Y = \) The log of total assessed value or market value;
- \( i = \) Takes the values 1 through 74 representing the different MSAs included in the data;
- \( ES = \) The ENERGY STAR dummy (takes value 1 if the building is ENERGY STAR, otherwise it is 0);
- \( RBA = \) The rentable building area;
- \( YB = \) The year built;
- \( BC = \) The building classification dummy (takes value 1 if the building is Class A, otherwise it is 0);
TW = A tenant dummy (takes value 1 if the building is multi-tenant, otherwise it is 0);

OW = An owner dummy (takes value 1 if the building is private, otherwise it is 0);

$LEED_{kj} = k$ represents the different types of LEED rating (e.g., NC, etc.) and $j$ the different levels of designation (e.g., platinum etc.).

Based on the size of the data, the following pairs were examined:

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<th>LEED-NC &amp; Platinum</th>
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<td>LEED-NC &amp; Silver</td>
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<td>LEED-EB &amp; Certified</td>
<td>LEED-CS &amp; Certified</td>
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All of the $LEED_{kj}$ variables were dummies, taking the value 1 based on their designation at the time and are 0 otherwise.
\( \beta \) = A “vector of coefficients”;
\( X \) = Represents all the independent variables from the original OLS model;
\( \lambda \) = The spatial autoregressive parameter;
\( W_e \) = The spatial weight matrix;
\( \mu \) = A “vector of homoscedastic and uncorrelated errors;” and
\( \eta_i \) = Different for each MSA accounting for the differences.

The OLS model did not include any variables accounting for the geographic location of properties such as State or Metropolitan Statistical Area (MSA) dummies, but additional testing on spatial dependence was performed. With the use of each property’s geocoding information (longitude & latitude), a spatial weight matrix was determined using Euclidean distance.9 Developing this spatial weight matrix allowed the testing of the OLS model for spatial error and lag dependence at the lowest possible geographic level (property level). Three tests of spatial error dependence were performed (Moran’s I, simple Lagrange multiplier, and robust Lagrange multiplier), along with two tests of spatial lag dependence (simple Lagrange multiplier and robust Lagrange multiplier) (Anselin, Bera, Florax, and Yoon, 1996). The results from Equation 1 provide partial
### Exhibit 11 | Averages of RBA & Year built Trends by LEED Certification

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NA = Not Available.
### Exhibit 12 | Averages of RBA & Year Built Trends by LEED Certification (with Assessed Values)

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<td>22</td>
<td>185,178</td>
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<td>4</td>
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<td>1984</td>
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NA = Not Available.
### Exhibit 13 | Average Assessed & Market Value Trends by LEED Certification (with Assessed Values and/or Market Values)

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<tr>
<th>Certification</th>
<th>Count</th>
<th>AAV</th>
<th>AMV</th>
<th>Count</th>
<th>AAV</th>
<th>AMV</th>
<th>Count</th>
<th>AAV</th>
<th>AMV</th>
<th>Count</th>
<th>AAV</th>
<th>AMV</th>
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</thead>
<tbody>
<tr>
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<td>31,300,000</td>
<td>45,600,000</td>
<td>51(53)</td>
<td>44,200,000</td>
<td>52,300,000</td>
<td>42(45)</td>
<td>23,300,000</td>
<td>28,900,000</td>
<td>33(34)</td>
<td>23,400,000</td>
<td>26,900,000</td>
</tr>
<tr>
<td>EB</td>
<td>9(9)</td>
<td>53,700,000</td>
<td>54,700,000</td>
<td>24(26)</td>
<td>52,900,000</td>
<td>70,600,000</td>
<td>29(29)</td>
<td>87,600,000</td>
<td>105,000,000</td>
<td>13(13)</td>
<td>26,900,000</td>
<td>38,700,000</td>
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<tr>
<td>CS</td>
<td>1(1)</td>
<td>7,865,453</td>
<td>7,865,453</td>
<td>16(16)</td>
<td>43,900,000</td>
<td>62,100,000</td>
<td>22(22)</td>
<td>39,300,000</td>
<td>47,000,000</td>
<td>4(4)</td>
<td>8,986,388</td>
<td>14,000,000</td>
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<tr>
<td>CI</td>
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<td>15,000,000</td>
<td>15,000,000</td>
<td>4(4)</td>
<td>12,800,000</td>
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<td>434,880</td>
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<td>7,350,003</td>
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<td>28,700,000</td>
<td>28,700,000</td>
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<td>30,000,000</td>
<td>32,100,000</td>
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**Values per square foot of rentable building area**

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<th>Count</th>
<th>AAV</th>
<th>AMV</th>
<th>Count</th>
<th>AAV</th>
<th>AMV</th>
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<th>AAV</th>
<th>AMV</th>
<th>Count</th>
<th>AAV</th>
<th>AMV</th>
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</thead>
<tbody>
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<td>NC</td>
<td>6(7)</td>
<td>116.33</td>
<td>138.54</td>
<td>51(53)</td>
<td>182.97</td>
<td>221.79</td>
<td>42(45)</td>
<td>131.51</td>
<td>161.90</td>
<td>33(34)</td>
<td>95.04</td>
<td>126.55</td>
</tr>
<tr>
<td>EB</td>
<td>9(9)</td>
<td>181.61</td>
<td>184.69</td>
<td>24(26)</td>
<td>179.00</td>
<td>219.57</td>
<td>29(29)</td>
<td>240.93</td>
<td>286.94</td>
<td>13(13)</td>
<td>95.85</td>
<td>141.36</td>
</tr>
<tr>
<td>CS</td>
<td>1(1)</td>
<td>131.83</td>
<td>131.83</td>
<td>16(16)</td>
<td>201.86</td>
<td>253.41</td>
<td>22(22)</td>
<td>206.25</td>
<td>237.04</td>
<td>4(4)</td>
<td>58.92</td>
<td>106.71</td>
</tr>
<tr>
<td>CI</td>
<td>1(1)</td>
<td>150.00</td>
<td>150.00</td>
<td>4(4)</td>
<td>86.53</td>
<td>88.40</td>
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**Notes:** The values in parenthesis represent the count of the MVD.

ARBA: Average Rentable Building Area
AYB: Average Year Built
AAV: Average Assessed Value
AMV: Average Market Value
NA = Not Available.
evidence of spatial dependence and, therefore, a spatial error model was applied (Equation 1-1) (Anselin and Hudak, 1992). Another model was also developed to test the effect of MSA level aggregation of the dataset (Equation 2). Due to concerns over contagions, multicollinearity tests were performed on all regression models derived from Equations 1 and 2 and no evidence was found. A final test performed to check for the stability of the results based on their statistical significance included the clustering of the assessed value subset by assessed values per square foot. Ten groups were determined using average-linkage clustering with Euclidean distance as the dis(similarity) measure (Exhibit 15). From the 10 groups generated, the most populated were groups 1 through 3. Each of the three groups was then isolated from the overall data and the results from Equations 1 and 2 were re-estimated. These results did not have significant differences from the original assessed value subgroup dataset based on MSAs and therefore the original fixed effects regression was used.

Results
The approach offered in this study provides interesting insights on the effect of property characteristics and LEED ratings/levels on assessed and market values, even though it is a departure from the controlled experiments of the recent literature. The restricted dataset of office buildings with more than 50,000 square feet of RBA and only A or B classification allows for an in-depth look of a relatively homogenous group with properties sharing the same use and partial characteristics. Exhibit 1 is the first introduction of the full extent of the dataset to the reader with volume allocation among all the states represented. A few observations can be made based on this exhibit. ENERGY STAR designation is found only on 17.4% of the overall number of properties in the dataset, which is a relatively low percentage considering their LEED designation. This low percentage shows that the full adoption of green strategies is still in its infancy. A good sign is that Class A properties are more easily embracing LEED designation (71.5% of the overall dataset) compared to Class B. This is partially expected, because Class A properties are usually newer and more likely to be constructed as LEED; they might also be more easily retrofitted to accomplish LEED designation faster than Class Bs, which might be lagging behind due to upfront cost, time required for retrofit, and payback period requirements imposed by the owner (e.g., if the owner is planning to sell the property in few years and the LEED payoff is beyond that timeframe, the owner is not motivated to pursue the retrofits). This argument is also reinforced by the analysis of the distribution of LEED ratings in the overall dataset. As expected, the LEED-NC designation outnumbers the other ratings in the overall dataset, with 56.9% when LEED-EB follows with 24.2%. The concentration of LEED-NC also indicates the commitment of the development community in accomplishing a more sustainable environment. Further examining the LEED levels, two are the most frequently accomplished in the overall dataset; Silver 35%, closely followed by Gold 34%. These levels are ranked by LEED as third and second highest. Accomplishing these levels is another indication that properties pursuing LEED designation are focused on levels beyond the minimum certification. The final element presented
in Exhibit 1 is the ownership distribution, which, as expected, is skewed significantly (80% of the overall dataset) towards private ownership, because CoStar Group is mainly focused on private properties.

Exhibits 2–4 show the geographical distribution of the overall dataset’s LEED ratings throughout the U.S. The comparison of these figures shows that LEED-NC is distributed more evenly throughout the country compared to the other two ratings. California, which has embraced environmental incentives throughout the years, has the highest number of buildings of all LEED ratings. The two other adjacent states of Oregon and Washington have increased concentration of LEED-NC and CS in the dataset, although LEED-CS is less prevalent in the dataset.

Exhibits 5–8 show the geographical distribution of LEED certification levels across the U.S. The number of Platinum level properties per state is very limited and, therefore, a conclusion cannot be drawn. In contrast, Gold and Silver level properties have more observations in the overall dataset, allowing for a better assessment of their distribution. Gold level properties are more evenly distributed throughout the U.S. compared to Silver-rated properties, which seem to be more concentrated along the West and East Coasts. Certified properties are more concentrated along the east and southern portion of the U.S.

Exhibits 9 and 10 show the geographical distribution of private and public LEED properties across the U.S. California and Oregon share a higher concentration of private LEED buildings, as does Texas and Colorado. Other adjacent states with similar levels of concentration in the public sector are Wisconsin, Illinois, and Missouri. Although the data are skewed towards the private sector, because one of the main sources is CoStar Group, some government facilities are also included. Their distribution is more linear from one coast to the other in our dataset compared to a more diversified allocation in the private sector.

Exhibits 11–13 offer additional insight on the dataset beyond aggregate counts by highlighting the average Rentable Building Area (RBA) and Year Built by LEED rating and level. Exhibit 11, which refers to the overall dataset of 351 properties, shows that LEED-EB buildings are larger in size on average compared to all other LEED ratings followed by LEED-NC (Gold level is the only exception). A further comparison between LEED-NC and EB trends for the various certification levels leads to two conclusions: (1) on average, New Construction (NC) is smaller in size compared to Existing Buildings (EB), because of the increased efficiency offered in new buildings; (2) on average, large EBs are able to accomplish LEED—Gold and Silver. This finding is another indication of the commitment and belief of owners and managers in sustainability and reduction of operating costs even for larger buildings, which will require an increased upfront investment in green technologies. Focusing on the average year built of the NCs, it is interesting to see mid to late 1990s, which is an indication that the properties included are not only the ones built after 2000, but there are older properties too, which went through major renovations with substantial retrofitting (adaptive reuse) to accomplish this rating rather than opting for LEED-EB. The Core & Shell type of LEED designation also seems to have larger in size properties in the Gold and Silver levels, but the lack of a significant number of observations in the
Platinum and Certified levels cannot help in generalizing this result. Exhibit 12's dataset overview focuses only on properties with Assessed Values (266 properties). Even though Assessed Values were not available for all properties (no data were available for 34 properties and 42 were tax exempt), the overall trends of Exhibit 11 remain almost the same. The only exception can be found on LEED-NC Silver buildings, which have a smaller on average size compared to LEED-CS of the same level of designation. Exhibit 13 focuses on the Average Assessed (AVD: 266 properties) and Market Values (MVD: 275 properties) found in the two subsets. The table shows both the total value and the value per square foot, as well as the subset sizes. Comments can be made on the Gold, Silver levels of NC, EB, and CS, because of the more significant number of observations. Although the total AAV and AMV are higher for EB-Gold properties, because of the size of these properties, when the value/sq. ft. is considered, LEED-EB Gold comes in to third place compared to CS and NC at the Gold level. In contrast at the Silver level EB properties and NC and CS share the same ranking between total assessed value and value/sq. ft. This indicates that although EB properties are larger (based on Exhibit 12), their value is also high. Another observation on the value/sq. ft. comparison among NC, EB, and CS is that the CS rating seems to overshadow both NC and EB ratings at the Gold level with higher values/sq. ft. A cause might be the smaller number of properties compared to the other two categories. At the silver level, the CS rating seems to accomplish the second highest values/sq. ft. with EB being the first. Very interestingly, NC is not ranked first in either the Gold or the Silver levels. At the Gold level the property sizes (based on Exhibit 12) are smaller for NC compared to CS, which means that the value proposition offered by this properties might not be similar to those of slightly large size with other ratings. In the case of Silver NCs, their size is, on average, even smaller compared to EB and CS and their value proposition per square foot is even less.

Exhibit 14 provides the result of the regression modeling (Equations 1, 1-1, and 2). Columns 1 through 6 show the results of the spatial dependence analysis (Equation 1), while controlling for the property’s location through its geocoding information. The p-values, which are zero in some cases, are indicative of strong spatial effects (Equation 1, columns 1 through 6). Equation 1-1 was developed to address the spatial dependence issues, by also analyzing the effect of property characteristics and LEED ratings/levels on AV and MV (columns 1-1 through 6-1). The focus, therefore, shifts on analyzing the results of LEED rating and level, based on Equation 1-1 and Equation 2. The results of Equation 1-1 indicate that MV decreases by 36% \[\exp(-0.45)\] for LEED-NC at the Silver level compared to the other LEED properties. Although this result was not expected, looking in Exhibits 12 and 13 we see that the values registered for LEED-NC Silver were the lowest compared to all other ratings and levels. In contrast, LEED-EB Gold and Silver properties have a positive and statistically significant effect on AV and MV. LEED-EB properties at the Gold level are associated with a 77% increase in AV compared to other LEED properties, while LEED-EB at the Silver level are associated with a 118% increase in AV and a 95% increase in MV compared to the other LEED properties. LEED-CS does not seem to have a statistically significant effect on AV or MV, with properties at the Certified level.
### Exhibit 14 | Regression Modeling

<table>
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<tr>
<th>Equation 1 Models</th>
<th>Equation 1-2 Models</th>
<th>Equation 2 Models</th>
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<tr>
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**Property Characteristics**

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<th>Rentable Building Area</th>
<th>Year Built</th>
<th>Building Class</th>
<th>Type of Tenant</th>
<th>Type of Owner</th>
<th>LEED Type &amp; Level of Certification</th>
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<tbody>
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<td>0.98</td>
<td>3.66**</td>
<td>1.01</td>
<td>0.27</td>
<td>0.08</td>
<td>0.51</td>
<td>LEED-NC &amp; Platinum</td>
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<tr>
<td>0.90</td>
<td>4.31**</td>
<td>0.01</td>
<td>0.34</td>
<td>0.17</td>
<td>0.09</td>
<td>LEED-NC &amp; Gold</td>
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<tr>
<td>0.79</td>
<td>2.71**</td>
<td>0.01</td>
<td>0.31</td>
<td>0.14</td>
<td>0.06</td>
<td>LEED-NC &amp; Silver</td>
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<tr>
<td>0.99</td>
<td>3.42**</td>
<td>0.01</td>
<td>0.36</td>
<td>0.16</td>
<td>0.07</td>
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<td>0.92</td>
<td>3.89**</td>
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<td>0.27</td>
<td>-0.31</td>
<td>0.04</td>
<td>LEED-EB &amp; Platinum</td>
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<td>4.50**</td>
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<td>0.27</td>
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<td>-1.97**</td>
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<td>-1.97**</td>
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<td>0.79</td>
<td>3.35**</td>
<td>0.01</td>
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<tr>
<td>0.61</td>
<td>2.53**</td>
<td>0.01</td>
<td>1.06</td>
<td>0.08</td>
<td>0.04</td>
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<tr>
<td>0.97</td>
<td>4.05**</td>
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<td>0.01</td>
<td>1.06</td>
<td>0.28</td>
<td>0.04</td>
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**Notes:**
- **LEED-NC & Platinum**
- **LEED-NC & Gold**
- **LEED-NC & Silver**
- **LEED-NC & Certified**
- **LEED-EB & Platinum**
- **LEED-EB & Gold**

---

### Effect of LEED Ratings and Levels
**Exhibit 14**  (continued)

Regression Modeling

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<tr>
<th></th>
<th>Equation 1 Models</th>
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<th>Equation 1-1 Models</th>
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<th>Equation 2 Models</th>
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<td>6</td>
</tr>
<tr>
<td></td>
<td>AV1</td>
<td>MV1</td>
<td>AV1</td>
<td>MV1</td>
<td>AV1</td>
<td>MV1</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>1.86***</td>
<td>1.52</td>
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<td>−0.08</td>
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<td>−0.13</td>
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**Exhibit 14** (continued)

Regression Modeling

<table>
<thead>
<tr>
<th>Equation 1 Models</th>
<th>Equation 1-1 Models</th>
<th>Equation 2 Models</th>
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<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>AV1</td>
<td>MV1</td>
<td>AV1</td>
</tr>
</tbody>
</table>

**Spatial error:**
- Moran's I
  - AV1: 6.99 (0.00)
  - MV1: 4.89 (0.00)
  - AV1: 5.34 (0.00)
  - MV1: 6.81 (0.00)
  - AV1: 4.63 (0.00)
- Lagrange multiplier
  - AV1: 44.09 (0.00)
  - MV1: 21.15 (0.00)
  - AV1: 49.71 (0.00)
  - MV1: 24.99 (0.00)
  - AV1: 42.44 (0.00)
  - MV1: 19.15 (0.00)
- Robust Lagrange multiplier
  - AV1: 2.79 (0.00)
  - MV1: 0.86 (0.00)
  - AV1: 6.33 (0.00)
  - MV1: 2.42 (0.00)
  - AV1: 0.78 (0.00)
  - MV1: 0.13 (0.00)

**Spatial lag:**
- Lagrange multiplier
  - AV2: 42.12 (0.00)
  - MV2: 21.64 (0.00)
  - AV2: 43.39 (0.00)
  - MV2: 22.87 (0.00)
  - AV2: 44.10 (0.00)
  - MV2: 21.58 (0.00)
- Robust Lagrange multiplier
  - AV2: 0.82 (0.00)
  - MV2: 1.35 (0.00)
  - AV2: 0.01 (0.00)
  - MV2: 0.30 (0.00)
  - AV2: 2.44 (0.00)
  - MV2: 2.56 (0.00)

**Notes:**
The dependent variable is log(total property assessed or market value). Values in the second line of each variable represent t-statistics. Multicollinearity testing of all models presented in this table were negative. For AV1 and AV2, N = 266; for MV1 and MV2, N = 275.

AV: Assessed Value.
MV: Market Value.

**Dummy variable.**

**Adj. R² for FE regressions.**

**Statistically significant at the 5% level.**

**Statistically significant at the 10% level.**
being the only exception. The negative effect at the Certified level is biased, because of the small number of observations (see Exhibits 12 and 13).

The model in Equation 2 was then developed to analyze the effect of the property and LEED independent variables while accounting for the location of properties at the MSA level (columns 7 through 12 in Exhibit 14). The designation of a building as ENERGY STAR (ES) has a positive effect on both Assessed and Market Values (AV and MV) in all cases. Although a relatively small portion of the dataset had an ES designation (almost 20% for the AVD and MVD), it seems to be affecting the valuation process significantly among LEED properties, as a distinctive feature, adding to AV and MV. An increase in the RBA is also associated with a small increase in AV and MV in all cases. The year built is the only property variable without a consistent effect on MV in four out of the six cases. The results indicate that an increase of the Year Built (YB) by one year is associated with a 1% increase in AV or MV, when controlling for LEED-NC, EB properties. YB is not statistically significant in the LEED-NC and LEED-CS cases. Very interestingly, building class and tenant and owner types were consistently not statistically significant in all cases. Focusing on the LEED-NC results of columns 7 and 8, we see that LEED-NC properties at the Gold level are associated with a 50.7% increase in MV, while their AV is not affected and is statistically significant. In contrast, the AV and MV of LEED-NC properties at the Silver level are affected negatively by 51.3% and 42.8% respectively. Although on the surface this result might be not expected, going back to Exhibits 12 and 13 we see that the values registered for LEED-NC Silver were the lowest compared to all other ratings and levels (this effect is consistent with column 2-1). This effect requires additional research in the future to determine if it is a lasting trend for buildings with similar characteristics as those gathered in this study. In the case of LEED-EB buildings (columns 9 and 10), none of the levels seem to have a statistically significant effect on AV or MV, which is surprising and needs to be examined in future studies. Columns 11 and 12 focus on LEED-CS at the different certification levels. Although AV is affected by properties at the different designation levels (column 11), there is no a statistically significant effect on MV. LEED-CS at the Gold level is associated with an 80.4% increase in AV and a 127% increase at Silver level. In contrast, LEED-CS at the Certified level is associated with a decrease of 91.8% in AV [this result is biased, because of the small number of observations and is consistent with column 5-1 (see Exhibits 12 and 13)]. Exhibit 14 also reports the F-statistic of the fixed effect regressions, which indicates that the MSA dummies are jointly significant in all cases. Comparing the results of Equation 1-1 and Equation 2, a few differences can be identified. LEED-NC at the Silver level and LEED-CS at the Certified level do not have a statistically significant effect on AV or MV accordingly (based on Equation 1-1). In contrast, LEED-EB Gold and Silver have a statistically significant effect on AV and MV (only at the Silver level) based on Equation 1-1. The results indicate that the level of geographic aggregation we use can affect the significance of a LEED rating on AV or MV.

Finally, Exhibit 15 identifies the clusters generated based on the AV subset. These groupings were used instead of the MSAs in Equation 2, but because of the
Exhibit 15 | Clustering Results Based on Assessed Values / Sq. Ft.

<table>
<thead>
<tr>
<th>Group</th>
<th>Count</th>
<th>Average</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>111</td>
<td>28.94</td>
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<td>2</td>
<td>69</td>
<td>119.36</td>
<td>23.59</td>
<td>81.01</td>
<td>161.46</td>
</tr>
<tr>
<td>3</td>
<td>44</td>
<td>218.74</td>
<td>37.26</td>
<td>170.97</td>
<td>291.61</td>
</tr>
<tr>
<td>4</td>
<td>30</td>
<td>360.78</td>
<td>27.59</td>
<td>304.02</td>
<td>410.51</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>498.15</td>
<td>50.56</td>
<td>447.70</td>
<td>583.52</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>668.46</td>
<td></td>
<td>668.46</td>
<td>668.46</td>
</tr>
<tr>
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<td>1</td>
<td>1,226.53</td>
<td></td>
<td>1,226.53</td>
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</tr>
<tr>
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<td>1</td>
<td>1,318.02</td>
<td></td>
<td>1,318.02</td>
<td>1,318.02</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>1,111.76</td>
<td></td>
<td>1,111.76</td>
<td>1,111.76</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>2,856.94</td>
<td></td>
<td>2,856.94</td>
<td>2,856.94</td>
</tr>
</tbody>
</table>

similarity results with the MSA, the models do not appear in the study. The table of clusters is included because it provides some descriptive statistics on the prices/sq. ft. seen in the AV subset. Forty-one percent of the AVD have low values/sq. ft. ($0.3/sq. ft. to $77/sq. ft.). The second lowest values/sq. ft. (25.9% of AVD) range from $81/sq. ft. to $161/sq. ft. The other two most populated groups are almost evenly distributed with 16% ($171/sq. ft. to $292/sq. ft.) and 11% ($304/sq. ft. to $410/sq. ft.) of the overall AVD. The table also shows some outliers.

Conclusion

Research conducted by companies, associations, and now academics are pointing out that green is here to stay, due to the cost savings and the increased ROI obtained by the owners. The most prevalent LEED rating in the dataset is LEED-NC, followed by LEED-EB. In terms of LEED designation level, Silver is followed by Gold as the most popular in the dataset. A first overview of the average values of the dataset shows that smaller (approximately 100,000 square feet) LEED-NCs at the Silver level have lower assessed and market values per square foot compared to the other LEED ratings. In the case of LEED-NC at the Gold and Certified levels, their values are among the second lowest for medium-sized properties (approximately 220,000 square feet). LEED-CS properties of medium size are valued relatively high compared to other properties within the Gold and Silver level. On average, medium- and large-sized LEED-EB properties at the Silver and Certified level are valued at the highest level of both assessed and market value per square foot. The regression modeling indicates the impact of ENERGY STAR designation, RBA, and in some cases, the year the building was built are statistically significant. LEED-EB has a statistically significant effect on either assessed value or market value, when controlling for the property’s location at the geocoding level and not the MSA. LEED-NC at the Gold level has a statistically positive effect on the property’s market value, while LEED-CS Gold
and Silver have a similar effect on assessed values, when controlling for MSAs. These findings are a first step in understanding the effect of LEED certification levels on valuation and addition research is needed in the future to identify long-term trends.

**Endnotes**

1. The USGBC reports that “U.S. buildings are responsible for: 38% of carbon dioxide emissions, 71% of electricity consumption, 39% of energy use, 12% of water consumption and 40% of non-industrial waste,” (USGBC, A Natural Green Building Research Agenda, February 2008).

2. Total Assessed Value (AV) in general is the amount (for both land and structure) assigned by the local assessor for tax purposes. In the majority of areas a ratio is applied to estimate AV based on the full cash or fair market value of the property. This paper uses the AVs as estimated by each county/city based on their own definition.

3. Fair Market Value (MV) is estimated again by the local assessors and it usually is a competitive sale price for the property considering existing market conditions. Similar to AV, for the purposes of this paper, it represents the definitions given by the various local assessors.

4. LEED ratings used in this paper include: LEED-New Construction (LEED-NC), LEED-Existing Building (LEED-EB), LEED-Core & Shell (LEED-CS), and LEED-Commercial Interiors (LEED-CI) (USGBC, 2009).

5. LEED certification levels include: Platinum 80 points and above, Gold 60–79 points, Silver 50–59 points, Certified 40–49 points (USGBC, 2009).

6. Properties in California were the most difficult in determining their MVs, due to the formula used in calculating their AV, which does not allow an easy backtrack to MV. In this case, their MV was determined by backtracking to their most recent sale or construction year information. Sale information for 18 properties was not available and their AV was also used as their MV.

7. A model analyzing the effect of property characteristics & LEED rating (NC, EB, CS) on Assessed Value (AV) and Market Value (MV) was considered, but the results were not statistically significant for the LEED ratings considered. Another model focused on the effect of property characteristics and LEED levels (Platinum, Gold, Silver, Certified) and the results were also similar. State dummy variables were also used, with similar results, as were clusters based on assessed values per square foot.


9. Euclidean distance: \(\sqrt{(\text{minlatitude} - \text{maxlatitude})^2 + (\text{minlongitude} - \text{maxlongitude})^2}\).

10. Average linkage was used because of “the closest two groups are determined by the average (dis)similarities between the observations of two groups,” (Stata Manual, release 10, 2007).

11. The observations made will reflect the overall dataset (351 properties) and not the subgroup of properties with available market values (275).

12. Both counts are offered in Exhibit 13, because they are slightly different between the AVD and MVD subsets. The difference is caused because certain properties were tax exempt, but the local assessor made the market value estimation available.

13. The effect of property characteristics on AV and FV seems to be almost consistent across all models and will be discussed from column 7 and beyond.
References


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An Investigation of the Effect of Eco-Labeling on Office Occupancy Rates

Authors
Franz Fuerst and Patrick McAllister

Abstract
This paper investigates the effect of eco-labeling on the occupancy rates of commercial offices in the United States. The occupancy rates of LEED and ENERGY STAR-labeled offices are compared to a sample of non-labeled offices. Using OLS and quantile regression analyses, a significant positive relationship is found between occupancy rate and the eco-label. Controlling for differences in age, height, building class, and quality, the results suggest that occupancy rates are approximately 8% higher in LEED-labeled offices and 3% higher in ENERGY STAR-labeled offices. However, for ENERGY STAR-labeled offices, effects are concentrated in certain market segments.

In the real estate sector, eco-labeling has been one of the most important elements of a blend of governmental policies used to encourage market participants to voluntarily improve the environmental performance of the commercial building stock. In many real estate markets it is possible to observe a range of policy options being implemented at the local and national level to encourage this trend. Policies include increasing mandatory minimum standards, offering fiscal incentives, using ‘positive discrimination’ procurement, and improving information dissemination. A key signal of a building’s environmental performance has been eco-labels provided by independent, albeit sometimes government-sponsored, third-party organizations. While there is a growing body of work investigating whether eco-labeled offices display evidence of rental and price premiums, this paper focuses on the effect of eco-labeling on occupancy levels.

This paper provides an empirical investigation of occupancy rate differentials between Leadership in Energy and Environmental Design (LEED) and ENERGY STAR-labeled offices and non-labeled commercial offices in the United States. In the analysis, eco-labeled offices are compared to a sample of non-labeled offices, which were selected to include properties in the same submarket areas as the labeled sample. Occupancy is related to a set of hedonic characteristics of the buildings such as age, location, number of stories, inter alia. Essentially, our hedonic model measures occupancy rate differences between labeled offices and randomly selected non-labeled offices in the same submarkets controlling for differences in lease contract, age, height, quality, sub-market, etc. We first estimate occupancy rate regressions for a sample of approximately 292 LEED and 1,291 ENERGY STAR-labeled buildings (the precise number varies slightly with model
specification), as well as approximately 10,000 offices in the control group. Using OLS and quantile regression analyses, a significant positive relationship is found between occupancy rate and the eco-label. Controlling for differences in age, height, building class, and quality, the results suggest that occupancy rates are 8% higher in LEED-labeled offices and 3% higher in ENERGY STAR-labeled offices. However, for ENERGY STAR-labeled offices, the effects are concentrated in certain market segments.

The remainder of this paper is organized as follows. The first section provides a background discussion of the topic focusing on the growth in environmental certification, the nature of eco-labeled offices, and previous research on their costs and benefits. The main empirical section outlines the data and methods used in the study followed by a discussion of the results. Finally, conclusions are drawn.

**Background and Context**

**Eco-labeling in Commercial Real Estate Markets**

Certification and labeling codes are usually part of a policy to increase the supply of environmental public goods (Kotchen, 2006). The mechanism is to alter the behavior of users by providing more information about the environmental performance of alternative products and services. The aims are to encourage a shift towards more environmentally responsible consumption and to encourage producers to enhance the environmental performance of products and services. It is envisaged that better information, increased market transparency, and the consequent price outcomes will produce superior environmental performance. A benefit of voluntary eco-labeling is that the market prices of products with superior environmental performance are revealed. As a result, potential inefficiencies associated with mandatory standards or complete prohibition are avoided.

A blend of voluntary and mandatory eco-labels has emerged in a number of commercial real estate markets. Voluntary environmental certification systems for buildings include schemes such as Green Star (Australia), LEED (U.S.), ENERGY STAR (U.S.), Green Globes (U.S.), and BREEAM (U.K.). Mandatory certification of energy efficiency was introduced in the European Union in 2008 following the EU Energy Performance of Buildings Directive and takes the form of Energy Performance Certificates and Display Energy Certificates. This paper focuses on two U.S. voluntary eco-labeling schemes: the Environmental Protection Agency’s ENERGY STAR and the U.S. Green Building Council’s Leadership LEED programs.

Office properties tend to dominate both the LEED and ENERGY STAR-accredited buildings in terms of space and numbers (Nelson, 2007). The ENERGY STAR program is used more for existing buildings. It is linked to an assessment of buildings’ energy performance. ENERGY STAR accreditation is based upon relative energy efficiency and environmental performance since only buildings that are in the top quartile are eligible for ENERGY STAR accreditation. LEED
accreditation is based upon scores in a number of different categories focused on sustainability of location, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, and innovation and design processes. The LEED thresholds are primarily absolute. Buildings that reach the required levels are labeled. There are four levels of certification: Certified, Silver, Gold, and Platinum. LEED certification is comparable to other eco-certification schemes in the United Kingdom, Germany, and Australia and is likely to provide the framework for prospective harmonized global standards. Given their differences, it is not surprising that studies have found important differences between ENERGY STAR and LEED-labeled buildings in terms of average size, age, height, and other variables.

While the presence of an eco-label and good environmental performance are not necessarily synonymous, there is a substantial body of literature suggesting that environmentally responsible buildings offer a bundle of benefits to occupiers and investors. Surveys of willingness-to-pay have identified occupiers who have stated that they are prepared to pay higher rents for eco-labeled buildings (e.g., McGraw Hill Construction, 2006; GVA Grimley, 2007; and National Real Estate Investor, 2007). Many states in the U.S. now offer subsidies and tax benefits for eco-labeled buildings. Occupiers benefit from costs savings due to lower energy and water usage. Less tangibly, since it is difficult to measure, it is argued that business performance may improve in environmentally responsible buildings due to reduced staff turnover, lower absenteeism, \textit{inter alia}. In addition, the rapid increase in allocation of corporate resources to environmental, social, and governance (ESG) issues allied with professed commitments to Corporate Social Responsibility (CSR) has created potential marketing and image benefits for occupying and investing in buildings labeled as environmentally responsible. Central to this paper is the possibility that, in turn, investors may also obtain a bundle of benefits linked to lower vacancy rates, rental premiums, lower energy and other utility costs, reduced depreciation, and reduced regulatory risks.

There have been a number of studies of the construction cost premium associated with achieving certification (e.g., Kats, 2003; Morrison Hershfield, 2005; and Berry, 2007). These studies suggest small construction cost premiums of around 2% on average. The most recent and authoritative studies have come from Davis Langdon (a global construction consultancy). Their most recent study compared 83 building projects with a primary goal of LEED certification with 138 similar building projects without the goal of sustainable design (Matthiessen and Morris, 2006). Confirming the findings of earlier studies, they found no significant difference in average costs for building projects with a primary goal of LEED certification as compared to non-labeled buildings.

As noted above, there have been a number of studies measuring the price effects of eco-certification on commercial offices. To date, most of the studies have used the CoStar database to compare the sale prices and/or rents of LEED and ENERGY STAR buildings in the U.S. These studies are summarized in Exhibit 1.
<table>
<thead>
<tr>
<th>Study</th>
<th>Data</th>
<th>Approach</th>
<th>Findings on Price Differentials</th>
<th>Other Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miller, Spivey, and Florance (2008)</td>
<td>Filtered sample of Class A buildings (larger than 200,000 sq ft, multi-tenanted, over five stories, built after 1970) to compare to 643 ES buildings. 927 sale transactions between 2003 and 2007. Breakdown between LEED and ES sale price observations is unclear.</td>
<td>Hedonic OLS regression for sale prices only. Controls for major markets but none for quality.</td>
<td>Finds no statistically significant sales price premium.</td>
<td>Occupancy rate is 2%-4% higher for ES compared to non-ES filtered sample. Report 30% lower operating expenses based on energy costs.</td>
</tr>
<tr>
<td>Wiley, Benefield, and Johnson (2008)</td>
<td>Class A office buildings only. 46 metropolitan markets (25 markets for sales). Breakdown between LEED and ES is unclear. We estimate 30 LEED and 440 ES rental observations and 12 LEED and 70 ES sales observations.</td>
<td>Hedonic OLS and 2SLS regressions for rental and occupancy rates. Control sample seems to be other offices in same metropolitan area. No controls for micro-location effects.</td>
<td>Hedonic OLS and 2SLS find rental differentials of 15%-17% for LEED and 7-9% for ES. Hedonic OLS model of sales prices in absolute form. Estimate sale price premiums of $130 psf and $30 psf for LEED and ES.</td>
<td>Hedonic OLS and 2SLS with occupancy rate as dependent variable finds occupancy rate differentials of 16%-18% for LEED and 10%-11% for ES compared to control group.</td>
</tr>
<tr>
<td>Eichholtz, Kok, and Quigley (2009)</td>
<td>Contract rents for 694 certified offices. Sale prices for 199 certified offices 2004-7. Breakdown between LEED and ES is unclear.</td>
<td>Hedonic OLS regressions for rental and sales prices. Control sample is offices within 0.25 miles of certified building.</td>
<td>No statistically significant rental premium for LEED; 3% rental premium for ENERGY STAR. No statistically significant sale price premium for LEED. 19% sale price premium for ENERGY STAR.</td>
<td>Find a positive relationship between energy efficiency measure and level of rental premium.</td>
</tr>
<tr>
<td>Fuerst and McAllister (2009)</td>
<td>Asking rents for 990 ES and 210 LEED certified offices. Sale prices for 662 ES and 139 LEED certified offices 1999-2009.</td>
<td>Hedonic OLS regressions for rental and sales prices. Control sample is based on offices within same CoStar submarkets.</td>
<td>6% rental premium for ES and LEED certified offices. 35% and 31% price premium for LEED and ES.</td>
<td></td>
</tr>
</tbody>
</table>
Nelson (2007) examined the performance differences between labeled and non-labeled buildings using a number of criteria. Drawing upon the CoStar database, the study compared LEED-rated offices and ENERGY STAR offices with a vastly larger sample of non-labeled offices in the CoStar database. While acknowledging the significant differences between the sample and the wider population, it found that labeled buildings tended to be newer, owner-occupied or single tenanted, concentrated geographically and sectorally (in the office sector). Recognizing that it did not control for these differences, the study identified lower vacancy rates and higher rents in LEED-rated offices. To control for differences between their sample of labeled buildings (927 buildings) and a much larger sample of non-labeled buildings, Miller, Spivey, and Florance (2008) include a number of control variables such as size, location, and age in their hedonic regression framework. They find that dummy variables for ENERGY STAR and LEED ratings show the expected positive sign but tests show that these results are not significant at the 10% level. Wiley, Benefield, and Johnson (2008) focused on the effect on rent, occupancy rate, and sale price of eco-certification for Class A office buildings in 46 metropolitan markets across the U.S. They found rental premiums ranging from approximately 15% to 18% for LEED-labeled offices and 7%–9% for ENERGY STAR-labeled offices depending on the model specification. In terms of sales transactions, they estimated premiums of $130/sq. ft. for LEED-labeled offices and $30 for ENERGY STAR. However, although plausible, these results need to be treated with some caution. A limitation of their hedonic model is their control for location. In essence, they identify rental and sale premiums for labeled offices relative to non-labeled offices in the same metropolitan area. However, if labeled offices tend to be more likely to be found in better quality locations within a metropolitan area, observed premiums may include a location as well as a certification premium.

In a working paper, Eichholtz, Kok, and Quigley (2009) also used a hedonic framework to test for the effect of certification on the contract rents of 694 office buildings. Using GIS techniques, they control for location effects by identifying other office buildings in the CoStar database within a radius of 0.25 miles of each labeled building. They identify a statistically significant rent premium (3%) on the contract rents per square foot of ENERGY STAR-labeled offices. They find no significant rent premium for LEED-labeled offices. However, when they used “effective” rents to reflect different vacancy rates in labeled offices, the premium increased to around 10% for ENERGY STAR-labeled offices and 9% for LEED-labeled offices. Similar results were found for transaction prices. Although not discussed in the paper, they found a substantial 19% sale price premium for ENERGY STAR-labeled offices but no statistically significant premium for LEED-labeled offices.

Within the real estate sector, occupancy (or vacancy) rates are commonly used as a portmanteau indicator of market conditions. Vacancies can impose substantial costs upon investors. In addition to the loss of income, investors incur a number of fixed and variable costs. These will include brokerage and legal fees associated with finding a new occupier and CAM-related expenses (maintenance, security, utilities, insurance, local real estate taxes, etc). In addition, variations in vacancy
rates among buildings in similar locations may be attributable to differences in demand which, in turn, may be attributable to the characteristics of the buildings. The vast majority of the academic literature on vacancy levels has been on modeling regional or metropolitan levels; typically focusing on their explanatory power in rent determination at the market level. Not surprisingly, these studies have tended to find a positive relationship between rent and occupancy rates. Essentially both rent and occupancy rates are analyzed as jointly determined and are modeled as outcomes of the interaction of the same supply and demand conditions.

In addition, there is a much smaller body of work drawing upon search theory that analyses the micro-foundations of rent and vacancy determination. An important insight is that, at the building level, vacancy rates consist of both voluntary and involuntary components. The voluntary component is part of a strategic trade-off by the owner in an attempt to identify equilibrium vacancy and rental levels. In this context, it is possible that, due to enhanced problems of noisy price information, eco-labeled offices present additional price setting problems for their owners. Although owners of eco-labeled offices are aware that occupiers will obtain an additional consumer surplus relative to non-labeled offices, information about the reservation prices of occupiers may be costly or difficult to obtain due to the relative novelty of the product. Following search theory, if the expected distribution of rental offers is higher for eco-labeled offices, there is an additional incentive to continue searching for occupiers (i.e., to keep space vacant). By searching longer, the owner is able to learn more about the range of offers available. Thus, the rational vacancy rate may be higher for eco-labeled offices.

There has been some empirical investigation of the strategic issues faced by owners and the simultaneous determination of rents and occupancy rates. Frew and Jud (1988) investigated the interaction between vacancy rates and rents at the individual building level. They essentially tested the hypothesis that “landlords who are willing to accept higher average vacancy rates, thus, will tend to have higher than average rents at any point in time,” (p. 3). They also postulate that there should be a negative relationship between building age and vacancy rate since they expect managers of new offices to trade off vacancy levels with the price discovery of the marketing process. In their empirical investigation, they analyze data from a single office market using a hedonic regression approach. In common with Sirmans, Sirmans, and Benjamin (1990), they find evidence of a positive relationship between vacancy and rent. In addition, they also found a negative relationship between age and vacancy.

In terms of this research, there are a number of other studies investigating differences in occupancy/vacancy rates between LEED and ENERGY STAR-labeled offices. In addition to examining the effects of certification on rents and sale prices, Wiley, Benefield, and Johnson (2008) also modeled occupancy rates. Using a similar approach to the pricing study discussed above, they find that LEED and ENERGY STAR-rated offices have occupancy rate premiums of 16%–18% and 10%–11%, respectively. They also report a positive relationship between rent
and occupancy rate. However, as noted, this study did not control for potential micro-location effects. Drawing upon the CoStar database also, Miller, Spivey, and Florance (2008) compared a filtered sample of Class A offices with ENERGY STAR-rated offices. Looking at the period 2004–2008, they find a much lower occupancy rate premium ranging between 2% and 5%. Nelson (2007) also finds that eco-labeled buildings have lower vacancy rates relative to the total CoStar universe.

In summary, since they provide a range of tangible and intangible benefits to occupiers, there are strong a priori grounds to expect eco-labeled offices to have lower vacancy rates than comparable non-labeled offices. There are also strong grounds to expect levels of occupancy differential to vary cross-sectionally. LEED and ENERGY STAR ratings are significantly different and tend to be associated with different market segments. Within LEED, there are different levels of certification. As a result, there are likely to be variations between labeled offices in the levels of the potential benefits (reduced costs of occupancy, image, and business performance) that may be obtained by occupiers.

**Empirical Research**

**Method and Data**

When attempting to measure differentials between a labeled and non-labeled product, the key methodological issue is to identify an appropriate benchmark to compare labeled and non-labeled products. In some product markets, apart from the certification label, eco-friendly goods may be indistinguishable from conventional goods (e.g., some timber or food commodities). As a result, it is often straightforward to identify a suitable benchmark against which to measure a differential. In contrast, in markets where products are bespoke (such as commercial real estate), the construction and design requirements of obtaining certification may add to inherent product heterogeneity. Thin trading and low market transparency may reduce the amount and quality of available information. The result is that measuring the differential for eco-labeled offices is hindered by the combination of a lack of an appropriate benchmark and limited information due to thin market effects.

Hedonic regression modeling is the standard methodology for examining price determinants in real estate research. This method is used here primarily to measure the effect of LEED and ENERGY STAR certification on occupancy rates. Rosen (1974) first generalized that the hedonic price function covering any good or service consisted of a variety of utility-bearing characteristics. In the office rent determination literature, hedonic modeling typically specifies that a range of physical, locational, and lease characteristics be used as the independent variables determining price. In this study, occupancy rate is specified as the dependent variable. For the purpose of this study, we specify two types of hedonic models: OLS and quantile regression.
**Hedonic Model**

The OLS regression model of building occupancy rates takes the following form:

\[
OR_i = \beta_0 + \beta_1 \ln A_i + \beta_2 \ln N_i + \beta_3 \ln S_i + \beta_4 \ln L_i \\
+ \beta_5 \ln T_i + \beta_6 \ln G_i + \beta_7 \ln R_i + \beta_8 BC_i + \beta_9 SU_i \\
+ \beta_{10} LD_i + \beta_{11} ES_i + \epsilon_i.
\]  

(1)

In this model, \(A_i\) represents the age of the property, measured from the year of construction or the year of a major refurbishment (whichever occurred more recently); \(N_i\) indicates a net lease with a value of 1 and a gross lease with a value of 0; \(S_i\) is the number of stories of the property; \(L_i\) represents the lot size; \(T_i\) and \(G_i\) are the latitude and longitude geographic coordinates of the property, which capture any large-scale effects of the spatial distribution of properties across the country; \(R_i\) represents the asking rent; \(BC_i\) are controls for building class (standard categories A, B, C, and F); \(SU_i\) are controls for submarkets; and \(\epsilon_i\) is the error term, which is assumed to be independent across observations and normally distributed, with constant variance and a mean of zero. A rent premium for LEED and/or ENERGY STAR-rated offices is captured by the \(LD_i\) and \(ES_i\) terms, a dichotomous variable that takes the value of 1 for labeled offices and a value of 0 otherwise.

Details of LEED and ENERGY STAR offices were obtained from the CoStar database. Given the discussion above, a key issue is the benchmark against which the sample of labeled offices can be compared. Our benchmark sample consists of approximately 24,479 office buildings in 643 submarkets in 81 metropolitan areas spread throughout the U.S. In effect, the hedonic model is measuring occupancy rate differences between eco-labeled offices and randomly selected non-labeled offices in the same sub-market area, controlling for differences in age, size, height, building class, and submarket.

In the first step, we drew details of approximately 2,147 eco-labeled offices, of which 667 were LEED-labeled and 1,480 were ENERGY STAR. In the second step, offices were selected in the same metropolitan areas and submarket as the labeled sample. Sample selection was based on the criteria a) same submarket or market as labeled offices and b) at least 10 comparable observations for each labeled building in the database. Although the market weightings may be different between the benchmark and the labeled samples, our regression model controls for market-specific effects.

A key consideration in measuring the effect of eco-certification on occupancy rates is that the different types of certification (LEED, ENERGY STAR, and non-labeled) have variations in their propensity to be leased to a single tenant. Since single-tenanted offices are typically 100% occupied, their inclusion may introduce
a bias if they are not represented in the eco-labeled and the control samples in equal proportions. For instance, the data suggests that ENERGY STAR-rated offices tend to be multi-tenanted compared to non-ENERGY STAR offices. We estimate that approximately 30% of the CoStar office database is single tenanted. The corresponding figures for ENERGY STAR and LEED-labeled offices are 9% and 40%, respectively. Although we do not have information on the number of tenants for each property in the dataset, the potential bias can be indirectly eliminated by including only those properties with positive rent observations. A simple count of properties in the CoStar database reveals that asking rents are only available for a small fraction (approximately 0.5%) of single-tenanted LEED buildings.

Our second approach involves the application of a quantile regression approach. Quantile regression is typically used to assess whether there is an unequal variation in the response of the dependent variable to the independent variables. Such unequal variation is associated with the presence of multiple relationships between the independent and dependent variables. In this instance, the quantile regression is providing a method of examining whether the effect of eco-labeling is more important in certain segments of the market.

Following Koenker and Hallock (2001) and Koenker (2005), the abbreviated specification of our quantile regression model for occupancy rates reads:

\[
\text{OR}_i = \beta_i X_i + \mu_i, \quad \text{with} \quad \text{Quant}_I(\text{OR}_i) = \beta_i X_i, \quad (2)
\]

where \(X_i\) denotes the vector of regressors and \(\beta_i\) is the vector of estimated parameters. \(\text{Quant}_I(\text{OR}_i) = \beta_i X_i\) is the \(\tau\)th conditional quantile of \(\text{OR}_i\) given the vector of variables \(X\). The \(\tau\)th quantile regression is then estimated by:

\[
\min_{\beta \in \mathcal{R}^p} \left\{ \sum_{i: \text{OR}_i \geq \beta X_i} \tau |\text{OR}_i - \beta_i X_i| + \sum_{i: \text{OR}_i < \beta X_i} (1 - \tau) |\text{OR}_i - \beta_i X_i| \right\}, \quad (3)
\]

which can also be expressed as:

\[
\min \sum_i \rho_\tau(\text{OR}_i - \beta_i X_i),
\]

where \(\rho_\tau(x)\) is the check function that weights positive and negative values asymmetrically, and \(\rho_\tau(x) = \tau x\) if \(x \geq 0\) or \(\rho_\tau(x) = (\tau - 1)x\) if \(x < 0\). This yields estimates for the specified quantiles (i.e., deciles in our empirical estimation).
Results

Descriptive statistics of the variables included in the model are displayed in Exhibit 2. There are major differences between eco-labeled and non-labeled offices and, in turn, between LEED and ENERGY STAR-labeled offices. LEED-labeled offices tend to be newer. The median age of LEED-labeled offices is five years. The comparable figure for the benchmark sample is 23 and for ENERGY STAR offices it is approximately 20. While there is relatively little difference between offices with ENERGY STAR certification and the benchmark sample in terms of age, the former tend to be dominated by tall buildings suggesting that they are mainly located in high value CBD locations. This is supported by the fact that ENERGY STAR offices tend to be on average much larger than non-labeled offices. Without controlling for the differences between the samples, eco-labeled offices have higher asking rents and lower vacancy rates than non-labeled offices. It is notable that the median occupancy rate for LEED is 100%. This is not solely due to the fact that 40% of LEED-labeled office buildings are single tenanted.

Exhibit 2 | Summary Statistics

<table>
<thead>
<tr>
<th>Overall</th>
<th>Occupancy Rate (%)</th>
<th>Rent ($ psf)</th>
<th>Age (years)</th>
<th>Size (sq. ft.)</th>
<th>Stories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>63.07</td>
<td>19.50</td>
<td>28.35</td>
<td>52,771</td>
<td>3.32</td>
</tr>
<tr>
<td>Median</td>
<td>78.63</td>
<td>18.00</td>
<td>23.00</td>
<td>10,800</td>
<td>2.00</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>38.95</td>
<td>9.16</td>
<td>27.45</td>
<td>145,147</td>
<td>5.80</td>
</tr>
<tr>
<td>Obs.</td>
<td>24,283</td>
<td>16,488</td>
<td>21,137</td>
<td>24,951</td>
<td>24,480</td>
</tr>
<tr>
<td>ENERGY STAR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>91.42</td>
<td>27.76</td>
<td>19.44</td>
<td>315,051</td>
<td>13.40</td>
</tr>
<tr>
<td>Median</td>
<td>95.76</td>
<td>25.04</td>
<td>20.00</td>
<td>217,082</td>
<td>9.00</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>12.44</td>
<td>11.37</td>
<td>12.76</td>
<td>301,264</td>
<td>12.89</td>
</tr>
<tr>
<td>Obs.</td>
<td>1,480</td>
<td>990</td>
<td>1,474</td>
<td>986</td>
<td>1,453</td>
</tr>
<tr>
<td>ES Multi-tenant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>90.30</td>
<td>27.80</td>
<td>19.10</td>
<td>328,135</td>
<td>14.45</td>
</tr>
<tr>
<td>Median</td>
<td>94.17</td>
<td>25.11</td>
<td>20.00</td>
<td>228,883</td>
<td>10.00</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>12.60</td>
<td>11.38</td>
<td>11.14</td>
<td>303,331</td>
<td>13.20</td>
</tr>
<tr>
<td>Obs.</td>
<td>1,291</td>
<td>1,291</td>
<td>985</td>
<td>1,291</td>
<td>1,291</td>
</tr>
<tr>
<td>LEED</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>91.07</td>
<td>26.74</td>
<td>11.77</td>
<td>179,290</td>
<td>6.45</td>
</tr>
<tr>
<td>Median</td>
<td>100.00</td>
<td>24.50</td>
<td>5.00</td>
<td>95,000</td>
<td>4.00</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>22.46</td>
<td>11.00</td>
<td>19.06</td>
<td>262,071</td>
<td>8.50</td>
</tr>
<tr>
<td>Obs.</td>
<td>667</td>
<td>210</td>
<td>504</td>
<td>667</td>
<td>622</td>
</tr>
<tr>
<td>LEED Multi-tenant</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>83.69</td>
<td>27.55</td>
<td>11.06</td>
<td>229,319</td>
<td>8.85</td>
</tr>
<tr>
<td>Median</td>
<td>99.00</td>
<td>25.92</td>
<td>4.00</td>
<td>127,690</td>
<td>5.00</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>27.74</td>
<td>10.74</td>
<td>18.32</td>
<td>320,370</td>
<td>10.47</td>
</tr>
<tr>
<td>Obs.</td>
<td>292</td>
<td>169</td>
<td>264</td>
<td>292</td>
<td>292</td>
</tr>
</tbody>
</table>
since the median occupancy rate for multi-tenanted LEED offices is 99%. The median occupancy rate for ENERGY STAR is over 95%. There is little difference in the occupancy rates of single-tenanted and multi-tenanted ENERGY STAR offices.

When controlling for the rent determinants such as building class, age, height, size, and sub-market location, we find evidence that eco-labeled office buildings have higher occupancy rates. In the OLS model, there is a statistically significant positive coefficient for the ENERGY STAR and LEED dummies, indicating that

**Exhibit 3 | Results of Hedonic Regression**

<table>
<thead>
<tr>
<th>OLS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>56.61</td>
</tr>
<tr>
<td>Class A</td>
<td>-6.01***</td>
</tr>
<tr>
<td>Class B</td>
<td>-1.61**</td>
</tr>
<tr>
<td>LEED</td>
<td>7.70***</td>
</tr>
<tr>
<td>ENERGY STAR</td>
<td>2.88**</td>
</tr>
<tr>
<td>Net Lease</td>
<td>-9.62***</td>
</tr>
<tr>
<td>Height</td>
<td>0.35</td>
</tr>
<tr>
<td>Size</td>
<td>9.71***</td>
</tr>
<tr>
<td>Area</td>
<td>-1.73***</td>
</tr>
<tr>
<td>Longitude</td>
<td>-0.51***</td>
</tr>
<tr>
<td>Latitude</td>
<td>-40.95**</td>
</tr>
<tr>
<td>3–6 years</td>
<td>17.98***</td>
</tr>
<tr>
<td>7–10 years</td>
<td>24.20***</td>
</tr>
<tr>
<td>11–19 years</td>
<td>20.85***</td>
</tr>
<tr>
<td>20–23 years</td>
<td>21.02***</td>
</tr>
<tr>
<td>23–26 years</td>
<td>23.27***</td>
</tr>
<tr>
<td>27–31 years</td>
<td>21.02***</td>
</tr>
<tr>
<td>32–42 years</td>
<td>20.31***</td>
</tr>
<tr>
<td>43–62 years</td>
<td>17.21***</td>
</tr>
<tr>
<td>&gt;62 years</td>
<td>13.36***</td>
</tr>
<tr>
<td>F-test</td>
<td>7.25***</td>
</tr>
<tr>
<td>Adj, R²</td>
<td>0.28</td>
</tr>
</tbody>
</table>

*Notes: We do not include rent in this specification of the model due to problems of endogeneity. However, we did estimate the model with asking rent included as an independent variable. The results and explanatory power of the model did not change significantly. There were 10,977 observations. 647 submarket dummies were included.

*Significant at the 10% level.
**Significant at the 5% level.
***Significant at the 1% level.
offices with these eco-labels have significantly higher occupancy rates than offices with similar attributes in the same sub-market (Exhibit 3). The results suggest an 8% higher occupancy rate for LEED-labeled offices. The occupancy rate premium is approximately 3% for ENERGY STAR-labeled office offices. These findings are similar to Miller, Spivey, and Florance (2008), who find a 2%–4% higher occupancy rate for ENERGY STAR offices.

The results for the other variables are in line with expectations. In line with previous research on price premiums in LEED and ENERGY STAR offices and in other studies of office rental determination, occupancy levels (similar to rent levels) display a positive relationship with size. Compared to recently constructed offices (aged 0–3 years), occupancy rates of offices tend to increase as offices get older, stabilizing after ten years. However, the lack of a statistically different occupancy rate differential linked to building quality is notable. The low explanatory power of the models suggests that important variables may have been omitted. It may also be due to the fact that the effects of the independent variables are concentrated in certain categories of the dependent variable. Quantile regression can provide an effective method for obtaining more reliable estimates.

### Exhibit 4 | Quantile Regression

<table>
<thead>
<tr>
<th>Decile (τ)</th>
<th>Coeff.</th>
<th>Pseudo R²</th>
<th>QLR Statistic (prob. QLR)</th>
<th>Sparsity</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEED</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.75</td>
<td>0.20</td>
<td>1,640.6 (0.00)</td>
<td>189.80</td>
</tr>
<tr>
<td>2</td>
<td>5.28</td>
<td>0.32</td>
<td>4,197.7 (0.00)</td>
<td>124.33</td>
</tr>
<tr>
<td>3</td>
<td>5.27*</td>
<td>0.29</td>
<td>4,004.2 (0.00)</td>
<td>107.35</td>
</tr>
<tr>
<td>4</td>
<td>6.75***</td>
<td>0.25</td>
<td>4,049.7 (0.00)</td>
<td>84.62</td>
</tr>
<tr>
<td>5</td>
<td>8.08***</td>
<td>0.21</td>
<td>3,143.6 (0.00)</td>
<td>82.50</td>
</tr>
<tr>
<td>6</td>
<td>6.71***</td>
<td>0.18</td>
<td>2,596.3 (0.00)</td>
<td>76.41</td>
</tr>
<tr>
<td>7</td>
<td>6.38***</td>
<td>0.14</td>
<td>2,010.4 (0.00)</td>
<td>72.88</td>
</tr>
<tr>
<td>8</td>
<td>7.11***</td>
<td>0.11</td>
<td>1,508.7 (0.00)</td>
<td>68.85</td>
</tr>
<tr>
<td>9</td>
<td>3.45***</td>
<td>0.07</td>
<td>1,186.6 (0.00)</td>
<td>52.87</td>
</tr>
<tr>
<td>ENERGY STAR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>12.63***</td>
<td>0.20</td>
<td>1,640.6 (0.00)</td>
<td>189.80</td>
</tr>
<tr>
<td>2</td>
<td>5.31***</td>
<td>0.32</td>
<td>4,197.7 (0.00)</td>
<td>124.33</td>
</tr>
<tr>
<td>3</td>
<td>1.02</td>
<td>0.29</td>
<td>4,004.2 (0.00)</td>
<td>107.35</td>
</tr>
<tr>
<td>4</td>
<td>-0.63</td>
<td>0.25</td>
<td>4,049.7 (0.00)</td>
<td>84.62</td>
</tr>
<tr>
<td>5</td>
<td>-0.94</td>
<td>0.21</td>
<td>3,143.6 (0.00)</td>
<td>82.50</td>
</tr>
<tr>
<td>6</td>
<td>-0.34</td>
<td>0.18</td>
<td>2,596.3 (0.00)</td>
<td>76.41</td>
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<tr>
<td>7</td>
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<td>72.88</td>
</tr>
<tr>
<td>8</td>
<td>0.68</td>
<td>0.11</td>
<td>1,508.7 (0.00)</td>
<td>68.85</td>
</tr>
<tr>
<td>9</td>
<td>0.00</td>
<td>0.07</td>
<td>1,186.6 (0.00)</td>
<td>52.87</td>
</tr>
</tbody>
</table>

**Notes:**
*Significant at the 10% level.
**Significant at the 5% level.
***Significant at the 1% level.
when the model coefficients vary significantly across the distribution of the dependent variable.

Exhibit 4 displays the results of the quantile regressions for each individual decile for the sample. The results suggest that there are clear differences in the effect of eco-labeling for the different segments. For ENERGY STAR-labeled offices, only statistically significant positive coefficients for this eco-label are identified for the bottom two deciles. For the LEED-labeled offices, we find a different pattern. The quantile regression finds a statistically significant positive relationship between the LEED eco-label and the occupancy rate for all deciles except the bottom two. This is probably due to the fact that relatively few ENERGY STAR buildings are completely vacant and thus command a large occupancy rate premium in the bottom decile of the market. Overall, the results confirm that the magnitude of the premium tends to be larger for LEED buildings, particularly in the upper deciles of occupancy rates.

**Conclusion**

Eco-labels are used both by businesses and regulators to increase the demand for, and the supply of, environmentally responsible products. Essentially, it is envisioned that by increasing awareness and improving information about the environmental performance of products, market prices will be altered by changes in supply and demand. Similar to other product markets, both mandatory and voluntary eco-labels have become increasingly important in the commercial real estate sector. There are strong a priori grounds to expect differences in occupier
demand for eco-labeled offices relative to non-labeled offices. It is generally accepted that there are benefits associated with environmentally responsible offices. Occupiers can gain tangibly from lower utility costs and incentives or subsidies and, perhaps less tangibly, from improvements in business performance and marketing benefits. In addition, from an investor’s perspective there are a number of channels by which superior environmental performance can influence the financial performance of the asset. These are mainly associated with higher incomes (rental premiums, higher occupancy levels), costs reductions (lower operating expenditure, lower vacancy rates), and reduced risk premia.

It is clear from the data that eco-labeled offices tend to be different from non-labeled offices. ENERGY STAR offices tend to be large, tall, and located in major metropolitan markets. LEED-labeled offices tend to be more diverse. There are distinct differences from both ENERGY STAR and LEED-labeled offices. In particular, from the perspective of occupancy rates, it is notable that approximately 90% of ENERGY STAR-labeled offices are multi-tenant. The comparable figures for LEED and non-labeled offices are 60% and 70% respectively. It is particularly striking that the median occupancy rate for multi-tenant LEED-labeled offices is 99%. Overall, the results suggest there is an occupancy premium of approximately 8% for LEED-labeled offices. The quantile regression finds that the LEED label has a significant positive effect on occupancy level for most deciles of LEED offices. Both regression models also indicate a significant positive relationship between occupancy rate and the ENERGY STAR label. For ENERGY STAR-labeled offices, the occupancy rate premium is lower at 3%. The quantile regression suggests that the ENERGY STAR effect is concentrated on offices that are in the lower deciles by occupancy level. Taking into account age, height, building quality, and rent levels, ENERGY STAR-labeled offices are much less likely to have severe vacancy problems than non-labeled office buildings. However, the results suggest that the ENERGY STAR label has no significant effect for offices with relatively high occupancy rates.

Given the relative novelty of eco-labeling in commercial real estate allied to its recent rapid growth, it is important to bear in mind that empirical studies of this type provide a backward-looking snapshot of market differentials for a specific sample in a specific time period. Given the rate of market growth, data will improve and patterns of supply and demand will change. Further, this study has focused on office properties only. Empirical studies of the retail, industrial, and residential markets may arrive at different results. Furthermore, there is little understanding of the relative contribution of the potential sources of occupancy rate or pricing differentials. What are the key drivers of demand—fiscal benefits and subsidies, improved business performance, image benefits or reduced operating costs? Finally, our study presents a static cross-sectional analysis of occupancy rates. As more detailed data and longer time series of eco-labeled properties become available, it will be possible to model differential occupancy rates in a dynamic fashion, potentially incorporating search theory and strategic considerations in determining optimal occupancy levels under given market conditions.
Endnotes

1 Eichholtz, Kok, and Quigley (2009) also find that there is a higher relative premium for cheaper locations. However, this is likely to be due to the fact that similar absolute premiums due, for example, to lower energy costs will invariably result in higher relative premiums in less expensive locations.

2 The specification of our quantile regression model uses the Hall-Sheather bandwidth method and Siddiqui (mean fitted) calculations for computing Ordinary (IID) covariances, which are valid under independent but non-identical sampling. Alternative estimations using the Huber sandwich method for computing covariances did not yield significantly different results for the coefficients in question.

References


The authors wish to thank the CoStar Group for providing the data and the participants of the 2009 Homer Hoyt/Weimer School meeting for comments.

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Green Buildings and Productivity

Authors
Norm G. Miller, Dave Pogue, Quiana D. Gough, and Susan M. Davis

Abstract
Healthier space need not be new space. In fact, some new buildings are extremely unhealthy as chemicals leach out into the air from glues, carpets, concrete, and paint. There is no reason this must be the case. The cost to provide healthier environments is modest compared to the benefits. Healthier buildings reduce sick time and increase productivity, making it easier to recruit and retain employees. The results provided here are based on a survey of over 500 tenants who have moved into either LEED or ENERGY STAR-labeled buildings managed by CB Richard Ellis (CBRE). It is part of a much larger study that includes details on operating expenses, leasing, and management available from the authors or www.josre.org.

Do Green Buildings Improve Productivity?
While we now have some evidence on rental premiums and occupancy differences for green buildings (e.g., Spivey and Florance, 2008; Eichholtz, Kok, and Quigley, 2009; and Fuerst and McAllister, 2009), defined as including both ENERGY STAR-labeled and/or LEED-certified at any level, we know little about the real impact on productivity for tenants. There has been one widely cited study by Kats (2003), which had a sample of 33 green building projects that suggested present value benefits of $37 to $55 U.S. dollars per square foot as a result of productivity gains from less sick time and greater worker productivity. These resulted primarily from better ventilation, lighting, and general environment.

Here we greatly expand our scope of analysis and re-visit the productivity issue. Unfortunately, one impediment to answering this question is the problem of measuring productivity. Studies in the past that dealt with typing speed or output are not quite satisfactory for those who wish to know about overall productivity in better environments. Here we review some of the literature on measuring productivity in office environments, then we examine some of the attempts to monitor productivity and last we examine our own efforts to determine if better environments result in greater productivity. This is part of a larger joint study by the authors with details available by request.

Subjective Productivity Measurement
An excellent review is provided by Kemmila and Lonnqvist (2003), who state that “Productivity is an important success factor for all organizations. Improvements in productivity have been recognized to have a major impact on many
economic and social phenomena, e.g., economic growth and higher standard of living. Companies must continuously improve productivity in order to stay profitable...There are several different methods for productivity measurement. Most of the methods are based on quantitative data on operations. In many cases, it is quite difficult and sometimes even impossible to collect the data needed for productivity measurement. An example of this situation is the work of professionals and experts. Their work is knowledge-intensive and the inputs and outputs are not easily quantifiable. Therefore, the traditional productivity measures are not applicable...An old but scarcely used approach to productivity measurement is subjective productivity measurement. Subjective productivity measures are not based on quantitative operational information. Instead, they are based on personnel’s subjective assessments. The data is collected using survey questionnaires.” Essentially, Kemmila and Lonnqvist point out that measuring productivity directly is a great challenge. This is because direct measurement for professionals in an office environment requires the monitoring of: (1) the ability to focus and think, synthesize, and add value to the firm; (2) the ability to measure the contribution of individuals that likely work in a team environment; and (3) the ability to monitor the quality of work as well as efficiency and output.

While productivity itself could be measured using financial and economic measures for the entire system, firm, or division using statistics like revenues, billable hours, net income, or market share gained, there are leads and lags from the input of capital and labor to the output effects based on measureable indicators. Even if these indicators can be measured in real time there is the question of external and internal influences that must be controlled. Did the competition change material costs in some way? We do not live in a status quo world so controlling for external changes is a challenge. Last, assuming you could control for all external changes, you need to be able to divvy up the output by internal inputs as well as vendors and others that contribute to the firm’s revenue generation or production of services.

Direct measures may be useful such as customers served by a cash register operator or calls taken by a customer service representative and certainly management does use such measures. But often these are hard to apply to professional service environments where many participants contribute to a process and service. Most commonly we use indirect measures such as absenteeism, hours worked, tardiness, safety rule violations, number of grievances filed, or employee turnover.

The reason these are indirect measures is that managers often assume that hours worked equates to productivity. Yet, there are many examples where workers are not efficient and hours worked do not equate to productivity. This is one of the problems with managers allowing more telecommuting. Telecommuting requires managers to use other measurements of productivity beyond hours worked such as projects completed or in the case of lawyers, billable hours.

In a fairly recent study in Australia a law firm tracked the before and after sick days after a move to a five Green Star-rated building, a high rating in Australia, and found sick days reduced by 39% overall to 0.28 days per month. That change
alone cut the average monthly cost of sick leave significantly. Other productivity gains were said to have “gone through the roof.” But this is one case study, and we need to know if we can generalize from such indicators (Dunckley, 2007).

Drucker (1999) also suggests that knowledge-intensive work is not easily quantifiable. He points out the common delays in outputs or results from inputs or the variations in quality and the lack of a measurement culture among management.¹ There is also the problem of controlling environments such as interruptions to work by colleagues or the general public or social interactions with clients that may support long-term or team success but take away from current short-term productivity. We are left with indirect and subjective productivity measures in most cases, based on subjective assessments. Subjective productivity data is usually collected using survey questionnaires gathered from employees, supervisors, clients, customers, or suppliers. Survey data is subject to all sorts of biases so any survey data including the qualitative data provided here should be repeated and based upon as large and representative a sample as possible.

## Objective and Subjective Productivity Measurement

Halpern, Shikiar, Rentz, and Khan (2001) performed a study to quantify the differences in productivity between current, former, and never-smokers in the workplace. The targeted sample was 300 employees at a reservation office of a major U.S. airline. The study consisted of three types of productivity measurement, including assessment of absenteeism, objective assessment, and subjective assessment of productivity.

The reservation center collected data on number of attendance interruptions, absenteeism days, and lost hours caused by both absenteeism and work injury as an assessment of absenteeism.

The reservation center collected other objective productivity measures based on an employee’s performance:

1. Revenue calls handled: The number of calls leading to a sale handled per month by an employee.
2. Ticket delivery system segments: The number of flight segments arranged by reservation personnel for delivery.
3. Call work time: The average time a reservation clerk is unavailable between calls.
4. Hours lost: The average time a reservation clerk is unavailable between calls without a sanctioned excuse.
5. Potential flown segments: The total number of flight segments booked in the past scheduled to fly during the time period reviewed.

In addition, five measures of productivity were assessed as performance ratios:

1. Dollar amount per revenue call handled.
2. Dollar amount per productive sign-in time.
3. Potential flown segments per revenue call handled.
4. Potential flown segments per productive sign-in time.
5. Ticket delivery system segments per productive sign-in time.

The Health and Work Questionnaire (HWQ) assesses productivity subjectively and consists of 24 questions. Six subscales were identified and include productivity, impatience and irritability, concentration and focus, work satisfaction, satisfaction with supervisor, and personal life satisfaction.

The results showed current smokers had significantly greater absenteeism than did never smokers, with former smokers having intermediate values; among former smokers, absenteeism showed a significant decline with years following cessation. Former smokers showed an increase in seven of 10 objective productivity measures as compared to current smokers, with a mean increase of 4.5%. Workplace productivity increased and absenteeism decreased among former smokers as compared to current smokers. If smoking affects productivity then so may air quality in general, something encouraged by better ventilation in green buildings.

**Evaluating Productivity Measurement**

In this paper, Haynes (2007a) evaluates different methods of assessing productivity. The author presents historical context to office design and reviews appropriate literature. The review aims to establish the limitations in defining office productivity and the range of approaches to its measurement. Aronoff and Kaplan (1995) suggest using absence measures, activity logs, and attitude and opinion surveys, along with direct measures. Hadi (1999) believes productivity measures should be split into three sections: quantifiable and tangible measures, indirect measures, and organizational measures such as teach-work and creativity using data collection methods such as questionnaires, observational techniques, structured interviews, focus groups, and job/task analysis. Oseland (1999) believes productivity measures should be split up into performance measures, self-assessed productivity, staff costs, and profit. The Office of Real Property (1999) suggests several measurements of productivity including turnover, absenteeism, self-assessment of workplace effects on one’s own productivity, time-tracking devices such as long books, overtime and project hours, observed downtime for modifications, complaints and interruptions, anecdotal evidence on workplace suitability, and finally churn costs, which include employee downtime, space move costs, and time to execute a move and get a person back up and running.

The review of the literature reveals that there is no universally accepted measure of office productivity but recent researchers have adopted the self-assessment approach. Haynes’ follow-up paper (2007b) establishes links between real estate and facilities performance metrics and the organizational performance metrics. The aim of Haynes’ follow-up paper was to provide a validated theoretical framework for the measurement of office productivity.

Haynes (2007b) suggests that office productivity can be linked to the physical office environment through office layout and office comfort. It can also be linked
Green Buildings and Productivity

Jennifer R. Ellis

Recent Workers’ Productivity Gains from Technology or Economic Pressures

According to the results from the 2008 White Collar Productivity Index (WPI), the only study of its kind providing long-term data on how people actually spend their time at work, there was a reduction in the time people are spending on low productivity tasks during 2007 as compared to both 2006 and 2005. According to Bary Sherman, CEO of PEP Productivity Solutions, “The WPI study indicate[s] that America’s white collar workers are becoming smarter and more effective in their day-to-day routines. They appear to have a better grasp on how to use technology as a productivity tool and are getting more of the right work done in less time. Until this year we have seen a steady increase in non-productive time usage every year since we started measuring office productivity in 1994. It will be exciting to see how this trend plays out over the next years.”

The WPI study (PEP, 2008) generated serious interest from academia and organizations when it was first made public in 2005, presenting annual statistics collected since 1994 from over 3,200 employees (administration, staff, middle management, and senior executives) in major U.S. companies representing a variety of sectors, including the manufacturing, automotive, finance, biotech, education, insurance, accounting, and technology industries. The core subjects to the behavioral environment, which likely has a greater impact on office productivity. Haynes established a model to represent the concept of office productivity with the dimensions of both the physical and behavioral environment. His model used seven distinct components to represent office productivity:

1. Distraction (interruptions, crowding, noise, privacy, overall atmosphere).
2. Environmental services (ventilation, heating, natural lighting, artificial lighting).
3. Office layout (personal storage, general storage, work area, desk, overall office layout, position of colleagues, circulation space).
4. Interaction (social interaction, work interaction, physical security, creative physical environment).
5. Designated areas (informal meeting areas, formal meeting areas, quiet areas).
6. Comfort (décor, cleanliness, overall comfort).
7. Informal interaction points (position of equipment, refreshment areas).

Evidence from the study proves that interaction and distraction have the greatest negative and positive influence on self-assessed productivity. The goal is then to find the optimum balance between encouraging positive interactions while reducing negative distractions and to allow group collaborative working to coexist with individual private working. This can only be achieved if the office designers can identify and quantify the impact of the behavioral environment on office occupiers’ productivity.
measured by the 2008 WPI study are handling email, handling paper mail, attending meetings, working overtime, delegating responsibility, dealing with interruptions, looking for lost data, managing work backlogs, and planning work. What may be happening is that as the economy weakens we are forced to work smarter and more efficiently. In other words, highly profitable firms or economies allow more goofing off.

The entire WPI, expressed in hours per week, per person, is as follows:

<table>
<thead>
<tr>
<th>Issue</th>
<th>2006</th>
<th>2007</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Handling Email</td>
<td>9.4</td>
<td>7.3</td>
<td>−22%</td>
</tr>
<tr>
<td>Handling Paper Mail</td>
<td>1.2</td>
<td>1.0</td>
<td>−17%</td>
</tr>
<tr>
<td>Attending Ineffective Meetings</td>
<td>3.0</td>
<td>2.2</td>
<td>−27%</td>
</tr>
<tr>
<td>Working Overtime</td>
<td>5.8</td>
<td>4.4</td>
<td>−24%</td>
</tr>
<tr>
<td>Delegating Work</td>
<td>4.3</td>
<td>3.0</td>
<td>−30%</td>
</tr>
<tr>
<td>Being Interrupted</td>
<td>4.6</td>
<td>3.8</td>
<td>−17%</td>
</tr>
<tr>
<td>Looking for Information</td>
<td>1.6</td>
<td>1.3</td>
<td>−19%</td>
</tr>
<tr>
<td>Working on Backlog</td>
<td>3.0</td>
<td>2.2</td>
<td>−27%</td>
</tr>
<tr>
<td>Planning Work</td>
<td>2.0</td>
<td>2.1</td>
<td>+0.5%</td>
</tr>
</tbody>
</table>

**Telecommuting and Productivity**

Telecommuting is becoming more prevalent in today’s workplace. It has evolved for various reasons for employees and employers. Employers may opt to allow their employee to work from home when rush-hour traffic is a true hindrance in arriving to work at a set time, hence reducing commuting time and potentially increasing productive work hours. Working mothers who cannot afford to maintain a full-time job and a full-time household now have access to achieving the goals of home and work through telecommuting options. In addition, the working student or professional that seeks to further his education is more valuable to the company working from home where he can still maintain his workload and focus on scholastic achievement simultaneously. Many workers, who for various reasons, prefer or need to work from home, when permitted assist firms in the retention of successful talent. Thus the prevalent need for telecommuting forces recognition of its pertinent impact on worker productivity.

Jensen (2008) examined employee and manager awareness of home-office distractions and productivity. He found that “a positive relationship exists between the level of managers’ self-reported awareness about telecommuters’ home-office environment distracters and managers’ self-reported levels of telecommuters’ productivity.” The managers’ mean reported that the immediate manager had a low level of awareness of home-office distractions for the telecommuting employee. His study showed that even when managers were aware of these
distractions, they did not rigorously attempt to solve the problem. Thus management acknowledged the changing workforce and is learning to manage the telecommuter. The telecommuter is becoming a growing percentage of the workforce, so if management does not determine how to effectively manage them now and implement new policies, there will be an insurmountable dilemma in the future.

Health and Productivity

Health care maintenance has a close relation to an employee’s productivity level. In times of economic turmoil, Taggart (2009) states that employers reduce company health care premiums to alleviate uncontrollable financial losses in other areas. When in actuality states Taggart, “the cost per month per employee for wellness programs can range from as low as $2 (more traditional health promotion only) to $10 depending on the complexity of the program.” Companies neglect the importance of the health of their workforce when it is in competition with financial incentives of reducing company health care costs. Perhaps the question to ask is “How much will NOT investing in wellness cost my business?”

The company obtains its cost reduction through passing-on higher deductibles and out-of-pocket expenses to the employee. Often the employer rationalizes that this shift of liability grants the employee autonomy over their own health, but in periods of economic hardships many employees also have a decrease in expendable cash flow and health care costs can be one of the first expenses to be eliminated.

Employees realize the benefits of a healthy mental and physical state of being, and prefer its rewards versus the companionship of stress and physical ailments. Therefore, through the implementation of employer-sponsored wellness programs “employees can and will change their lifestyles if approached in the right way and consistently reinforced through the process,” (Taggart, 2009).

Taggart (2009) believes that company wellness programs must be aligned with the preferences of the employees. If programs are viewed as beneficial to employees’ health, there can be a two-fold advantage for the company. First, worker productivity will improve in the future for the organization. Second, company morale will increase due to the company’s interest and success in the betterment of employee health. Successful wellness programs focused on the employee include time management training, conflict resolution classes, and team-building exercises. Yet some alternatives are coordinated to assist with external employee matters, such as child care, legal assistance, and elder care. All approaches should be available through numerous access points, whether via online learning, telephone, one-on-one, or group activities, so that all employees can utilize these resources despite their personality type.

Today’s work culture is team oriented, hence if one employee is absent or not working at full productivity, then the team is hurt exponentially. If employer-implemented wellness programs can reduce absenteeism, increase presenteeism
(when employees come to work in spite of illness), decrease employee turnover, and increase employee retention then the financial benefits to the company will eventually outweigh the present costs of health care premiums. “The challenge for employers is to help employees begin to connect productivity with being in better health, greater life satisfaction, and being physically active,” (Taggart, 2009).

Temperature and Productivity

Many office studies were performed in call centers where the time required talking with customers, the processing time between calls with customers, and other relevant information were automatically recorded in computer files. In these studies, the speed of work, e.g., average time per call or “average handling time,” was used as a measure of work performance. Laboratory studies typically assessed work performance by having subjects perform one or more tasks that simulated aspects of actual work and by subsequent evaluation of the speed and/or accuracy of task performance. Seppanen, Fisk, and Lei (2009) calculated the quantitative effect on performance of temperature. “We calculated from all studies the percentage of performance change per degree increase in temperature, positive values indicating increases in performance with increasing temperature, and negative values indicating decreases in performance with increasing temperature. We also applied a weighting factor based on the authors’ judgment of the relative relevance of the performance outcome to real work. For these judgments, we assumed that measurements of the performance changes of real work in office workers was more representative of overall real-world work performance, and should be weighted higher than performance changes in computerized tasks, such as proofreading or typing, that simulate a portion of work. We also assumed that performance changes in simulated work tasks were more relevant (deserved more weight) than performance changes in school tests, manual tests, and vigilance tests. Using command “regress” in Stata 8.2 for Windows (a program that selects the best-fitting linear model of dependent variable on explanatory variables), we fit a quadratic model to the data for normalized percentage change in performance vs. temperature unweighted, weighted by sample size, and weighted by combined final weight separately.” The results show that performance increases with temperature up to 21–22°C (69–72°F), and decreases with temperature above 23–24°C (73–75°F). The highest productivity is at a temperature of around 22°C (71.6°F). For example, at the temperature of 30°C (86°F), the performance is only 91.1% of the maximum (i.e., the reduction in performance is 8.9%). The conclusion is that temperature matters and influences productivity.

Indoor Air Quality and Productivity

A series of experiments to determine limiting criteria for human exposure to the very low levels of indoor humidity that occur in aircraft cabins at altitude (<10% RH) and in winter in cold countries (<20% RH) was performed in two climate
chambers at The International Center for Indoor Environment and Energy (ICIEE). Three different office tasks were simulated, including text-typing from a hard-copy onto a computer screen, proofreading a printed text into which spelling, grammatical, and logical errors had been inserted, and an addition of a column of five two-digit random numbers, without zeros, printed conventionally. In these tasks, the rate of working and percentage errors were examined separately. In the first air quality experiment, a performance assessment battery that has been widely used for military purposes was used instead of the proofreading task, but as it proved insensitive to environmental conditions it was not used in subsequent experiments. Open-ended tests of memory, recall, and creative thinking were applied in most of the experiments. “Field intervention experiments in two call-centers demonstrate that the decrement in performance can be larger in practice than it is in realistic laboratory simulation experiments,” (Wyon, 2004).

“It has now been shown beyond reasonable doubt that poor indoor air quality in buildings can decrease productivity in addition to causing visitors to express dissatisfaction. There is an approximate 20% to 70% linear relationship between the percentage dissatisfied with indoor air quality and the measured decrement in performance. The size of the effect on most aspects of office work performance appears to be as high as 6%–9%, the higher value being obtained in field validation studies. It is usually more energy-efficient to eliminate sources of pollution than to increase outdoor air supply rates. The experiments summarized by Wyon (2004) documented and quantified relationships that can be used in making cost-benefit analyses of either solution for a given building. The high cost of labor per unit floor area ensures that payback times will usually be as low as two years.”

Indoor Pollution and Productivity

Bako-Biro, Wargocki, Weschler, and Fanger (2004) describe a study where 30 subjects were exposed for 4.8 hours in a low-polluting office to each of two conditions: the presence or absence of three-month-old personal computers (PCs). During exposure, subjects performed simulated office work consisting of text typing, proofreading, and arithmetical calculations (addition and multiplication of numbers). These are typical office tasks requiring concentration and in previous studies were shown to be sensitive to changes in air quality. The subjects assessed perceived air quality, indoor climate, and SBS (Sick Building Syndrome) symptoms upon entering the office and on several occasions during exposure. The subjective responses and performance data were analyzed using either the Wilcoxon matched-pairs test or the paired t-test, depending on whether or not the data were normally distributed. A binomial test was used whenever the other two tests failed to show significance. A chi-square test was used to analyze the data in $2 \times 2$ contingency tables. Reported $P$-values for a one-tailed test were in the expected direction, showing that the presence of PCs has negative effects on air quality, increases SBS symptoms, and reduces productivity.
Moving and Productivity

What is the impact on worker productivity of an organization physically moving their office into a new space from a pre-existing space? This question is important as we could have a placebo effect and thus biased results when asking about worker productivity after moving into a green building. A Montreal corporation chose to relocate its office to provide employees with an open atmosphere for increased communication, collaboration, teamwork, and an overall increase in the quality of the company’s services. The new office was designed to increase productivity through the creation of accessible space for employees to share and generate new ideas.

Vischer (2005) showed “that the two buildings differ slightly in their effects on work, with workstation comfort being more supportive in the new building. Air quality is rated positively in both buildings, but more so in the new building. Thermal comfort and lighting quality are neutral in both buildings but draw no energy away from the performance of work. Privacy (or lack of it) is drawing energy away from task performance in both buildings, and in the new building, poor acoustic conditions are also having a negative effect.”

Overall, the Vischer (2005) survey results indicate that the newer workspaces are more supportive of workers but that new buildings often had chemicals that polluted the air from concrete, paint, or carpets. So new buildings do not necessarily increase worker productivity and often decrease it when the presence of pollutants is temporarily increased.

Building Intelligence and Productivity

Clemets-Croome (2000) argue that occupants of an office with “advanced building intelligence” experience decreased rates of illness and absenteeism and that advanced building intelligence should ultimately increase worker productivity. He begins by examining brain rhythm patterns to understand the nature of concentration, which is at the fundamental level of productivity since the mind and body need to be in good condition for ideal work and concentration. Brain rhythm patterns can be observed by measuring the beta and theta rhythms, which are related to different states of concentration and are therefore linked to productivity.

Clemets-Croome (2000) reviews many academic papers regarding productivity and the workplace. Some of the productivity measures mentioned include absence from work or workstation, sickness records, incidents of accidents, health costs including sick leave, accidents and injuries, interruptions to work, controlled independent judgments of work quality, self-assessments of productivity, speed and accuracy of work, output from pre-existing workgroups, cost for the product or service, exchanging output in response to graded award, volunteer overtime, cycle time from initiation to completion of process, multiple measures at all organizational levels, visual measures of performance, health and well-being at
work, development of measures and patterns of change over time, mental performance through word puzzles, number of errors made per subject per hour, employees leaving work early, extra long breaks/lunches, and self-reports of productivity.

Measuring productivity using absentee rates, sick leave, and health and well-being at work are deemed unreliable because they may be attributable to entirely different factors. It costs more to employ people than to maintain and operate a building; hence spending money on improving the work environment may be the most cost-effective way of improving productivity. Overall Clements-Croome (2000) concludes that determining a quantitative relationship between environment and productivity proves to be highly challenging and controversial.

**Innovative Workplaces and Productivity**

"Two concurrent trends have helped our professional focus shift from ‘place’ to ‘workplace.’ One is the recognition of knowledge work as being qualitatively—and fundamentally—different from the task-oriented work of the industrial age (a category that, despite the nomenclature, would include ‘office work’). The other trend is the recognition of knowledge workers as ‘human capital’ that can be enhanced by environmental improvements and amenities,” (Kaczmarczyk and Murtough, 2002).

Kaczmarczyk and Murtough (2002) established three models to measure total workplace as opposed to facility performance. Those models are the “GSA Cost Per Person” model (U.S. General Services Administration), the “Employee Satisfaction with the Workplace” model, and the “Productivity Payback” model.

The “GSA Cost Per Person” model measures the default values for the base case based on an actual pilot study in the GSA Central Office building in Washington, D.C. The model is a spreadsheet that allows users to input their own data or to accept default values in the absence of known cost data. Reviewers of the draft model consist of professional colleagues from the facility management and real estate disciplines, who could not provide feedback on the information technology and telecommunications cost data in the model. Often these data were not available in their organizations. Consequently, a good deal of the professional interest in the Cost Per Person Model lies in the value of the base case data it supplies. The model is a useful tool for systematically comparing the cost implications of working in the main office facility versus alternative work environments such as that of a telecommuter. Some basic components are: real estate, telecommunications, information technology, workstation furniture, and alternative work environments.

The “Employee Satisfaction with the Workplace” model developed the conceptual “Workplace Performance Model.” The workplace can be divided into three components: people, places, and tools. A high-performing workplace is defined by three measures: employee satisfaction, productivity, and employee retention. A workplace analysis based on the survey design was developed on the above
assumptions: the presence of particular factors in the people, places, and tools; the components of the workplace; and then gauged the respondents’ satisfaction with each component.

The “Productivity Payback” (PPM) model used the concept of productivity in a broader analytical framework. The PPM is based on the perspective that investments in the workplace are primarily investments in the people who work there. The model uses compensation cost as a proxy for productivity. Investments are categorized according to the people, places, and tool’s scheme discussed earlier. PPM addresses two questions: (1) How much must productivity of the employees increase to offset the workplace investment (return on investment)? and (2) How confident are we that the required productivity increase can be achieved?

A matrix in the PPM collects the results of workplace upgrades and interventions. Users can refer to the matrix to input the productivity increase required by the proposed investment in a real world context. The value of the PPM is its effect on the people, facilities, information technology, productivity, and investment in a relative context that facilitates better decision making.

“Many organizations, including the national governments of the U.S. and Canada, have realized that the workplace has a critical impact on the performance of the people who work there...The measurement challenge has already moved past the justification stage. This is not an attempt to ‘prove’ that innovative workplaces are a good idea. They are already part of the facilities management picture, and will become increasingly more prevalent and important. What is needed are tools and models that will help to measure their impact on human capital development so that the best investment decisions can be made—investment focused on primarily people and not buildings,” (Kaczmarczyk and Murtough, 2002).

Office Environment Color and Productivity

Kwallek (2007) provided a report from a large-scale study that examined the effects of three office color interiors (white, predominately red, and predominately blue-green) on worker productivity. Matched on relevant variables, participants were assigned to one of three offices and performed simulated office tasks for four consecutive days. Productivity was measured through workers’ task performance and task accuracy, taking into account individual differences in environmental sensitivity (i.e., stimulus screening)... Trait arousability can be defined ‘by strength of arousal response to sudden increase in complexity, variation, novelty, and/or unexpectedness of stimuli,’ stimulus screening is conceptualized as individual innate ability to routinely block or filter out irrelevant stimuli within one’s surrounding. Screeners are individuals who are more capable of screening irrelevant stimuli and thus are more adept at simplifying information from sensory input... The findings suggested that the influences of interior colors on worker productivity were dependent upon individuals’ stimulus screening ability and time of exposure to interior colors. Implications of office workers’
long-term productivity are discussed in relation to issues concerning the visual complexity of interior environments.”

This study was performed to measure a correlation of office wall color with productivity. Productivity was measured through workers’ task performance and task accuracy. Participants spent four days in a simulated office setting performing office tasks. Three tasks were chosen to test task performance and task accuracy: proofreading text, proofreading ZIP Codes, and a typing test. Subjects were judged by the number of errors made.

Kwallek (2007) found that, “There is a prevailing perception that some colors are more productive than other colors. Specifically, warm colors, such as red, are assumed to have more arousing effects on human responses than cool colors, such as green and blue. On the basis of his work with brain-impaired participants, Goldstein proposed that red, a warm color, has an ‘expansive’ property. The color red increases human receptiveness to external stimuli and induces a state of excitation, which would affect an individual’s emotional and motor responses. In contrast, he suggested that green, a cool color, has a ‘contractive’ property, which provokes human withdrawal from the external stimulation and reduces one’s receptiveness to external influences. In addition, he suggested that green has a soothing effect on emotion and performance.

Kwallek (2007) found that: “In terms of text proofreading accuracy, no overall significant interaction effect of stimulus screening ability and color interior was found, F(4,81) = 1.23, ns. There was no significant difference found in any of the offices. In brief, except for ZIP Code proofreading task, no overall pattern of difference (color-stimulus screening-day interaction) was detected in task accuracy. This can be due to the fact that, on average, the number of errors made by the participants was small and it prevented us from identifying significant group difference in task accuracy. The color stimulus screening interaction was only reported in the white office interior in terms of task accuracy. In general, low and moderate screeners committed more errors in both typing and ZIP Code proofreading tasks toward the end of the work week, compared with high screeners. However, contrary to the hypothesis, this pattern was not found in either the predominantly red or blue-green office interior.” Color was found to have a very modest impact on productivity and could be eliminated if workers were able to self-focus on the task at hand.

Workplace Illumination and Productivity

Hoffman (2008) writes about the relationship between workplace illumination and employee productivity and well-being. Eleven volunteers performed experimental office work in two different lighting environments. The simulated office work consisted of general and special ability tests, which were all part of the Vienna Test System. Urine samples and a questionnaire were the measurement tools used in this study. Power analyses and statistical evaluations of the data were
performed. Hoffman concludes that variable light exerts a potential advantage in indoor office accommodations with respect to subjective mood. Light matters.

**Employee Engagement and Productivity**

The question of productivity is difficult to study absent some controls for management and behavior. Some managers may believe that it is not important for an employee to like their job, but Irvine (2009) has reported otherwise. Employees must be engaged strategically by their firm. It is not enough to think that the mere appreciation of being employed gives the employee satisfaction, but the employer must proactively design a system to engage each employee or face turnover. Taggart (2009) has found that 40% of employees turnover within five years of employment. Yet when workers are connected with the company mentally and emotionally, they “are twice as likely to be top performers and miss 20% fewer days of work,” (Irvine, 2009). Among engaged employees, employers reap the benefits of increases of operating income in upwards to 19% “vs. companies with the lowest percentage of engaged employees saw a 33% decline.” (Irvine, 2009). Employers need to follow the example of these companies and dedicate their employees to the company, not to a paycheck. Employee retention is at the heart of how well a company engages and motivates their human capital. Management likely matters more than most environmental factors.

**Sick Building Syndrome**

According to the U.S. Environmental Protection Agency, Sick Building Syndrome (SBS) is caused by four major categories, as listed below:

*Inadequate Ventilation*

In the early- and mid-1900s, building ventilation standards called for approximately 15 cubic feet per minute (cfm) of outside air for each building occupant, primarily to dilute and remove body odors. As a result of the 1973 oil embargo, however, national energy conservation measures called for a reduction in the amount of outdoor air provided for ventilation to 5 cfm per occupant. In many cases, these reduced outdoor air ventilation rates were found to be inadequate to maintain the health and comfort of building occupants. Inadequate ventilation, which may also occur if Heating, Ventilating, and Air-Conditioning (HVAC) systems do not effectively distribute air to people in the building, is thought to be an important factor in SBS. In an effort to achieve acceptable indoor air quality while minimizing energy consumption, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) revised its ventilation standard to provide a minimum of 15 cfm of outdoor air per person (20 cfm/person in office spaces). Up to 60 cfm/person may be required in some spaces (such as smoking lounges) depending on the activities that normally occur in that space (see ASHRAE Standard 62-1989).
Chemical Contaminants from Indoor Sources

Most indoor air pollution comes from sources inside the building. For example, adhesives, carpeting, upholstery, manufactured wood products, copy machines, pesticides, and cleaning agents may emit volatile organic compounds (VOCs), including formaldehyde. Environmental tobacco smoke contributes high levels of VOCs, other toxic compounds, and respirable particulate matter. Research shows that some VOCs can cause chronic and acute health effects at high concentrations, and some are known carcinogens. Low-to-moderate levels of multiple VOCs may also produce acute reactions. Combustion products such as carbon monoxide, nitrogen dioxide, as well as respirable particles, can come from unvented kerosene and gas space heaters, woodstoves, fireplaces, and gas stoves.

Chemical Contaminants from Outdoor Sources

The outdoor air that enters a building can be a source of indoor air pollution. For example, pollutants from motor vehicle exhausts, plumbing vents, and building exhausts (e.g., bathrooms and kitchens) can enter the building through poorly located air intake vents, windows, and other openings. In addition, combustion products can enter a building from a nearby garage.

Biological Contaminants

Bacteria, molds, pollen, and viruses are types of biological contaminants. These contaminants may breed in stagnant water that has accumulated in ducts, humidifiers, and drain pans, or where water has collected on ceiling tiles, carpeting, or insulation. Sometimes insects or bird droppings can be a source of biological contaminants. Physical symptoms related to biological contamination include cough, chest tightness, fever, chills, muscle aches, and allergic responses such as mucous membrane irritation and upper respiratory congestion. One indoor bacterium, Legionella, has caused both Legionnaire’s Disease and Pontiac Fever.

These elements may act in combination, and may supplement other complaints such as inadequate temperature, humidity, or lighting.

Some New Research

Research discussed above suggests that new buildings may often result in sickness-inducing environments as pollutants are generated from carpets, paint, and concrete and constructed without regard to chemical compound release. Thus, it is not uncommon for newly occupied buildings to not meet modern ASHRAE standards or LEED standards and result in an increase in SBS where occupants report higher levels of illness. ENERGY STAR-labeled buildings do not necessarily have healthier environments, although we presume that the ENERGY STAR label is correlated with healthier buildings.

Our hypothesis: Green buildings (ENERGY STAR-labeled or LEED-certified) provide more productive environments for workers than non-green buildings.
Methodology: We use two measurements of productivity: sick days and the self-reported productivity percentage change after moving into a new building. We admit that this is preliminary, but the data set is far larger than any other previously collected from ENERGY STAR or LEED certified buildings.

Data and Results

In May of 2009 a team from CBRE and the University of San Diego surveyed 154 buildings containing over 2,000 tenants that were deemed green by virtue of either the ENERGY STAR label or LEED certification (at any level). Some 534 tenant responses were collected from buildings spread across the country, as shown in Exhibit 1. Forty-four percent of the buildings were located in the central business district (CBD) while 56% were midtown or suburban; 94% of the buildings were multi-tenant. Most buildings were Class A or A−. Exhibit 2 shows the legal status of the tenant types, predominantly the private sector. Exhibit 3 shows the breakdown of tenants by industry type with the largest being Other at 33%, suggesting we need to pin this down in further research. Of standard categories, financial services and legal were the largest groups. Exhibit 4 shows the years in business, and we can see that most firms have been in business a long time—more than 20 years. Exhibit 5 shows the gross annual pay of employees; the mode group is in the $50,000 to $75,000 range while the average was about $106,644. As shown in Exhibit 6 (see the left bar for the sample group), this figure is far above industry averages, suggesting that green-occupying tenants

Exhibit 1 | Location of Buildings Surveyed
Exhibit 2 | Tenant Types by Ownership Status

Source: CBRE and USD Survey Data 2009.

tend to be from more productive industries. In Exhibit 7, we see some other benefits of occupying green buildings—higher employee morale, lower turnover, and greater ease of recruitment.

With respect to those all important questions on productivity and sick days, we show in Exhibit 8 that 12% strongly agree that employees are more productive, 42.5% agree that employees are more productive, and 45% suggest no change. In Exhibit 9, we see that 45% agree that workers are taking fewer sick days since moving, 45% find it is the same as before, while 10% of those find more sick days. The 10% that reported more sick days were residents of ENERGY STAR-labeled, not LEED-certified buildings. But both LEED buildings and ENERGY STAR buildings have air quality requirements, so we see this result as difficult to explain. It appears that they suffer what often happens to new buildings when ventilation systems are not kept clean or VOCs are not eliminated from new construction materials and finishes. We need to do further work on this 10% to verify why they ran into more sick time, but we should emphasize that these are not LEED-certified buildings. Of those who did find less sick time than before, the mode was two days less sick time, followed by five days less sick time, as shown in Exhibit 10.

Note that not all tenants found productivity increases; the literature suggests that behavioral influences such as management mean as much or more than environmental factors. Note also that these buildings are for the most part ENERGY STAR-labeled buildings and not necessarily LEED-certified buildings. If we take only those tenants who claimed an increase in productivity, we observe economic impacts based on salaries that approach the cost of rent using a very conservative square foot per worker assumption. Total revenue enhancement may be more or less. If we used 200 square feet per worker the results would be closer to or exceed typical rents from this one single impact. The LEED results were
slightly better at 5.24% increased productivity but we use the entire sample here. We expect that future data on LEED-certified buildings, which score high on environmental dimensions, will see similar if not better results.

<table>
<thead>
<tr>
<th>Productivity Impact for Those Tenants Who Claimed Greater Productivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Productivity Increase</td>
</tr>
<tr>
<td>Average Salary (Note: There are other ways to measure this)</td>
</tr>
<tr>
<td>Average Impact Per Worker in Value Add</td>
</tr>
<tr>
<td>Net Impact at 250 Sq Ft Per Worker Using Salary as Index</td>
</tr>
<tr>
<td>(Note: Impact could be more on marginal revenues than this)</td>
</tr>
</tbody>
</table>

Repeating the same analysis using the average sick day declines and excluding the 10% that claimed an increase in sick days, we find potentially another nearly
$5 PSF in economic impact. Again, it would be better to have real productivity impacts based on longer-term revenues, but these are nearly impossible to estimate. We also recognize that simply being located in an ENERGY STAR building does not ensure less sick time. We do know that highly rated LEED-certified buildings (Gold, Platinum) should exhibit fewer sick days with better light, ventilation, and less contaminated, cleaner air.
**Exhibit 6** | Mean Wage of Employees in Green Buildings Compared to Industry Averages


**Exhibit 7** | Tenant Perceived Benefits from Occupying Green Space

Source: CBRE and USD Survey Data 2009.
**Exhibit 8** | Employees are More Productive

Source: CBRE and USD Survey Data 2009.

**Exhibit 9** | Number of Sick Days Taken Compared to Previous Location

Source: CBRE and USD Survey Data 2009.
Exhibit 10 | How Many Fewer Sick Days are Employees Taking?

Source: CBRE and USD Survey Data 2009.

Exhibit 11 | Other Benefits

Source: CBRE and USD Survey Data 2009.
Productivity Impact of Fewer Sick Days Using Average Survey Results

<table>
<thead>
<tr>
<th>Product</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Fewer Sick Days</td>
<td>2.88</td>
</tr>
<tr>
<td>Working Days Per Year</td>
<td>250</td>
</tr>
<tr>
<td>Average Salary</td>
<td>$106,644</td>
</tr>
<tr>
<td>Average Impact Per Worker in Value Add</td>
<td>$1,228.54</td>
</tr>
<tr>
<td>Net Impact at 250 Sq Ft Per Worker</td>
<td>$4.91</td>
</tr>
</tbody>
</table>

Conclusion

In the extreme, tenants tend to look for two kinds of space: as cheap as possible or high-quality space. Those who fall in the middle are often in space they have either occupied a long time or they have placed greater weight on location and other features. Healthier space need not be new space. In fact, some new buildings are extremely unhealthy as chemicals leach into the air from glues, carpets, concrete, and paint. There is no reason this must be the case. The cost to provide healthier environments is modest compared to the benefits.

Healthier buildings reduce sick time and increase productivity. The steps required to provide a healthier building are not that much of a design and engineering challenge. Generally, natural light, good ventilation, and the absence of organic compounds leads to happier, healthier workers. Appropriate temperature ranges or localized controls are also a big plus to workers and past research does support the notion of greater productivity from any or all of these improvements. Sick Building Syndrome should be a thing of the past, but it is not. ENERGY STAR-labeled buildings need not also be healthier, although generally they appear to be. More recently, we are finding a surge in LEED-certified buildings, which tend to require better and safer environments. We now have some evidence that there is an economic pay-off to tenants who pay attention to space quality. If you consider the benefits in terms of recruitment, retention of employees, lower sick time, and greater productivity, tenants should be willing to pay more rent for such space or require steep discounts for less healthy space. We have seen some evidence of rent differentials, even if tenants do not admit to being willing to pay more, and now we see economic support for a differential which will likely persist until all buildings improve environmental workspace quality.

What is increased productivity and reduced sick time worth in net present value terms? The early study by Kats (2003) suggested NPV benefits in the range of $37 to $55 per square foot. For an owner-occupied building, we can easily imagine NPVs equal to much more than these figures. For example, discounting $25 per year per square foot for 10 years at 10%, based on the sum of the two benefits shown above and rounded and assuming a 10-year differential for such benefits and a fairly conservative discount rate, we get a present value of $153.61 per square foot. It costs much less than this to build a better environment for workers, so the NPV certainly could reach $100 per square foot or more when an owner-occupant captures those benefits. But when the productivity and lower sick time
benefits accrue to a tenant who does not receive the higher residual building value created by a better building within an informed market, the NPV to tenants is less clear. Tenants should be willing to pay higher rent for better buildings and even though most tenants won’t admit to this (84% or more say “No”), we have found evidence in past studies that suggests they do pay premiums and based on the results here, these premiums of only 5% to 10% are a bargain.

Endnotes

1 Perhaps the challenge of developing new ways to measure productivity within knowledge-based work environments is too great for management researchers to solve.


References


*With assistance from Myla Wilson, University of San Diego; Lisa Collichio, CBRE Director of Operations, Sustainability CBRE; Judy Hill, CBRE; Kristin Bush (Golden Valley, Minn.); and Mahsa Allandet (Atlanta), who performed much of the data analysis during the summer of 2009.*

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How Risky Are Sustainable Real Estate Projects? An Evaluation of LEED and ENERGY STAR Development Options

Author  Jerry Jackson

Abstract  Recent empirical evidence on rent and occupancy premiums associated with sustainable buildings is used to evaluate risks and returns associated with green real estate development projects. Green building premium estimates are derived from four recent empirical studies while incremental green construction costs are based on a review of existing literature. Monte Carlo analysis is applied to determine the expected return and risk associated with two green building certifications. Findings reveal a mean internal rate of return for Leadership in Energy and Environmental Design (LEED) buildings of 126% with a 10% probability of achieving an IRR of 50% or less. Buildings with an ENERGY STAR certification achieve a mean IRR of 140% with virtually no probability (1.6%) of achieving an IRR less than 50%.

Recent public focus on sustainability issues has raised the visibility of Leadership in Energy and Environmental Design (LEED) and ENERGY STAR-certified real estate development projects. The U.S. Green Building Council’s (USGBC) LEED certification requires achievement of a minimum number of points from a scoring system based on sustainable design and construction practices. ENERGY STAR is a joint Environmental Protection Agency and Department of Energy Program that certifies buildings as ENERGY STAR if their energy use is in the best quartile of buildings in their business category.¹

The objective of this study is to apply recently available empirical evidence on sustainable building rent and occupancy differentials and sustainable building cost premiums to provide the first assessment of returns and risks associated with both LEED and ENERGY STAR sustainable real estate development projects.

A growing body of empirical literature indicates that LEED and ENERGY STAR-certified buildings do command higher rents and greater occupancy rates relative to conventional buildings. For example, rent premium estimates from four recent studies using the CoStar national real estate database range from 4.4% to 51%. Occupancy premiums range from 4.2% to 17.9%. Each of these studies attempted to control for other factors such as building age.

Many advocates promote LEED certification as a no-cost or minimal cost option. Indeed, the cost-consultancy firm of Davis Langdon (2007) evaluated costs of
LEED-certified buildings and found no statistical difference in cost/square foot between samples of LEED and non-LEED buildings for five different building types.

Considering this information from the developer’s perspective would seem to make the choice of sustainable versus conventional project development a rather easy choice. However, developer views of sustainable building projects are considerably less enthusiastic. A recent survey by Building Design and Construction (2007) in August 2007 found that while 94% of respondents thought the trend in sustainable building projects was “growing,” 78% thought sustainable design added “significantly to first costs.” Thirty-two percent of respondents estimated additional costs to be from 6% to 10%, while 41% estimated sustainable construction premiums to be 11% or greater.

These results are consistent with other surveys of developers and industry participants. For example, a recent survey by the World Business Council for Sustainable Development (2007) determined that U.S. building professionals estimated an average cost increase of 16% associated with sustainable buildings. CB Richard Ellis (Gomez, 2008), the largest real estate developer in the world, reports cost increase estimates of 5%–20% from design and construction consultants.

These developer views of significant incremental cost help explain why, despite prominent media coverage of LEED and ENERGY STAR projects provided by local media (U.S. Green Building Council, 2009), LEED and ENERGY STAR-certified buildings still reflect a small fraction of commercial building. New building LEED-certified construction projects totaled just 1,361 and existing building certifications number 162 as of November 2008 (U.S. Green Building Council, 2008). ENERGY STAR-certified buildings number 7,299 as of June 1, 2009 (Environmental Protection Agency, 2009). By comparison, the U.S. building stock includes over 5.5 million buildings with more than 120,000 buildings greater in size than 100,000 square feet (Market Analysis and Information System, 2009). Conventional building design is still the predominant design choice in most markets.

The discrepancy between the views of sustainable building advocates and general developer attitudes is the result of a variety of factors. While case study results make a compelling argument that some LEED building designs cost no more than conventional designs, these costs often do not include the “soft costs” associated with the extra cost of certification and issues such as code-compliance delays and related additional design and engineering support costs. In addition, promotion of the no-cost position is often viewed as biased because it is a common assertion of sustainable building advocates.

Until recently, the only information on sustainability premiums for building rents and occupancy was based on anecdotal information, which likely explains the perception by 60% of the respondents to the Building Design and Construction survey that markets are “not willing to pay a premium” for sustainable building.

The recent availability of empirical results from four national studies on sustainability rent and occupancy impacts along with an application of incremental
cost data derived from a variety of sources provides a new opportunity to evaluate the financial risks and returns associated with sustainable real estate projects.

Assessing financial returns on sustainable construction investments requires consideration of both the stream of benefits and the additional initial cost of sustainable construction and certification. If discounted rent and occupancy premiums are greater than the initial cost premium, sustainable real estate projects provide greater returns compared to conventional projects. On the other hand, if there is limited recognition of actual sustainable building benefits, like reduced energy costs, market forces will prohibit landlords from increasing rents sufficiently to cover costs.

The risks associated with sustainable real estate are determined by the uncertainty surrounding market-determined rent and occupancy premiums and cost premiums associated with sustainable buildings.

Developers considering sustainable projects also face an additional decision concerning certification options. Should they aspire to the more comprehensive, expensive, and stringent LEED certification process or the alternative ENERGY STAR certification that focuses only on energy use?

The next section discusses empirical data from four national studies on sustainable building premiums along with a summary of the literature on incremental cost differentials. The section that follows provides estimates of internal rates of return implied by each of the four studies. The next section applies Monte Carlo analysis to evaluate sustainable real estate development investment returns and risk based on simultaneous consideration of data from all four studies and information on LEED and ENERGY STAR costs. The final section provides several caveats and a summary of the analysis.

Empirical Evidence on Green Premiums and Costs

Rent and Occupancy Premiums

Four studies of sustainable building rent and occupancy premiums have been conducted with national CoStar Data (Fuerst and McAllister, 2008; Miller, Spivey, and Florance, 2008; Eichholtz, Kok, and Quigley, 2009; and Wiley, Benefield, and Johnson, forthcoming). CoStar is the leading collector of commercial property data providing information on hundreds of building attributes including rent, occupancy, value, and LEED and ENERGY STAR certification. Information on rent and occupancy premiums from the four studies is provided in Exhibit 1.

The Miller, Spivey and Florance (2008) study applied the CoStar “peered” data where each LEED or ENERGY STAR-certified building was matched to a non-green building with similar characteristics to provide one non-certified building for each certified building. The Fuerst and McAllister (2008), Eichholtz, Kok, and Quigley (2009), and Wiley, Benefield, and Johnson (forthcoming) studies analyzed certified buildings and a larger sample of non-sustainable buildings extracted from the CoStar database. Since the same basic data source is used for each of the
### Exhibit 1 | Comparison of Sustainability Rent, Occupancy, and Value Results

<table>
<thead>
<tr>
<th></th>
<th>MSF</th>
<th>FM</th>
<th>EKQ</th>
<th>WBJ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rent Premium (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENERGY STAR</td>
<td>8.93</td>
<td>18.88</td>
<td>8.90</td>
<td>8.62</td>
</tr>
<tr>
<td>LEED</td>
<td>50.54</td>
<td>9.68</td>
<td>4.40</td>
<td>17.3</td>
</tr>
<tr>
<td>Occupancy Premium%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ENERGY STAR</td>
<td>4.21</td>
<td>2.72</td>
<td>9.39</td>
<td>11.03</td>
</tr>
<tr>
<td>LEED</td>
<td>4.78</td>
<td>2.72</td>
<td>9.39</td>
<td>17.92</td>
</tr>
</tbody>
</table>

Notes: The sources: MSF (Miller, Spivey, and Florance, 2008), FM (Fuerst and McAllister, 2008), EKQ (Eichholtz, Kok, and Quigley, 2009), WBJ data are two-stage least squares estimates from Wiley, Benefield, and Johnson (forthcoming).

Studies, differences in parameter values are a result of model specification and the estimation data sample developed from the CoStar properties.

### Incremental LEED Costs

As indicated above, developers consistently refer to substantial incremental costs associated with sustainable buildings. Estimates of 10% to 15% are not unusual. However, reported developer and designer estimates may reflect a desire to accept “high-side” costs compatible with an extra hurdle requirement added to reflect the real option value of delaying the investment (Holland, Ott, and Riddiough, 2000; and Bulan, Mayer, and Somerville, 2009) or decision-maker loss aversion (Camerer, 2005), both of which are associated with investment uncertainty.

A variety of independent estimates of incremental green costs is available. The Miller, Spivey, and Florance (2008) study estimates a hard cost of about 2.5% based on a survey of 26 projects. Soft costs that include design, documentation, commissioning, modeling, and other costs associated with a green project probably range from about 0.5% (General Services Administration, 2004) to 1.5% (Simpson, undated). Using a soft cost midpoint of 1.0% (Choi and Scott, 2007) gives a Miller, Spivey, and Florance total (hard plus soft) certification cost of 3.5% of construction costs.

The Kats (2003) study reported costs of 0.66%, 2.11%, 1.82%, and 6.5% for certified, silver, gold, and platinum LEED buildings with an average of 1.84% for a sample of 33 buildings. These estimates, however, are based on data derived from a literature review, architects, building personnel, and members of California’s Sustainable Building Task Force USGBC staff and others and appear not to include a variety of soft costs. Adding an additional 1% for soft cost provides a middle range estimate of about 3%.

A more recent study by Kats (2006) found incremental LEED costs of 2% for educational buildings; however, the study did not incorporate all soft costs, which likely would increase the average to around 3%.³
The General Services Administration (2004) conducted a LEED cost study and estimated ranges of 0.03% to 1.45%, 0.14% to 4.94%, and 1.96% to 8.83% for certified, silver, and gold certifications. The average of the middle range is 2.5%.

Several sources point to higher costs. The American Chemistry Council (2003) estimated incremental construction costs of 3% to 8% with an additional soft cost estimate ranging from 1.5% to 3.1% to provide an overall average range of 4.5% to 11.1%. CB Richard Ellis (Gomez, 2008) reports incremental cost estimates of 5% to 20% from consultants for their sustainability initiatives; however, these estimates reflect both U.S. and international green applications.

Many LEED advocates suggest that LEED buildings actually cost less to construct than conventional buildings; primarily through savings associated with purchasing smaller chillers and savings in lighting and other HVAC costs. However, these savings are also associated with “best-practice” conventional design and construction, which is the appropriate baseline for identifying incremental costs of LEED and ENERGY STAR construction.

As indicated above, a wide range of LEED cost estimates exists. A developer considering a LEED project can reduce costs by planning for the lower LEED certification levels, since most tenants are unlikely to be aware of distinctions between certified, gold, silver, or platinum LEED designations.

After considering the 3.5%, 3%, 3%, 2.5%, 4.5%–11%, and 5%–20% estimates for incremental costs described above, 3% was selected as a reasonable “expected” estimate of a lower LEED certification cost. The studies mentioned above also suggest that a range of 1% to 5% is likely to capture most outcomes for a cost-conscious developer to achieve a LEED certification.

Other LEED Cost Issues

It is important to note one issue related to LEED costs that has caused considerable confusion. Several studies by the firm Davis Langdon (2004, 2007) have compared mean cost estimates for a sample of LEED and a sample of non-LEED construction projects for individual building types. Davis Langdon (DL) concludes in both the 2004 and 2007 report that “there is no significant difference in average costs for green buildings as compared to non-green buildings.” These statements are, understandably, generally interpreted to mean there is no additional cost associated with applying a LEED building design to what would have been a conventional building design.

While the DL statement is technically correct, the common interpretation is not. To see this distinction, consider the test used to evaluate the statistical difference between the two sample means shown below.

\[
t = \frac{\text{Difference in sample means}}{\text{Standard error of the difference}}.
\]
A *t*-value of about 2.0 or more establishes a statistical difference between the means. If the difference in sample means is $30/square foot but the standard error of the difference is $20/square foot, no statistical difference will have been established even though the measured difference is $30/square foot. The standard error of the difference is a measure of the variation in costs/square foot within each of the two samples. The greater the variation in $/square foot within each sample, the more difficulty the test has in distinguishing true difference in the sample means. A brief look at the DL report shows that costs/square foot variations within the samples are large, varying by a factor of two or more, resulting in large standard errors. In other words, the variation within the two samples swamps whatever true variation exists in LEED and non-LEED samples in the statistical test.

An analysis with data approximated from the DL report graph of academic buildings indicates that a true difference of about $50/square foot is required to overcome the variation inherent in the two samples. Since the true cost is certainly less than $50/square foot, the DL methodology virtually guarantees from the outset that the statistical test will fail to establish a statistically significant difference. This misapplication can be corrected by regressing building costs on all identifiable cost attributes and determining the incremental cost associated with those that are required for LEED certification.

**Incremental ENERGY STAR Costs**

Little direct information is available on incremental costs of achieving ENERGY STAR certification. However, the nature of the ENERGY STAR program lends itself to reasonably straightforward development of an incremental cost estimate. ENERGY STAR certification requires a building to achieve energy use in the best quartile of buildings in their business category based on an analysis of a national sample of commercial buildings.

The ENERGY STAR requirement is a relatively easy target to achieve, primarily because most commercial buildings are relatively inefficient. Two energy efficiency initiatives are typically sufficient for most new buildings to meet an ENERGY STAR target. The first is appropriate lighting design. Most commercial building lighting systems are overlit and undercontrolled. Since waste heat from lighting must be removed by the air conditioning and ventilation system, careful lighting design can dramatically reduce building energy use, reduce the size and cost of the air conditioning system, and reduce lighting system costs. Appropriately-designed lighting systems including task lighting, bi-level controls, low-cost daylight, and occupancy controls can reduce total building electricity by as much 20% or more.

The second efficiency initiative is building commissioning, which is the assessment and adjustment of building energy systems after construction to insure optimal performance given current occupancy characteristics and other factors. Building systems are rarely commissioned. Design flaws, neglected maintenance, equipment performance degradation, equipment failures, post construction
modifications, and other factors typically result in poor energy efficiency performance in most commercial buildings.

Commissioning for new buildings, which incidentally is required for LEED certification, costs around 0.7% of construction cost (Mills, et. al., 2004). Careful lighting design, including analysis of impacts on HVAC system requirements, is similar in many ways to commissioning efforts; consequently, we assume that the sum of lighting design and commissioning costs total 1.5% of new construction cost. This estimate is likely to be on the high side since lighting design savings in fixtures, ballasts, and lamps and resulting reduction in air conditioning and ventilation system costs can potentially pay for a significant portion of lighting controls and extra design costs.

A lower bound ENERGY STAR cost reference of 0.5% is provided in a recent Lawrence Berkeley National Laboratory study (Brown, Borgeson, Koomey, and Biermayer, 2008) that identified 34% savings potential (9% more than required for ENERGY STAR) in existing commercial buildings at a cost of about $1.25/square foot, or about 0.5% of a new building cost of $250/square foot.

We specify an ENERGY STAR mean incremental cost value of 1.5% of costs with a likely range from 0.5% to 2.5%. Exhibit 2 summarizes estimated incremental costs of LEED and ENERGY STAR certification.

---

**Sustainable Real Estate Investment Returns: Expected Values**

Financial benefits of a sustainable building option can be calculated with data on conventional building rent \((R, \$/\text{square foot})\), the green rent premium \((RP, \$/\text{square foot})\), conventional building occupancy \((O, \%)\), the green occupancy premium \((OP, \%, \text{difference between conventional and sustainable occupancy rates})\), the mean incremental cost of sustainable construction \((CP, \$/\text{square foot})\) from Exhibit 2, and the discount rate, \(r\), with the following equation:

\[
NPV = \sum_{t=1}^{T} \frac{O \times RP + OP \times (R + RP)}{(1 + r)^t} - CP. \tag{1}
\]

---

**Exhibit 2** | Incremental Costs of Sustainability Certification as a Percentage of Construction Cost

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>Mean</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEED</td>
<td>1.0</td>
<td>3.0</td>
<td>5.0</td>
</tr>
<tr>
<td>ENERGY STAR</td>
<td>0.5</td>
<td>1.5</td>
<td>2.5</td>
</tr>
</tbody>
</table>
Where NPV is the net present value in \$/square foot of the sustainability option, the first term to the right of the equal sign discounts and sums future annual financial benefits to a present value over the life of the asset, \( T \). \( CP \) is incremental cost of the sustainability option. An NPV greater than zero is a profitable investment, showing the present value of benefits and costs of developing a sustainable project rather than a conventional project. That is, NPV shows the value of the discounted financial premium stream beyond the cost premium required to develop a sustainable building.

Another measure of the return on the incremental sustainability investment is the internal rate of return (IRR). The IRR is the discount rate, \( r \), required to make the discounted benefits exactly equal the incremental sustainability cost (i.e., NPV = 0). That is, the IRR is the return implied by the investment cost and the future discounted benefits. Mathematically, the IRR is determined by solving the following equation for \( r \):

\[
CP = \sum_{t=1}^{T} \frac{O \times RP + OP \times (R + RP)}{(1 + r)^t}.
\]

IRR values greater than the firm’s cost of capital are considered profitable investments since the return on the investment is greater than the cost of funding the investment. This calculation is more complicated in reality because other factors such as tax issues enter the equation. However, the IRR calculation used here is indicative of the pre-tax return on an investment in the sustainability option.4

While rent and occupancy premiums can be expected to vary over time in response to the market demand and supply for commercial space generally and the demand for and supply of sustainable space in particular, we assume here that these costs are constant in real terms. Under these conditions, all of the variable values under the summation signs are constant over time providing the following Equation 2 simplifications:

\[
CP = (O \times RP + OP \times (R + RP)) \sum_{t=1}^{T} \frac{1}{(1 + r)^t}.
\]

Equation 3 is used in this study to determine the IRR implied by sustainability rent and occupancy premiums and incremental sustainability costs. A financial asset life \( T \) of 25 years is used for these calculations. It is important to note that Equation 3 does not require that assets actually be held for 25 years; rather it reflects the fact that benefits of a sustainability investment continue throughout the life of the asset. Individual developers can capitalize the stream of rent and occupancy premiums by selling the building; however, from a market perspective, this transaction reflects only a transfer of the asset from one owner to another without changing the underlying value of the rent premiums or capital value.
The values for the variables in (3) reflect expected values. Data from the MSF, FM, EKQ, and WBJ studies in Exhibit 1 and mean incremental costs in Exhibit 2 are applied to Equation 3 and presented in Exhibit 3. As indicated in Exhibit 3, financial analysis using empirical results from the four studies shows significant IRR for both LEED and ENERGY STAR buildings, though LEED results from the FM and EKQ studies may be too small to tempt developers.

Results in Exhibit 3 provide interesting insights on the financial returns implicit in the empirical results reported in the four studies; however, except for a general comparison of IRRs between the four studies, these results provide little guidance in assessing the financial risks of undertaking a sustainability project. For example, an average return of 97% on a sustainability development option is certainly attractive; however, if there is a 30% chance that the return will actually fall below a developer’s hurdle rate of 50%, the sustainability option is not attractive after all.

Real estate developers are certainly attuned to risk; consequently, a risk analysis is a more appropriate framework for addressing developer sustainability choices. Before turning to risk analysis, it is interesting to note that Exhibit 3 provides conflicting LEED versus ENERGY STAR comparisons across the four studies with MSF favoring LEED certification and the other three showing greater IRRs for ENERGY STAR certification.

Sustainable Real Estate Investment and Risk Analysis

Viewing the results of the four studies as independent samples from the population of CoStar buildings suggests a strategy for assessing sustainability investment risk. One can view the occupancy differentials for LEED buildings of 2.34%, 4.2%, 7.64%, and 17.0% across the studies as four estimates of the true population parameter. In this way it is possible to combine information from the studies into a single empirical framework.

LEED Risk and Return

Information from Exhibits 1 and 2 along with occupancy and rental rate data from the four studies is used to define distributions of likely population values for each parameter. Low, mean, and high distribution values for each of the variables are

<table>
<thead>
<tr>
<th></th>
<th>LEED</th>
<th>Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSF</td>
<td>189</td>
<td>89</td>
</tr>
<tr>
<td>FM</td>
<td>36</td>
<td>125</td>
</tr>
<tr>
<td>EKQ</td>
<td>42</td>
<td>115</td>
</tr>
<tr>
<td>WBJ</td>
<td>97</td>
<td>106</td>
</tr>
</tbody>
</table>
shown in Exhibit 4 for LEED analysis. Low and high rent and occupancy premium values are derived from low and high values for each parameter reported in Exhibit 1. Low and high values for incremental costs are discussed in a previous section and are shown in Exhibit 2. Normal distributions are applied with low and high values viewed as spanning 90% of the population values. Mean values are the average of the low and high values.

It should be noted that cost distributions are specified as normal rather than lognormal as often used to reflect distributions of actual construction costs (Davis Langdon, 2009). Lognormal distributions include a tail to the right that reflects the tendency of costs to vary more in the high-cost direction than in the low-cost direction. However, a priori, one would expect the “best practice” cost of achieving a lower-LEED or ENERGY STAR certification to exhibit a random variation around a mean representing variations in well-executed projects as a result of local market costs and other factors. The extended right-hand tail in actual cost distributions is likely to reflect unnecessarily high costs associated with project difficulties, an inexperienced design team, or other design objectives. Since this study assumes that costs reflect best practice, minimum certification sustainable design and construction, a normal cost distribution is applied in the empirical analysis. In addition, a normal distribution for green costs reduces the likelihood that the results will be biased in favor of conventional construction practices.

Monte Carlo analysis draws sample values simultaneously from each variable distribution, computes the IRR by solving Equation 3, saves the result, and continues the process many times. One million sample draws and calculations are completed. The resulting distribution of IRRs provides expected or mean IRR and the probabilities of IRRs less than a specific IRR (risk measure). These results reflect a distribution of likely outcomes for a single LEED project.

While occupancy and rents are simultaneously determined within local real estate markets (Wiley, Benefield, and Johnson, forthcoming), data are not available and an empirical estimation of a joint distribution is well beyond the scope of this study. Consequently, the occupancy and rent distributions are assumed to be independent. Positively correlated occupancy and rent distributions can be expected to result in a wider dispersion of Monte Carlo outcomes.

### Exhibit 4 | Distribution Parameters for LEED Monte Carlo Analysis

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>Mean</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupancy (O)</td>
<td>76.30</td>
<td>82.05</td>
<td>87.80</td>
</tr>
<tr>
<td>Occupancy Premium (OP, %)</td>
<td>2.72</td>
<td>10.32</td>
<td>17.92</td>
</tr>
<tr>
<td>Rent (R)</td>
<td>24.68</td>
<td>26.42</td>
<td>28.16</td>
</tr>
<tr>
<td>Rent Premium (RP, %)</td>
<td>4.40</td>
<td>27.47</td>
<td>50.54</td>
</tr>
<tr>
<td>Cost Premium (CP, %)</td>
<td>1.00</td>
<td>3.00</td>
<td>5.00</td>
</tr>
</tbody>
</table>
Results of this Monte Carlo analysis are provided as a probability density function of IRR shown in Exhibit 5. By definition, the area under a probability density function sums to 1.0. The sum of the area between the two IRR values, irr1 and irr2, is the probability that the IRR will be greater than irr1 and less than irr2. Exhibit 5 shows IRR ranges and probabilities for a number of outcomes based on one million draws from the cost, rent, and occupancy distributions.

As indicated in the Exhibit 5, the curve is skewed to the right reflecting the fact that distributions of occupancy, rent, and cost premiums are assumed to remain positive. The mean IRR on a LEED development is 126.4% (Exhibit 6), a healthy return on investment. Risk analysis shows the probability that the realized IRR will be less than a specific amount. For example, the results show that there is a 10.1% chance that the IRR will be less than 50% (that is, greater than 0 and less than 50) and a 20.7% chance that the IRR will be less than 70%. Depending on the firm’s risk tolerance and other investment opportunities, these returns may reflect an investment that carries too great a chance of falling short of required IRR targets in today’s capital-constrained world.

**ENERGY STAR Risk and Return**

The same Monte Carlo analysis process is applied to ENERGY STAR results from the four studies using the low, mean, and high values in Exhibit 7. Exhibit 8 shows the distribution of ENERGY STAR investment outcomes. Exhibit 9 verifies the results that are obvious from Exhibit 8: investment returns are even more attractive for ENERGY STAR opportunities based on results drawn from the four studies. The mean IRR for ENERGY STAR investments is 139.7% with
### Exhibit 6 | Monte Carlo IRR Outcomes and Probability of Occurrence: LEED

<table>
<thead>
<tr>
<th>IRR</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>2.3%</td>
</tr>
<tr>
<td>30</td>
<td>3.4%</td>
</tr>
<tr>
<td>35</td>
<td>4.8%</td>
</tr>
<tr>
<td>40</td>
<td>6.3%</td>
</tr>
<tr>
<td>45</td>
<td>8.1%</td>
</tr>
<tr>
<td>50</td>
<td>10.1%</td>
</tr>
<tr>
<td>55</td>
<td>12.4%</td>
</tr>
<tr>
<td>60</td>
<td>14.9%</td>
</tr>
<tr>
<td>65</td>
<td>17.7%</td>
</tr>
<tr>
<td>70</td>
<td>20.7%</td>
</tr>
</tbody>
</table>

Notes: The mean IRR = 126.4. The median IRR = 116.0.

### Exhibit 7 | Distribution Parameters for ENERGY STAR Monte Carlo Analysis

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>Mean</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupancy (O)</td>
<td>76.30</td>
<td>82.05</td>
<td>87.80</td>
</tr>
<tr>
<td>Occupancy Premium (OP, %)</td>
<td>2.72</td>
<td>6.88</td>
<td>11.03</td>
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<tr>
<td>Rent (R)</td>
<td>24.68</td>
<td>26.42</td>
<td>28.16</td>
</tr>
<tr>
<td>Rent Premium (RP, %)</td>
<td>8.62</td>
<td>13.75</td>
<td>18.88</td>
</tr>
<tr>
<td>Cost Premium (CP, %)</td>
<td>0.50</td>
<td>1.50</td>
<td>2.50</td>
</tr>
</tbody>
</table>

little risk (1.6%) of achieving an IRR of less than 50% and only a 9.9% of achieving a 70% IRR or less.

### Comparison of LEED and ENERGY STAR Risks and Returns

The LEED and ENERGY STAR results provide interesting insights on the current state of the sustainable building market. The results show that, on average, both ENERGY STAR and LEED projects enjoy rent and occupancy premiums with attractive returns on incremental sustainability costs.

A rather surprising finding is that despite its more exclusive positioning and the additional claims of productivity and environmental achievements, LEED projects currently provide slightly smaller financial returns than ENERGY STAR projects while incurring greater risks of achieving unacceptable investment outcomes.
How Risky Are Sustainable Real Estate Projects?

Exhibit 8 | IRR Distribution for ENERGY STAR Sustainability Option

Exhibit 9 | Monte Carlo IRR Outcomes and Probability of Occurrence: ENERGY STAR

<table>
<thead>
<tr>
<th>Risk Analysis</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRR</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>0.0%</td>
</tr>
<tr>
<td>30</td>
<td>0.1%</td>
</tr>
<tr>
<td>35</td>
<td>0.2%</td>
</tr>
<tr>
<td>40</td>
<td>0.4%</td>
</tr>
<tr>
<td>45</td>
<td>0.8%</td>
</tr>
<tr>
<td>50</td>
<td>1.6%</td>
</tr>
<tr>
<td>55</td>
<td>2.8%</td>
</tr>
<tr>
<td>60</td>
<td>4.6%</td>
</tr>
<tr>
<td>65</td>
<td>7.0%</td>
</tr>
<tr>
<td>70</td>
<td>9.9%</td>
</tr>
</tbody>
</table>

Notes: The mean IRR = 139.7. The median IRR = 119.0.

The general implications for developers are clear. In general, expected rates of return on green investments are less risky and slightly greater for ENERGY STAR

mean IRR for ENERGY STAR investments is only slightly greater than those for LEED (139.7% vs. 126.4%); however, the risks of poor ENERGY STAR investment outcomes are less than LEED investments. For example, the risk of achieving an IRR of 50% or less is only 1.6% with an ENERGY STAR project but 10.1% with a LEED project.
projects than for LEED projects. Green building investment advantages, at least those revealed to date in the four studies, can, on average, be achieved with ENERGY STAR investments for about half the cost of LEED investments (an ENERGY STAR mean of 1.5% of construction costs compared to a 3.0% premium for LEED construction).

Caveats and Summary

This study has sidestepped a variety of issues that determine risks and returns for individual sustainability projects such as the availability of utility and state financial incentives, conditions of excess demand or excess supply for sustainable space or space in general in local markets and other issues. As market supply and demand for green space changes over time, the rent and occupancy premiums observed at any point in time will also change, although comparisons of rent and occupancy premiums over time provided by CoStar (2009) suggest that currently observed rent and occupancy premiums reflect a reasonably robust picture of green premiums.

To the extent that LEED practices become less expensive to incorporate and/or productivity and health benefits that may be associated with LEED buildings are recognized and reflected in LEED building rents and occupancy, ENERGY STAR may lose its advantage relative to LEED as a real estate development option.

However, to the extent that ENERGY STAR buildings continue to capture a significant portion of the green benefit established jointly by ENERGY STAR and LEED promotional efforts, the less costly ENERGY STAR certification process and the law of diminishing returns may continue to provide an advantage to ENERGY STAR developments.

Finally, every project is unique and capabilities and costs of support resources as well as sustainable space demand and supply vary by market so the results in this study should be viewed as representative of the general market for sustainable real estate development and should not be applied as a fixed rule for individual real estate projects.

Despite these caveats, this study accomplishes its objective of utilizing results from four recent CoStar-based empirical analyses to assess the risks and returns associated with sustainability projects. The results show that, on average, both ENERGY STAR and LEED projects enjoy rent and occupancy premiums that not only pay for the additional green development costs but also provide attractive IRR on green investments. On average, ENERGY STAR projects provide slightly greater returns and less risk of poor outcomes compared to LEED projects.

Developers looking for a comprehensive commitment to sustainability can obtain an IRR with LEED that is nearly as great as that from an ENERGY STAR development though the risk of falling short of any given risk threshold is greater. The fact that incremental costs of ENERGY STAR investments are about half of LEED investments makes ENERGY STAR an attractive option for developers who desire a more cautious approach to sustainable project development.
Endnotes

1 LEED and ENERGY STAR differ in several other aspects. ENERGY STAR certification requires monitoring a year of energy use for certification whereas LEED certification is based only on design and construction. LEED requirements are provided for both new construction and existing building, though only 162 existing buildings certifications have been completed through 2008 (U.S. Green Building Council, 2008).

2 In other words, market processes determine whether or not developers recover increased costs of sustainable development. This situation provides considerably greater risk for developers compared to building owner-occupiers. A building owner who occupies the building will capture all energy saving and other benefits associated with green investments. While these investment decisions are still subject to uncertainty associated with technology performance, weather, energy prices, and other factors, risk management approaches have been developed to assess risks and returns of these investments for building owner-occupiers (Jackson, 2008).

3 Most studies are not specific about what soft costs are included. These costs include additional design, engineering, commissioning, and costs associated with permitting and other possible delays.

4 Component lifetimes also impact this calculation. While anecdotal evidence suggests that well-designed buildings are less costly to maintain, no reliable empirical information exists on the net cost of replacement/maintenance requirements of sustainable buildings. The IRR specification applied here assumes that the net impact of these factors is negligible.

References


——. Personal email correspondence with Peter Morris, April, 2009.


———. Greening America’s Schools: Costs and Benefits. Capital E Analytics. 2006.


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Removing Market Barriers to Green Development: Principles and Action Projects to Promote Widespread Adoption of Green Development Practices

Author Christopher Choi

Abstract This paper examines how the market may intentionally or unintentionally create barriers to green development practices. It also offers ideas and recommendations for those who build, finance, and are in positions to approve or support green development in all our communities on how to eliminate these barriers to begin making green development the norm rather than the exception.

In late 2006, the U.S. Environmental Protection Agency’s Region 5 assembled a steering committee to develop a process to identify and address market barriers to green development practices. The steering committee developed a process that involves the following four phases:

- Identify the most significant market impediments to green development practices;
- Develop strategies to eliminate/minimize targeted market barriers;
- Research and begin to implement strategies to remove market barriers; and
- Communicate findings and successes through white papers, reports, additional research, and outreach.

This paper is the product of this process and examines how the market may intentionally or unintentionally create barriers to green development practices. It offers ideas and recommendations for those who build, finance, and are in positions to approve or support green development in all our communities on how to eliminate these barriers to begin making green development the norm rather than the exception.

Defining Green Development

Buildings are a part of the environmental, economic, and social systems of communities and, as such, do not operate independent of their environment. How a building is designed and where it is located clearly affects the users of the

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building, the community, and the environment. However, even for those who do not live or work in a particular building, the impacts can be significant and can include traffic congestion, reduced street accessibility, and higher utility costs due to excessive use of energy and water. These are external costs that are borne by everyone. There are also global implications in how the built environment uses diminishing natural resources and how heavily it contributes to climate change. Therefore, green development strategies should examine impacts at the site, neighborhood, regional, and global levels. We strongly support the inclusion of the following strategies as part of green development: energy and water efficiency, reuse of materials and use of sustainable materials, on-site stormwater management, healthy indoor air quality, building preservation and reuse, accessibility to public transportation options, infill and brownfield redevelopment, and smart growth principles.

Many developers and builders use third-party rating systems to help guide their projects. The rating systems typically focus on specific building types (residential, commercial, industrial), construction type (retrofit, interiors), or resources (energy, water) that help organize the various strategies that green building should include. The U.S. EPA is actively engaged with these organizations and will work with them to enhance their systems to incorporate feedback from this research initiative. However, this paper does not address the relative merits of these various rating systems, focusing instead on the recognition of the value of green building approaches within the market.

The Case for Green Development

A building’s location, construction methods, and ongoing maintenance have major implications for the environment. Collectively, the impact of the built environment is significant:

- Buildings accounted for 39.4% of total U.S. energy consumption in 2002; residential buildings accounted for 54.6% of that total, while commercial buildings accounted for the other 45.4%.
- Buildings accounted for 67.9% of total U.S. electricity consumption in 2002; 51.2% of that total was attributed to residential building use, while 48.8% was attributed to commercial building usage.
- Buildings in the U.S. contribute 38.1% of the nation’s total CO₂ emissions, including 20.6% from the residential sector and 17.5% from the commercial sector.
- On average, Americans spend about 90% or more of their time indoors. Indoor levels of pollutants may be two to five times higher, and occasionally more than 100 times higher, than outdoor levels.
- Building-related construction and demolition debris totals approximately 136 million tons per year, accounting for nearly 60% of total non-industrial waste generation in the U.S. (1996).
Building occupants use 12.2% of the total water consumed in the U.S. per day. Of that total, 25.6% is used by commercial building occupants and 74.4% by homeowners (1995).\(^1\)

Addressing development, building, and transportation issues is fundamental to the EPA’s mission of protecting the environment. By employing green development strategies when constructing new buildings and roads, retrofitting existing buildings, and promoting sustainable redevelopment of brownfields and infill development, we can reduce energy use, conserve potable water, increase recycling, decrease use of raw materials, preserve natural systems, improve indoor air quality, and reduce greenhouse gas emissions.

The benefits of greening the built environment are considerable. For example, a recent study completed by the U.S. Green Building Council and the New Buildings Institute found that buildings constructed to Leadership in Energy and Environmental Design (LEED) standards are 25%–30% more energy efficient than existing non-LEED buildings. Along the same lines, commercial buildings that have earned an ENERGY STAR (a joint program of the U.S. EPA and U.S. Department of Energy) rating use nearly 40% less energy than average buildings and emit 35% less CO\(_2\). The EPA’s findings from the recent “Lifecycle Building Challenge” indicate that 27% of existing buildings will be replaced between 2000 and 2030, and that 50% of buildings in 2030 will have been built since 2000. This furthers the case for making green building and sustainable development projects an important focus area.

Although the EPA’s primary mission is environmental protection, green buildings affect our economy and society as well. On a micro level, a CoStar study that looked at occupancy and rental rates for commercial buildings showed that LEED and ENERGY STAR buildings command higher rental rates, have lower vacancy rates, and have higher resale value, proving that consumers understand the value of green buildings.\(^2\) On a greater scale, green development has the potential to become an engine for economic regeneration. Green development practices provide an important pathway to a stronger green economy where unnecessary spending—on energy, long commutes, waste disposal, producing new products when recycled or reused ones are just as good, disaster relief from extreme weather events, and other problems caused by traditional development patterns—is minimized and resources are freed up to invest in education and new jobs, technologies, products, and services that support new frontiers in sustainable development.

**Framing the Issue**

**Identifying Market Barriers to Green Development**

On May 22, 2007, the first of two workshops to examine market barriers to green development was held in Chicago, IL. The goal for the first workshop was to identify and describe the most significant market barriers to green development...
practices. In order to achieve this goal, we brought together a select group of approximately 50 experts familiar with both conventional and green development projects. The participants included architects, attorneys, appraisers, bankers, brokers, developers, equity providers, owner/operators, and others directly involved in the real estate development process.

Many of the barriers identified during the first workshop, whether actual or perceived, can be attributed to multiple failings within the market to recognize the value of green development. We found that the overriding reasons for most barriers fell into one of five major categories:

1. **Knowledge Gaps in Green Development Quantification.** One of the major barriers that participants cited is the need for reliable performance, cost, and benefit information of green features. Without this information, it is difficult for the market to justify the occasionally higher up-front costs for a green development project. Quantification of energy savings, lower utility bills, building longevity, lower environmental impact, increased occupant productivity, and the public health benefits of green developments over those that are conventionally built is required if green development is to move from a being a niche market to the norm for construction projects in the U.S.

2. **Communication Shortfall.** Participants offered a range of thoughts that point to misconceptions and uncertainty about green development and failures in the communication chain regarding the benefits associated with such projects. Developers cite a lack of demand from consumers for such features. Consumers, especially in the residential sector, typically place higher value on amenities such as space or finishes over less visible features such as energy efficiency, and may do so because they lack an awareness of what alternatives exist or the range of benefits that could be realized from green properties. Those who oversee or facilitate the exchange of property from developer to occupants—brokers, appraisers, property search specialists—rarely possess the data, tools, or knowledge necessary to convey the value of green features to buyers or tenants.

3. **Ownership Structure and Operating Cost Responsibility.** Ownership and standard lease structures determine who captures the benefits from green features, primarily in terms of associated cost savings. Unfortunately, the beneficiaries of cost savings are often not the decision makers in charge of design, improvement, and development decisions. There is little motivation for a developer to build or install energy-efficient, transit-friendly, or on-site storm water management features, some of which will only have benefits over the longer-term, if they will be selling the building immediately after completion of construction. Under typical short-term leases where the tenant is responsible for utilities, owners may not want to go through the hassles or costs of energy-efficient system retrofits.

4. **Funding Issues.** When evaluating projects, equity and secondary markets often use criteria that are geared more toward conventional developments
rather than green developments. For example, time horizons are usually not long enough to capture the benefits that accrue over time from up-front investments. Also, it may be difficult to “package” or sell mortgages for non-conventional projects for the secondary markets. Market conditions often make green development projects more challenging from a risk and return point of view.

Industry and government standards used in project evaluation, especially as they relate to factors such as cost escalation assumptions, can determine whether projects are financially feasible. Many of these accepted assumptions need to be revisited to ensure that they are not unintentionally impeding green development by lengthening the payback period.

5. Risks and Process Issues. The lack of expertise and resources for green building in many communities often creates an environment that lengthens development time frames. In the public sector, approvals and permitting processes, many of which are not equipped to handle green construction, may cause delays. Building codes that were written for conventional developments often do not allow more environmentally friendly systems. Additionally, when people have fears about legal liability, they often default to rules that are in place and well-tested rather than adjusting them to meet the different requirements of green systems. In the private sector, the difficulty in identifying appropriate architects, construction firms, attorneys, construction materials, and other sources can also lengthen the project schedule. Delays often lead to greater risks and higher costs, which many developers would rather avoid given tight budgets and time frames. However, experienced developers also mentioned that up-front collaboration between the architect, developer, contractor, and the owner/tenant minimized complications.

Principles for Removing Market Barriers to Green Development

In our work, we have encountered many communities, organizations, and individuals who have managed to overcome market and other barriers to successfully promote and build green buildings. We have aggregated and augmented some of these ideas and put forth some of our own findings that we hope will bridge the access, knowledge, and process gaps that are preventing widespread adoption of green development practices.

Green Development Principle 1: Integrated design is a key component of successful green building projects. Using this approach, developers are able to improve the end result by ensuring that all building systems work cooperatively in the most cost effective manner. However, the process can be further improved by involving other project stakeholders, especially those that are involved in appraising, financing, and insuring the property, and by developing a common vocabulary to improve communication among stakeholders.
- Use integrated design to maximize the impact of green features.
- Use integrated design to minimize overall green development cost.
- Involve market representatives and municipal building officials at the beginning of the integrated design process.
- Use integrated design as a risk mitigation strategy.
- Do not use third-party rating systems as a substitute for integrated design.

**Green Development Principle 2:** Green building and infrastructure cost less than conventionally built structures over their lifetime. The lack of access to knowledge and materials, especially in parts of the country where green building is lagging, imposes initial costs that can be deal-breakers for many developers. This problem is compounded since many of the benefits of green buildings are realized over the longer term. However, even if an organization is able to overcome the issue of first cost versus long-term cost, the budgeting, accounting, and incentive practices within many organizations are not designed to recognize green development benefits. In order to truly capture the benefits green development practices can provide, these processes need to be adjusted so as to address all the factors that affect an organization’s and community’s bottom line.

- Adopt integrated design as a cost savings strategy.
- Include maintenance and operation expenses when comparing costs.
- Include other green development benefits when determining overall costs.

**Green Development Principle 3:** Incentives can stimulate the adoption of green development practices. Many communities have used incentives to promote green development practices. Incentives are not limited to providing monetary grants or tax breaks. Many process-type incentives have been embraced and used successfully throughout the U.S. In designing incentives, it is important to put together a program that motivates the type of behavior that would not have happened if the incentive was not available.

- Offset the “learning curve” in new markets with incentives.
- Design incentives to motivate or change behavior.
- Offer monetary or process-oriented incentives based on what works best in the market.

**Green Development Principle 4:** Regulatory processes and codes can help to promote green development practices. Public and government policies can heavily influence whether green developments get built. Existing codes and standards in many municipalities do not account and adjust for green features. In this sense, they can be a barrier to more widespread adoption of green features. Codes and ordinances can also be used as a regulatory tool to encourage green development by setting clear criteria that developers need to meet.

- Adopt and align codes to meet environmental goals.
- Use codes, ordinances, utility fees, and process improvements to encourage green development practices.
Green Development Principle 5: Building transactions and leasing agreements can be designed to accommodate green building. The relationship among developers, owners, and tenants disconnects investment cost from benefits received. However, the building transaction and bidding processes can be adjusted to encourage green building development. On the lease side, agreements can be structured to motivate tenant behavior, as well as provide opportunities for owners to invest in green features. A few organizations in the U.S. and Canada have developed model language that can serve as templates for creating these leases.

- Change bidding process to require green features
- Create model language for lease contracts that includes provisions for green practices

Green Development Principle 6: The cost, benefits, and performance of green buildings must be documented and communicated to expand the market for green development. The benefits of green development are often not tangible; they are only evident over the longer period with lower operating costs, healthier tenants, and a positive environmental and social impact on the surrounding community. Educating consumers and organizations should be a part of the strategy to increase adoption of green development practices. However, there should also be tools that help those that are directly involved in marketing these properties to be able to easily communicate the benefits to their clients. Additionally, knowledge on green development techniques and features cannot stop with architects. To support green development, all professionals that are involved in the building trade, whether they are equity or loan providers, brokers, appraisers, construction companies, permit approvers, or operations and maintenance personnel, will need to be educated on the specific features, performance, and care that set green buildings apart from conventionally built ones. A few organizations have started this process, but education and training programs need to quickly ramp up to meet this growing need.

- Expand market data to specifically address the performance and value of green features.
- Make collection of performance data a priority.
- Use third-party rating systems to help consumers recognize the value of green buildings.
- Extend green building education beyond architects.

Use Integrated Design

An integrated design approach to green building requires that all stakeholders including designers, engineers, the construction team, environmental planners, and users are involved in the project and meet early in the development stages to address project goals, needs, and potential barriers (Exhibit 1). Bringing all stakeholders together early in the process allows the project team to take a “whole building approach,” which is central to the concept of integrated design. The whole building approach allows the project team to make a highly effective
### Exhibit 1 | Comparison of Conventional vs. Integrated Design Process

<table>
<thead>
<tr>
<th>Conventional Design Process</th>
<th>Integrated Design Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Involves team members only when essential.</td>
<td>Inclusive from the outset.</td>
</tr>
<tr>
<td>Less time, energy, and collaboration exhibited in early stages.</td>
<td>Front-loaded time and energy invested early.</td>
</tr>
<tr>
<td>More decisions made by fewer people.</td>
<td>Decisions influenced by broad team.</td>
</tr>
<tr>
<td>Linear process.</td>
<td>Iterative process.</td>
</tr>
<tr>
<td>Systems often considered in isolation.</td>
<td>Whole-systems thinking.</td>
</tr>
<tr>
<td>Limited or constrained optimization.</td>
<td>Allows for full optimization.</td>
</tr>
<tr>
<td>Diminished opportunity for synergies.</td>
<td>Maximizes synergies.</td>
</tr>
<tr>
<td>Emphasis on up-front costs.</td>
<td>Life-cycle costing.</td>
</tr>
<tr>
<td>Typically finished when construction is complete.</td>
<td>Process continues through post-occupancy.</td>
</tr>
<tr>
<td>Higher potential for cost overruns, delays, and change orders.</td>
<td>Change orders are minimized due to early planning/iterative process.</td>
</tr>
</tbody>
</table>

*Note: Revised from Busby, Perkins + Will and Stantec Consulting, Roadmap for the Integrated Design Process.*

The integrated design process can be used to avoid “over design.” Over design of buildings will add additional costs for features that are unnecessary or are already taken care of by natural environmental factors or parts of other systems in the building.

Using an integrated design approach can minimize green building cost through all phases of a building’s lifecycle. Using this approach early in the concept phases of a green development can organize priorities to align with a project’s budget. During the design and construction phase it can help avoid cost overruns, minimize delays, and decrease change orders during construction. Finally, it can streamline operations and maintenance of the building in the post-occupancy phase as well as provide lower utility and maintenance costs because of its superior design from the onset.

A well-designed green building benefits from full recognition of its features as well as a smooth approval process from the local planning or buildings department. While it is crucial for all members of the integrated design team to share their knowledge and work together to ensure that the systems they put in
place are complementary, it is also important to include market representatives and municipal building department officials who may financially support or approve the project. Market representatives such as lenders, equity providers, brokers, appraisers, or insurers who are educated about a green building project can better market, value, finance, and insure the development. Working with the building department early on can make the approval process go smoothly or may offer perks or incentives that are exclusive to green development projects, such as expedited permitting or dedicated green project coordinators.

Risk Management

An unfortunate consequence of the increase in green building projects is the corresponding rise in performance-related liability issues. In a report by Marsh, a broker and risk management firm, the scope of risks and concerns over building green generally includes failure to achieve a desired LEED certification, failure to deliver expected energy savings performance, improper installation of new products or faulty design issues, and delays from lack of green product availability.

Insurance companies are monitoring these developments to determine how they can offer coverage to their clients. However, insurance coverage should never be the sole tool used to manage risk. A risk management plan should include multiple strategies, regardless of whether the project is a green development or a conventional one. An obvious rule is to not over promise what can be delivered, including a specified certification or exact utility savings. Communication and contractual language can help manage expectations. Using the integrated design approach can also be a powerful tool to understand client needs and requirements, evaluate and correct design flaws, determine proper green material usage and installation, and foster communication among all stakeholders. Having a better designed plan and process may also be favorably viewed by financing institutions and insurers.

Don’t Use Third-Party Rating Systems as a Substitute for Integrated Design

Third-party rating systems, such as the USGBC’s LEED, the Green Building Initiative’s (GBI) Green Globes, and ENERGY STAR provide useful frameworks for implementing strategies towards making developments greener. However, as some developers and owners have realized, using these systems as checklists to obtain a desired certification level will not necessarily produce a high-performing building. Critics of third-party rating systems cite this flaw in such systems as contributing to the stock of buildings that are green in label only.3,4 While it is possible to put together various elements that will allow a building to be certified “green,” many of the benefits associated with integrated design may not be realized.

Recommended Action Projects

*Expand Integrated Design Discussions to Include Market Representatives Such As Appraisers, Funders, Insurers, and Other Support Resources.*
representatives may not contribute to the green design process, but their understanding of the design and process specifications can help provide the proper valuation and funding for the project. Municipal contacts can assist with code, regulatory, and incentive issues, as well as provide resources based on their experience with other projects. It is in the best interest for the development team to start working with these agencies early in the process.

Incorporate Building Information Modeling (BIM), Which Uses Multidimensional, Real-Time, Dynamic Modeling Software, to Gather Building Data to Decrease Wasted Time and Resources During the Design and Construction Phases. Advanced modeling tools allow simulation of proposed designs and systems before any construction takes place and should be used by the design team as part of the integrated design approach. For complex development projects, this can be invaluable in creating the best possible design, as well as save time and expenses by avoiding change orders.

Create and Use a Common Glossary to Facilitate Project Comprehension Across Various Professions. Different professions have different terms for communicating their specifications and needs. When working with any large design team that involves those outside of your immediate profession, it is useful to have a common lexicon to speed understanding and avoid miscommunication.

Develop Funding Mechanisms that Address Up-Front Integrated Design Costs. Financing loans for green building projects have generally proceeded without incident because lenders regard a better-designed and well thought out project favorably. Where there is a funding gap is in the initial integrated design process. Integrated design has primarily been funded internally by owners or companies with custom developments, or funded by grants such as those offered by Enterprise Community Partners for green affordable housing and Savings by Design. However, inclusion of integrated design into standard practice will not occur without easy access through mainstream funding organizations such as lending institutions or local governments. Grants, low interest loans, or other financial tools can help bridge the difference between the cost of activities under an integrated design approach versus a conventional process that may just involve an architect or designer. These activities may include conducting charrettes, modeling building systems, and establishing periodic stakeholder meetings.

Green Building and Infrastructure Cost

Green building and infrastructure cost less than conventionally built structures over their lifetime. Initial investment cost is often cited as a major barrier towards widespread adoption of green development. A common practice to determine the costs between a conventional development and a green project is to aggregate the costs of all the comparable features. Using this methodology, it is not surprising that green developments are usually the more expensive option, given that premiums are often charged for newer products and services. However, such comparisons are flawed because they do not consider that green building projects need to follow a more integrated design and construction process than what
is typically required by conventional developments. Additionally, the most significant benefits associated with green developments, including external impacts on the community, are usually not realized until post construction. Recognizing these additional benefits and using full-cost accounting procedures provides a more fair assessment, as building expenses are never limited to just initial material and service costs.

Adoption of an integrated design and whole building approach to green building capitalizes on concepts that will lower overall building costs including:

- Promotion of synergies between building systems that may minimize or eliminate the need for certain building features.
- Early incorporation and modeling of design features that may minimize change orders during later stages, where costs may be much higher.
- Production of a more efficient, durable structure, which will lower long term operating and replacement costs.
- Using a commissioning agent to help verify the building’s systems are performing correctly before occupancy.

The perception that initial costs are higher may at least be partly due to the inaccessibility to green development knowledge, materials, and contractors. This is especially true in certain markets across the U.S., where a critical base of providers has not surfaced to meet this need. As green building service providers and products become more commonplace, the expertise premium for soft costs should decline and cost differential should narrow, much as it does for any emerging industry. Capital E’s Green Building Costs and Financial Benefits study (Kats, 2003) showed that between 1995 and 2000, the premium to build a LEED Silver building dropped from 3%–4% to 1%–2% in Portland, Oregon and from 2% to no premium at all in Seattle, Washington. Follow-up studies in 2004 and 2007 by Davis Langdon, a construction consultancy, disproved the notion that greener buildings necessarily mean higher costs. Analyzing only the construction costs, both studies found that “there is no significant difference in average cost for green buildings as compared to non-green buildings.”5 Obviously, the specific systems that are used for a building will make a difference. It is also important to keep in mind that regional, and perhaps even local, capacity may offer better insight into the initial cost differential. Municipalities that have professionals with experience in the green development field and easy access to green contractors, knowledge, and materials will find the costs for green development to be more competitive.

Initial costs aside, the benefits of green buildings are most evident over the longer term, where a better designed and built structure can save the owner and tenants on operating and maintenance costs. Kats (2003) reports that “the total financial benefits of green buildings are over ten times the average initial investment required to design and construct a green building.”6 As with any long-term purchase or investment that has an ongoing cost component—and a building definitely fits in this category—a more reasonable comparison of value will include the maintenance and operating costs.
While lower maintenance and operation costs remain one of the key selling points of green buildings, there are also other benefits that should be factored into the overall cost. These include higher occupancy, rental rates, and sales prices. A recent study by the CoStar Group, a real-estate information organization, found that buildings that are LEED or ENERGY STAR certified had higher occupancy rates, rental rates, and sales prices than their conventionally built counterparts. This information is summarized in Exhibit 2.

While there are differing opinions regarding the reliability of the CoStar Study, it does offer initial encouragement that the market values LEED or ENERGY STAR buildings more highly. Developers, appraisers, and financial institutions should consider this information when assessing a development’s potential market viability and risk.

**Standards Used For Investment Decisions**

Return on investment (ROI) and other financial calculations are useful in capturing the longer term benefits that green buildings provide. However, as with any evaluation that involves estimating future costs or earnings based on historical information, the trend may not hold. Particular to green development projects are estimates for standards such as the anticipated annual increase in energy rates. While these standards are created by governments, organizations, or agencies to provide a rule of thumb, they may be outdated or may not truly reflect current market rates. By underestimating what energy, fuel, water, and other natural resources may be priced at in the future, the calculated ROI period may be much longer than reality. This can affect a developer’s decision to forgo including green features in favor of a cheaper alternative if the anticipated holding period for the property is shorter than the calculated ROI period. It is important to examine the standards of escalation used to see if it is grounded in the most current market information.

**Financial Risks of Not Building Green**

Early adopters of green development technologies or methods may incur risks that may be avoidable with conventional practices. However, there are also risks

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**Exhibit 2 | National Averages for Green and Non-Green Buildings**

<table>
<thead>
<tr>
<th>Rental and Occupancy Rates</th>
<th>ENERGY STAR</th>
<th>Non-ENERGY STAR</th>
<th>LEED</th>
<th>Non-LEED</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006 Occupancy Rates</td>
<td>90.0%</td>
<td>86.9%</td>
<td>91.1%</td>
<td>88.3%</td>
</tr>
<tr>
<td>2008 Occupancy Rates</td>
<td>91.5%</td>
<td>87.9%</td>
<td>92%</td>
<td>87.9%</td>
</tr>
<tr>
<td>2006 Rental Rates (p/sq. ft.)</td>
<td>$26.33</td>
<td>$24.69</td>
<td>$33.69</td>
<td>$27.03</td>
</tr>
<tr>
<td>2008 Rental Rates (p/sq. ft.)</td>
<td>$30.55</td>
<td>$28.15</td>
<td>$42.38</td>
<td>$31.05</td>
</tr>
</tbody>
</table>

*Note: CoStar is the source. See: [www.costar.com/partners/costar-green-study.pdf](http://www.costar.com/partners/costar-green-study.pdf).*
associated with not building green that developers and property owners should consider, especially as buildings are long-term investments that are not easily or cheaply replaced. These include:

- Obsolescence and changing market conditions can easily make developments fall out of favor with consumers. The property market collapse and recent spike in energy and oil prices has led to an equally dramatic downturn in demand for housing in far suburbs and large, fuel-guzzling automobiles.

- Effects of escalating costs for natural resources and utilities will be exacerbated for owners and tenants who are more dependent on usage to operate their properties. Those who use these resources more efficiently may still feel the effects of such changes, but at a more manageable rate.

- Changing environmental regulation, including climate change policies, may necessitate retrofits to accommodate new guidelines to avoid penalties and fines. Redesigning and constructing existing space and features for new standards will be more difficult than incorporating these ideas initially.

It is important to weigh the potential risks and costs of not building green as they can likely affect a property’s financial viability and should be taken into account when calculating the cost of a potential development.

**Indirect Costs and Benefits**

Indirect costs and benefits should also be looked at when determining the costs of building projects. The following are some aspects to consider:

- Development projects that consider their access to various forms of transportation, its on-site stormwater management, and its usage of municipal resources will reduce their environmental footprint on the site and the surrounding community, thus lowering the clean-up and replacement costs caused by flooding on the community.

- Infill and high-density developments minimize the need for new investment in infrastructure including roads and utilities. The initial and longer-term maintenance costs should be a serious consideration for municipalities permitting developments on greenfields and virgin land.

- Better indoor air quality and environments may decrease absenteeism and improve productivity.

- Being an environmental steward offers positive public relations.

**Recommended Action Projects**

*Adjust Budgeting and Accounting Practices to Ensure Alignment with Long-Term Costs and Benefits.* Disconnects within an organization’s budgeting, accounting, and reward system may mask the most efficient decision on real estate transactions. An example of this may be that a corporate real estate department’s goal is to find the best space at the lowest cost. However, without consulting other
internal operations, that particular space may negatively impact areas such as maintenance and operation costs. Beyond reforming budgeting and accounting practices, indirect benefits such as occupant wellness, productivity, and satisfaction will also affect the overall value and attractiveness of a space. It is in the company’s financial interest to account for their costs and benefits across the organization as a whole. As many organizations have realized, the expenses associated with these issues will affect the bottom line and may change the overall costs picture of competing properties. This approach should also be taught as part of the curriculum in our schools so that future business leaders will be familiar with full cost accounting concepts.

**Acquire Comprehensive Post-Occupancy Data for Financial Benefits in Order to Develop Cost Models that are Sensitive to Indirect Benefits and Account for Lifetime Costs.** Quantification of the benefits from green buildings, including information tied to specific features and information related to other indirect benefits such as health, can help promote more widespread adoption of green development projects and direct attention to particular research and investment gaps. Universities and organizations involved in green building can work with owners and operators to collect and disseminate this information.

**Create a Common Reporting Practice and Metrics for Case Studies, Which Will Allow Comparable Financial Evaluations of Green Building.** Data collection and evaluation is only useful if the consumers and users of this data can understand their measurement. With multiple sources of data, it is difficult to discern which numbers are reliable and trustworthy. Regardless of certification systems, the administrators for these systems, governments, and building owners and operators need to collaborate and agree to a common reporting practice and metrics for green buildings.

**Incentives Can Stimulate the Adoption of Green Development Practices**

Higher up-front costs, lack of knowledge, or potential risks are often cited as reasons developers might reject green development practices. To overcome these barriers, governments—primarily on the local or state level—have offered incentives as a way to minimize or eliminate costs or issues related to their adoption. However, incentives should never be treated as “giveaways,” but rather as tools to motivate a desired behavior or outcome that would not have happened if the incentive was not available. Incentives can be used to generate interest, bridge knowledge gaps, and encourage green building practices over conventional ones.

In new markets where the knowledge base and services for green development projects have not been established, incentives can be used to ease the initial cost differential or difficulty factor. Incentives can also be added to fund integrated design or bring in expertise for consultation. Additionally, a well-advertised or marketed incentive can bring positive publicity to such practices, offering developers an alternate design where they and the community may both benefit.
Incremental adoption of green projects will expand the knowledge base and services offered in the community.

Incentives should be used to promote specific behavior that may not have occurred if the incentive was not available. It is important to design incentives as contracts, where dates, dollar amounts, or services are clearly presented, but also to make sure they are attractive and easy to use. Incentives do not need to be created from scratch; existing programs can be restructured to favor or require green or sustainable designs. Existing programs such as Tax Increment Financing (TIF) Districts, Community Development Block Grant (CDBG), Congestion Mitigation, and Air Quality (CMAQ) Improvement Program can all be further expanded to include provisions requiring green development.

An alternate way to promote green or sustainable practices is to tie them to economic or community development incentives. Public finance mechanisms can be used to subsidize private investment and promote a certain type of development. For example, a municipality can make location within walking distance to a rail station or transit stop a criterion for obtaining an economic development incentive. Linking green development requirements or incentives with existing incentives, such as those offered through brownfield redevelopment grants, can also be effective. Planning and development practitioners have an opportunity to simultaneously achieve multiple goals of business or community needs while enhancing environmental objectives.

Periodic evaluations of program effectiveness are required to determine if changes need to be made to the incentive or whether it is meeting expectations. To encourage use of the incentive, a counter requirement can be set up to eliminate codes and subsidies that support unsustainable behavior and practices. Incentives are generally most effective on the local level where they can be designed to meet local or regional environmental needs and standards. However, state or federal guidelines can also be used to set a minimum standard that local municipalities can build upon.

U.S. EPA Region 5 convened a meeting on July 31, 2008 to examine parameters to consider when creating financial incentives. This meeting was primarily focused on the affordable housing market, but many of the ideas are applicable to developments in general. The proceedings for this meeting are available for download from the websites of the Northeast-Midwest Institute and the Delta Institute.

Offer monetary or process-oriented incentives based on what works best in the market. Incentives can be designed as a financial, time-saving, or regulatory benefit. Monetary incentives include tax breaks, grants, vouchers, and rebates. Non-monetary incentives include technical assistance, business planning assistance, marketing assistance, expedited permitting, regulatory relief, preferred loans, guarantee programs, and dedicated green management teams in building and planning departments. Monetary incentives can offset any cost differential or provide savings for choosing green development over conventional development, making the adaptation to green development more feasible for property owners and developers.
By providing sales tax exemptions and property tax exemptions, the government either partially or wholly offsets the cost of purchasing, creating, installing, and building new green technologies. It is important to structure applicable exemptions prior to the investment to prevent the owner’s property tax from increasing due to the improvement.

Other options for sharing the cost of green development practices include using vouchers, rebates, and grants. A voucher is a check for credit against future expenditures. A rebate is a credit for expenditures made in the past. A grant is a monetary gift, often used in a specific manner. These three monetary tools can be used to offset the cost of developers or property owners who are learning how to build green, or who are literally calculating the difference between conventional and green technologies in order to properly finance their projects. Furthermore, these tools can also be offered to tenants to promote purchases such energy-efficient appliances.

Non-monetary incentives can save developers and property owners’ time and money by mitigating risk and process issues. These incentives include preferred loans, expedited permitting, zoning/floor area ratios, technical assistance, business-planning assistance, research and development assistance, marketing assistance, regulatory relief, and dedicated staff for green development in building and planning departments. Non-monetary incentives work especially well in situations where financial options are politically difficult to pass or where the existing infrastructure or regulatory atmosphere is complex or restrictive. They are also flexible and can be set up to fit local conditions.

**Recommended Action Projects**

*Create Financial and Non-Financial Incentives at the Local Level to Target Specific Behavior.* Local governments are in an ideal position to create incentives that will appeal to developers while furthering their own environmental goals. Depending on the local building and development conditions and the resources of the local government, incentives can be set up as monetary rewards, assistance with navigating the development process, or easements on development restrictions.

*Augment Existing Public Financing Programs to Encompass Green Development Incentives.* Tight budgets may prohibit the development of new public financing programs. One way around this is to augment existing local, state, and federal funding mechanisms to make green development practices a requirement or an award consideration in competitive situations. Using existing programs may also be more politically acceptable.

*Track Incentive Successes and Failures and Adjust as Required.* Regardless of the incentive created, it is important to review their success and failure at furthering intended environmental and planning goals. Local, state, and federal agencies may work internally or with organizations skilled with administering, tracking, and fine-tuning these programs to conduct periodic reviews. This will ensure that their programs are adequately funded and the criteria for the incentive are properly set so that the results are aligned with these goals.
Regulatory Processes and Codes Help to Promote Green Development Practices

Public policies and procedures can heavily influence whether developers incorporate green design into their projects. Existing codes and standards in many municipalities do not account and adjust for green development features, creating regulatory barriers that make permitting such projects difficult. In this sense, standards and codes can be a barrier to more widespread adoption of green development practices. However, codes and ordinances can also be used as a tool to encourage green development practices by setting criteria that developers and property owners need to meet.

Building, stormwater, and energy codes are all established to provide minimum safety or performance standards. These are often issued by agencies such as the International Code Council (ICC), who partner with organizations such as the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) or Illuminating Engineer Society of North America (IESNA) to set engineering and safety standards. Individual codes are bundled and are offered to municipalities for adoption. Codes are updated on a standard cycle based on input from members. Municipalities can choose to update or alter their codes based on their needs, but there are no requirements that the most recent version of the codes be used.

Issues arise when codes are not up-to-date because the local government does not have the resources to update their codes or when different codes conflict. This is especially the case for green development projects where performance information may still be in its infancy or the latest code version the municipality has adopted does not account for newer systems. For developers, two common problems arise when working with municipal building departments that do not have codes that account for green technologies: (1) the staff’s lack of knowledge of green technologies will delay review, approval, and permitting; and (2) development projects may still need to meet conventional building code requirements, thus increasing costs and forgoing benefits that may have been realized with the greener approach. The second issue is common with on-site stormwater management systems.

Codes are often developed by an agency such as the International Code Council (ICC), who work with engineering organizations, or they are created by municipalities. Municipalities may extract parts of these codes to create a framework for their own codes. The ICC has a specific development cycle (I-Code Development Cycle, Exhibit 3) for their codes, which is as follows: code changes are submitted; code changes are printed and distributed; a code development hearing is held; the public hearing results are printed and distributed; the public comments on public hearing results; public comments are printed and distributed; a final action hearing is held; and a supplement or new edition is published.

Public comments are due within 45 days after changes to ICC codes are published. New editions of codes are published every three years, and supplements to codes
are published every 18 months. The creation of new editions and supplements involves a range of stakeholders that include code officials, design professionals, trade associations, builders/contractors, manufacturers, and government agencies. Code officials have the ability to adopt new codes as they are published, but this may be time consuming and costly for most municipalities.

Once established, codes still require an ongoing process of improvement. Regular review and adaptive changes will help to accommodate new information on green system performance. Municipalities have adopted performance-based codes and prescriptive codes to encourage or require green development.

Performance-based codes allow the design team to fulfill a performance requirement regardless of how they achieve the requirement. While this can encourage innovative solutions, it is also difficult for municipalities to implement because verification of performance compliance is resource intensive. Additionally, it may not achieve an overall superior design because innovation in one system may offer opportunities to neglect other areas and still achieve the established minimum performance standard.

Prescriptive codes dictate how the requirement should be fulfilled, which requires the design team to operate within set boundaries. Conventional codes are often prescriptive and provide a requirements checklist for designs. This can allow developments to meet regulatory standards, yet still produce an inefficient, poorly designed building.

Both performance-based and prescriptive codes have advantages and drawbacks. Municipalities should determine what the most effective method based on their particular situation or create hybrid codes to encourage innovation, while setting minimum feature standards.
Certain states are home rule entities that may allow local jurisdictions to have greater administrative roles in determining issues over state regulations. For these states, implementation of statewide codes is difficult because local municipalities may overrule them.

Code improvements have progressed in some areas, such as energy efficiency, but still require further resources in other aspects of development projects. Some of the more urgent needs include stormwater management issues, site and location planning, and transportation and parking needs and requirements. All of these areas have an environmental impact and financial cost to the community and require attention to ensure longer term environmental, social, and economic sustainability goals.

Use Codes, Ordinances, Utility Fees, and Process Improvements to Encourage Green Development Practices

Regulatory guidelines and processes are areas where incentives or allowances can be adjusted to encourage green practices. Many communities have crafted green ordinances that can be readily adopted or adjusted for local needs. Processes and regulations related to ordinances need to be easy to understand and implement. The following are some tools and examples that can serve as a springboard to allow for and encourage green development. However, they must be approached from a standpoint where they can make a significant difference to a developer.

Floor Area Ratio. One tool municipalities have used to leverage green development is floor area ratio (FAR) bonuses. FAR bonuses increase the building’s allowable building density, meaning a developer can add floors or more usable space in the building. These bonuses may be granted in exchange for such features as installation of a green roof or fulfilling defined green standards. Developers and property owners may recoup some or all of their expenditures on the green development designs with the increased rentable/saleable space resulting from FAR bonuses.

Expediency. Some municipalities have chosen to create expedited permitting programs, shortening waiting periods. Such a program allows developers and property owners who integrate “green features” into the design and site selection of the building to bypass the normal permitting system, with a guaranteed approval or denial within a certain period of time. However, this incentive may only work where permitting time is an issue within the municipality and if there is a team with knowledge on green building design.

Impact Fees and Performance Bonds. Impact fees and performance bonds may also be used as a tool to encourage green development. Impact fees are payments required by local governments of new development for the purpose of providing new or expanded public capital facilities required to serve that development. Performance bonds can be used as leverage to guarantee satisfactory completion of a development, as well as a guarantee that funds are available to complete the project if a developer/property fails. The performance bond shifts the responsibility for controlling, monitoring, and enforcement to individual producers and consumers who are charged in advance for the potential damage.
Although impact fees and performance bonds may not directly encourage adoption of green features, they hold the developer or property owner accountable for the effects of their development. Additionally, funds raised from impact fees can also be used to subsidize green developments. The American Planning Association has comprehensive information on impact fee standards.

Green Tutor and Green Go-to-Staff. “Green tutors,” or dedicated staff in the planning or building department, are growing in popularity. Green tutors meet with the developer or property owner at the beginning of the development process, walk them through the permitting processes timeline, identify what information they will need to provide in the application, and identify a range of incentives for which the development may be applicable. Planning departments may scale staff time to the maturation of the market, or a consortium of cities may share a staff of green tutors depending on demand.

For a green tutor program to be the most effective, it is important for the applicant and green tutor to meet at the beginning of the planning process. This will allow any challenges to be addressed before the plan is solidified, as altering plans can prove to be time consuming and costly. Furthermore, it will allow the green tutor the time to address opportunities to integrate different green development elements into the building’s design.

Effective green tutor programs designate staff from each municipal department to meet regularly and address how green development can be accounted for in codes and ordinances more effectively. This process helps streamline departmental operations and break down operational silos that can cause conflicting codes.

On a national level, federal dollars can be tied to requiring large infrastructure projects to incorporate green principles. For buildings, all General Services Administration (GSA) new construction projects and substantial renovations must be certified through the LEED Green Building Rating System of the U.S. Green Building Council. Other construction projects, such as transportation infrastructure and water treatment plants, need to go beyond National Environmental Policy Act (NEPA) impact reviews to create designs that integrate environmental features up front.

Recommended Action Projects

Lead by Example—Incorporate Green Development Requirements into Plans and Projects. Governments at all levels can show leadership in green development by including sustainability requirements for all their building projects. Many public buildings have become showcases for successful green building technologies because governments are willing to share their experiences and building performance information. By being a steward of green development practices, governments can use the experience to shape all future land and building development within their jurisdiction to be aligned with their environmental and economic goals.

Work with Standards Organizations to Ensure Accommodation for Green Technologies. Organizations such as the International Code Council (ICC) work
with researchers to develop new standards and codes as they are requested by municipalities or members. Municipalities can help promote green building by working with standards organizations to continually develop and improve codes for green practices, working with researchers who may need performance information to refine standards, and adopting newer codes that include accommodation for green building. This will allow more green building plans to be assessed through a typical review rather than an exception, freeing valuable time for developers and minimizing their frustration with the regulatory process.

**Modify Regulatory Codes and Mechanisms to Create Incentives for Green Building.** Two common approaches to adjusting regulations are allowing a higher floor area ratio or lowering minimum parking requirements. Both of these approaches allow more intensive development of the site and can allow a developer to build and sell additional units. However, there are other ways that regulatory mechanisms can be used to promote green building. Some cities have turned a particularly cumbersome process, such as permitting, into a benefit (expedited permitting) that can be accessed by green project developers. Other cities are looking at lowering the tax burden on owners who manage and treat their stormwater on site and may not use a municipal service as intensively. These examples are just a few of the ways that governments have been able to use their regulatory structure to further environmental and planning goals.

**Develop In-House Programs to Help Businesses and Internal Offices Navigate the Green Building Development Process; Offer “Green Tutor” Assistance to Developers.** Dedicated programs in local planning and construction departments to help green project developers navigate the various regulatory steps can make a significant impact on whether such projects get built—and let the community know that green development is a priority. It may be easier to begin by educating and training a small dedicated staff that will focus on green development issues and personally work with developers. Make sure to open up communication channels across different departments and align various programs to ensure there are no conflicting procedures.

**Building Transactions and Leasing Agreements Can Be Designed to Accommodate Green Buildings**

The relationship between the developer, owner, and tenant creates split incentives that do not promote investment in green development. Developers are hesitant to incorporate features that may increase costs or create permitting hassles if the market does not value such features or if the benefits accrue only after their association with the property is terminated. However, the development bidding process and leasing language can be changed to make investments in such features more feasible.

When developers build with the intention of selling properties upon completion, the decision to add green features is weighed against the premium that the market will pay for such features. As the investment time horizon for the developer does not extend to the savings that are typically realized during the post-development
period, the developer relies on the valuation by the user, the appraiser, and the
lender. This requires a new set of valuation and budgeting tools, as well as better
communication across disciplines and stakeholders to understand the potential for
savings that offset the up-front costs. Transparency and complete information in
the marketplace gives developers a better gauge for the demand of green buildings
and offers consumers the tools to make informed choices.

**Change Bidding Process**

The bidding process and request for proposals on development projects often
discourage green building unless it is specifically required by the owner. In the
interest of limiting the costs to create the proposal as well as making the project
more financially attractive among other bids, developers are hesitant to form an
integrated design team or may cut green features that drive up costs.

Property owners who are seeking bids for their green building project should
consider the experience and approach of the development team. A bid that
demonstrates a commitment to the integrated design approach and consideration
for whole building design will produce a better product and may reduce change
order costs. These goals can be written into contractual agreements once they are
set so that the final product reflects the intentions that were decided in the process.
Governments can take a leadership role and require all their projects to meet
minimum standards for green building. This can set an example for private
developers and allow a municipality to establish more environmentally sustainable
development policies.

**Create Model Language for Lease Contracts**

Crafting a “Green Lease” is a task that is gaining a lot of attention in the
sustainable building and operating community. Understanding that the lease
establishes the ground rules for the relationship between the owner/operator and
tenant, the objective is to create a framework that will be economically sustainable
for all parties without compromising the mission of environmental sustainability.

**The Lease Structure Dilemma.** In the commercial building sector, an important
step to overcoming the barrier of split incentives is to examine current net and
gross lease structures. The gross lease, which incorporates energy and utility costs
into the base rent, provides little feedback to the user regarding utility
consumption. Moreover, gross leases provide little incentive to reduce
consumption since tenants will not directly benefit from savings. Conversely, the
net lease may provide incentives for the user to conserve, but it does not provide
incentives for the owner or operator to make capital investment outlays for more
efficient operating systems as they will not benefit from the savings and recoup
the costs of the investment. This separation of investor costs from user benefits is
often referred to as split incentives. Under these lease arrangements, savings that
can be achieved if both investments were made in energy-efficient operating
systems and if overall energy demanded was reduced is concealed.

Energy costs as a percentage of total costs look very different for the average
commercial tenant when compared to the average commercial building. While a
tenant may only spend 1%–2% of their budget on energy, a building’s energy costs typically account for approximately 30% of total costs.\(^9\) For the average individual tenant, retrofits that reduce energy costs by 30% (average for LEED buildings) would not yield large savings overall, whereas from a building owner’s or operator’s perspective, the aggregate savings (including re-investment potential or interest rates applied to those savings) provides a significant incentive to reduce energy costs.\(^10\) In comparing the tenant’s versus the building owner/operator’s incentives for energy efficiency, we see that the net lease’s incentive to the tenant (savings in energy and utility bills) is not as strong as the gross lease’s incentive to the owner/operator (greatly reduced operating costs). However, direct feedback on utility usage for tenants is an integral component of understanding and reducing demand to meet environmental goals.

Operating under a gross lease also challenges owners and operators to engage tenants in conservation and demand reduction of energy. Communicating to tenants how utility, insurance, and maintenance savings affect rents is important. Providing direct feedback, such as through sub metering, can demonstrate usage costs to tenants.

*Create a System of Co-benefits.* Creating a system of co-benefits that will provide incentives to both the tenant and owner/operator is key to the success of green buildings and to increasing energy-efficient measures, while also promoting conservation. A system for cooperative action and channels for communication needs to be in place, clearly outlining costs and benefits, and how those will be shared appropriately. The tenant requires direct feedback regarding usage, and also an owner/operator who will correctly reward that tenant’s efforts. For example, an owner/operator cannot merely apply costs based on square footage if trying to promote usage conservation; the reward system has to be much more transparent and linked to proactive measures taken by the tenant. Tenants play an integral role in promoting greener practices in commercial buildings. Lead tenants, or a group of tenants, can communicate the priority of a healthy and sustainable environment to owners and operators. This is most evident today in requirements for green office and institutional space in the federal, state, and municipal sectors. However, any tenant can enter into negotiations for ongoing improvements in the building(s) they occupy. Communicating to owners and operators these preferences will help them better understand the demand for greener space.

Several agencies and organizations, including Real Property Association of Canada (REALpac) and the California Sustainability Alliance have developed leasing structures that begin to address the issue of split incentives. They provide good starting points to change the leasing relationship so that owners and tenants can both gain benefits from investment in green systems.

**Recommended Action Projects**

*Require Green Building and Integrated Design Approach.* One way that public building projects, as well as other building projects that use a competitive bid process, can improve the quality of their projects is to make integrated design a requirement. While integrated design can create a better built structure at an
overall lower cost due to tighter integration of building systems and reduction in change orders, developers may be hesitant to initiate this process because it shifts the cost up-front—an expenditure they feel they may not be able to recuperate if they do not win the project. By requiring an integrated design process just as any other feature or construction method, a municipality will demonstrate leadership that other developers can follow.

Factor in the following when evaluating project proposals:

- Experience of design team with green buildings and their ability to deliver products with less cost overruns and change orders; and
- Anticipated post construction building costs for operation and maintenance.

Successful green development projects are unique in that they require a design team that has experience with different building systems, materials, goals, and approach. It would be difficult for a design team without green building experience and knowledge to build a structure that capitalizes on all the economic and environmental benefits. Choose a team with a portfolio of successful green building projects and work with them to determine what building operations, maintenance, and costs may look like during occupancy.

**Use Green Lease Templates to Define Owner/Tenant Responsibilities.** New leasing language developed by various municipalities and entities can be useful guidelines for green buildings. These leases can help create the proper motivation to alter tenant and owner behavior. Sample leases are available from REALpac and the California Sustainability Alliance.

### The Costs, Benefits, and Performance of Green Buildings Must Be Documented and Communicated

Expand market data to specifically address the performance and value of green features. Adoption of green development practices by the market, including developers and consumers, requires education on the expected performance of green development features. Armed with this information, consumers can better gauge the value of their “purchases,” much like they do with automobiles, where not only the purchase price is offered, but information regarding mileage efficiency, maintenance, insurance, and depreciation are relatively easy to obtain. For homes, offices, and industrial spaces, investments that are much more expensive, there is much less transparency regarding maintenance and operations costs. Consumers and market representatives, such as appraisers, therefore generally ignore the value of these features. The result of this leads to the perception that green development practices offer little if any additional value in the market.

**Consumer Market Needs**

Drastic increases in energy costs in recent years disprove the idea that environmental and energy-efficient features should be treated as afterthoughts. The
2008 housing market collapse is at least partially due to these higher costs. Homeowners strapped by the increase in utility costs in their homes and gas costs for transportation find that they do not have enough cash flow to meet their mortgage and property tax payments. While information on projected maintenance, operations, and transit cost may not have prevented the housing market collapse, it would have at least been registered into the overall affordability and value of a property.

The Energy Performance Certificate (EPC) currently being phased in throughout the European Union mandates that buildings undergo an energy audit, and that the score or the EPC be included with the building information for prospective renters or buyers. This provides consumers with access to full information about the building’s energy needs and can motivate owners to update systems. This concept is gaining momentum in the U.S. and will allow consumers to better value green features when conducting a property search.

**Tools Needed for Market Representatives**

Consumers are only a part of the equation when valuing green properties. Along the process chain of developing, financing, marketing, and insuring, representatives require information tools on green building performance to properly value development projects. Brokers need to be able to convey the features and performance to their clients. Bankers rely on the appraisal report to determine how much financing can be offered for a project. Insurers need quantification information to determine whether projects can be insured and at what price. There are still many information gaps that need to be addressed to help the market fully value green development projects.

**Make Collection of Performance Data a Priority**

Green development performance information is important to market adoption of green practices. Collecting and providing this information will help those who may need validation on green project investments and will create a positive feedback loop to the green building community to improve design and features for future projects. In addition to cost and performance data within a building, information on occupant health, satisfaction, and commuting patterns can make the case for better indoor air quality and location choice. Local and regional performance data is especially useful to determine best practices given specific climate or geographic features. Additional information that recognizes the impact that buildings have on their surrounding community, including traffic patterns and congestion, utility and road buildup, and stormwater flows and habitat changes will provide an even stronger case for green development.

**Third-party Rating Systems**

Third-party rating systems provide an easily recognizable way for consumers to identify green buildings. Developers have already started using these systems to market their buildings. Although rating systems are not a guarantee of
performance, they can initiate dialog between different stakeholders on the features and benefits that have been incorporated into a property.

**Green Building Education**

Green building education needs to reach beyond designers and architects for the market to begin embracing green practices for every project they initiate. While we can present the market for green buildings as a supply and demand curve (as demand for green building features increases, developers will increase the supply to meet this need), we cannot simplify the training and education that will be required to produce this shift.

The 2005 Green Value study conducted by the Royal Institution of Chartered Surveyors (RICS) for the American and Canadian market found that knowledge of the green building field varied considerably among professions who deal with development issues. Exhibit 4 shows the results to RICS’ survey question. The results of this survey underscore the need to educate market representatives such as lenders, appraisers, and brokers on green development issues because they determine property value and viability. Without a green building knowledge base, they will not be able to evaluate such projects accurately and effectively. In addition to the marketing and finance fields that support these projects, development of green building education is most urgent in the engineering, construction, maintenance, and operations fields.

**Development of Green Collar Jobs**

The transition from conventional building to green building will require skilled workers who can build, install, and maintain the systems to ensure the development is constructed as designed and will operate efficiently in the future. Existing workers, primarily professional and blue collar employees, can expand their skill set to include green systems and techniques to ready themselves for an evolving market. Professional and trade union organizations are invaluable networks that can assist in disseminating information on green building to their members and can act as a liaison between green building education organizations and workers. Widespread adoption of green development practices will bring about significant opportunities in these fields, but a workforce knowledgeable about the practices and tools needs to be in place beforehand.

**Work with Educational Institutions**

Developing a mind set for sustainable development begins in schools. An educational institution’s curricula can equip students with the necessary knowledge on sustainability issues, while its actions and practices can demonstrate environmental stewardship. Many universities are beginning to add sustainability directors to their staff who oversee all aspects of university activities to make sure they are aligned with the school’s sustainability goals, including green development projects. The addition of green building design, technology, and economics have been added to the architecture, design, and engineering
Creating a Common Vocabulary

Communication is a key element of any development project. Therefore, we urge integrated design teams to speak with each other frequently to create a fully integrated high-performance building. However, communication is complicated by the fact that all professionals in the development community have their own specialized vocabulary. That specialized vocabulary—terminology specific to each discipline—has evolved to meet a need to describe a critical component of the development process that is part of the building landscape and should be respected and not necessarily replaced. Nevertheless, to bridge that divide, it is critical that all parties become familiar with the basic vocabulary central to the work of their colleagues. For example, although an architect might think “asset” diminishes a sophisticated design—and a building is surely more significant than a line on an investment sheet—the term is an important reminder that finance is integral to the green process. Creating a glossary or dictionary for a green building project team
is an important method to bridge the remaining language barriers and can translate to cost and time savings.

**Recommended Action Projects**

*Create a Research Effort, in Concert with Other Ongoing Efforts, to Document the Costs and Performance Of Green Projects.* Green building performance and cost information is crucial to adoption of green building practices. Research organizations and universities have led many of the efforts to gather and analyze information that will be invaluable to green building advocates and developers. Many need support to help fund, organize or participate in these efforts. The federal government, private foundations, and trade groups can support these efforts with funding, while it is the responsibility of green building owners and operators to participate and share their development’s performance information.

Accurate, comprehensive, geographically-relevant data provides one of the strongest cases for incorporating green features into building projects and can help provide justification for return on investment projections. This is especially true for new developers or owners, or those that may be located in regions of the country where green development is more sporadic.

*Use Existing Lines of Communication and Data Sources to Document the Performance of Green Buildings; Augment (or Develop) Information Tools that the Market Already Accepts as Standards to Include Green Building Information.* Many of the tools that are currently used in the market can be enhanced to include green building information. Making available information such as estimated energy usage, water usage, and other utility, maintenance, or operation costs available will help consumers make an educated choice about their purchases. For example, estimated utility costs can be listed on MLS listings to provide information to potential purchasers on how much they can expect to pay in utilities, in addition to their mortgage, property tax, and insurance. The benefit of using an existing system, versus creating a new system, is established market acceptance and a built-in distribution network.

*Develop Green Training and/or Certification Programs for Market Representatives Such As Appraisers, Brokers, and Lenders to Help Them Recognize and Communicate the Value of Green Building.* Market representatives often control the construction, value, funding, and sale of development projects. While some of these influential professionals have taken steps to educate themselves on green building issues and understand the possible need to approach their work in such a way to accommodate any green development differences, many view green building features as insignificant to a property’s value, or worse, as liabilities. Trade and umbrella organizations have taken notice and are working to address this gap by creating relevant training courses to educate their members, but much more needs to be done to bring these important roles up to speed on the specifics of green building issues so that the benefits these developments provide are reflected in their valuation.

*Engage in Public Education Connecting Green Building with Climate Change, Environmental Degradation, and Energy Usage.* Include green development issues
as part of discussions surrounding climate change, energy independence, environmental degradation, and natural resource depletion. All of the issues are inter-connected and need to be considered as a part of any management strategy. This can help drive public knowledge, demand, and market acceptance of the benefits of green development.

**Current and Future Issues and Opportunities**

Those who are involved in the development field are experiencing many of the barriers discussed here. A lot of work needs to be done to remove these barriers and adjust the market to accommodate current green development strategies. However, the concept of green development is one of continuous improvement, where new ideas and technologies offer opportunities to further sustainability goals.

Future changes to environmental policies will present opportunities to develop new products and services in the green development field. Higher accountability for emissions, waste, runoff, and usage may boost interest in sustainable development practices. Some of the more innovative ideas that are being discussed by leading organizations include:

1. **Incorporating Energy Efficiency and Location Efficiency Criteria.** Sharp increases in utility and fuel prices underscore the significant portion of expenses that go towards energy usage and transportation; those who live in higher density housing closer to work with plentiful transportation options were often the least impacted. Mortgage and loan underwriters are beginning to look at including these expenses as part of their affordability criteria. For development projects that use public funding, there is already a movement to include LEED or ENERGY STAR as prerequisites; this may be expanded to include energy and location efficiency criteria to further influence land use planning.

2. **Developing Strategies for the Sustainable Reuse and Redevelopment of Land.** Location is usually acknowledged as a component of an overall green development strategy with its contribution to lowering vehicle miles traveled and offering building occupants various transportation options. Brownfields and other environmentally impaired sites are often in highly desirable locations within or near central cities and with established road and utility infrastructure. While programs such as LEED recognize brownfield redevelopment as a strategy, sustainable redevelopment of these sites is an opportunity that has not been fully explored. From reuse and deconstruction to redevelopment, every process can be completed in a more sustainable manner. Sustainable brownfield redevelopment offers an opportunity to examine how we can conduct land planning and development on a continuous lifecycle basis.

3. **Incorporating Embodied Energy into Development Projects.** When existing buildings are torn down to be replaced by a new building, the embodied energy, or the energy that is required to manufacture the
original building is lost. New buildings require a lot of energy with respect to materials and transportation—even for the greenest of structures. It would take many years for any new green building to recuperate the lost energy from an existing one. Under a cap and trade or carbon exchange system, carbon emissions saved through the reuse of our existing structures may provide market opportunities to focus on retrofitting our existing building stock to be greener.

Conclusion

Green development practices can yield positive environmental, economic, and health benefits. With the overall advantages that such practices offer, it would seem clear that every building project would choose to incorporate green features into their plans. Our hope is that implementation of our recommendations will bring us closer to this goal.

Our objective is to highlight how many processes and tools are still not equipped to handle the unique challenges that green development entails. Our survey participants presented ideas on how to overcome these issues. Those of you who are closely involved in specific processes and tasks that support development projects may recognize other barriers or gaps to wider adoption of green development practices. We encourage you to work with your community or organizations that support green development to find solutions. Continued collaboration among the market and private interests, research institutions, and government—and a level playing field that gives every opportunity for green developments to financially succeed—is the best measure of success.

Endnotes

3 Malin (2008).
4 Gifford (2008).
5 Matthiessen and Morris (2007).
6 Kats (2003).
10 Ibid.
References


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The Effect of State and City Green Policies on the Market Penetration of Green Commercial Buildings

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Abstract
Pro-green building policies originated in the not-for-profit sector, and have worked their way into public policy since their inception in the early 1990s. These policies generally include Leadership in Energy and Environmental Design (LEED) for new construction and ENERGY STAR for ongoing building operations. Additional policy at the state and local level are present, and take many forms, including: (from weak to strong) blandly supporting these two main green paradigms; suggesting guidelines without teeth; leading by example with green public buildings; providing financial incentives; and mandating green outcomes by a certain date. The main question addressed in this research is: How do these policies affect the market penetration of green buildings in various commercial markets throughout the United States?

Pro-green building policies originated in the not-for-profit sector in the early 1990s, and have worked their way into public policy. These policies generally include Leadership in Energy and Environmental Design (LEED) for new construction and ENERGY STAR for ongoing building operations. There are additional policies at the state and local level that take many forms, including: (from weak to strong) blandly supporting these two main green paradigms; suggesting guidelines without teeth; leading by example with green public buildings; providing financial incentives; and mandating green outcomes by a certain date. The main question addressed here is: How do these policies affect the market penetration of green buildings in various commercial markets throughout the United States?

To address the research question, we conducted a literature review of scholarly papers on the topic. Next, searched the Internet for state and local green policies. After identifying the state of California and the city of Chicago as leaders, we interviewed representatives of those governments. Next, we accessed CoStar data on office and retail buildings to determine the percentage that are classified as green (both LEED and ENERGY STAR) in the top 130 U.S. markets. We present these market penetration rates overall, and over time, for these top markets and for California. We close with observations on green policies that seem to work, plus address emerging trends and opportunities for future research.
Background on Green and Green Policies

The United State Green Building Council (USGBC) was established in 1993 as a non-profit entity interested in promoting sustainable development. The USGBC developed the LEED standards in 1998. LEED is a green building rating system that looks at the design, construction, and operation of buildings. LEED was developed from a checklist of recommended construction practices to include development as well. The LEED rating system is an ongoing collaborative process between architects, builders, and building owners and operators. The USGBC released LEED Version 3 on April 27, 2009, which among other things incorporates regional issues. Special emphasis on water management in dryer states is one example of a LEED V.3 modification.

ENERGY STAR is also a measurement of green, developed in 1992 through the efforts of the United States Environmental Protection Agency. First created for the U.S., several other countries have now adopted the program including, Japan, Austria, the European Union, and New Zealand. The focus of the ENERGY STAR program is to reduce energy consumption thereby lowering greenhouse emissions. ENERGY STAR measures energy efficiencies for operating buildings and building systems, as well as equipment used inside buildings and homes. ENERGY STAR is incorporated into LEED standards for the renovation of existing buildings.

Green Globe is a set of international standards initially endorsed by 182 Heads of State at the United Nations Rio De Janeiro Earth Summit in 1992. Green Globe is a worldwide benchmark program developed for industry. The elements of benchmarking go beyond a physical structure to include energy, water, waste, community, paper, cleaning, and pesticides. Green Globe has been applied to the international tourism industry.

Founded in 1989, Green Seal is a non-profit entity helping set standards for the service industry and individual products. Green Seal’s first green standards were issued in 1991. Their first product certifications were done in 1992. For example, Green Seal has established guidelines for hotels and restaurants. Green Seal has also developed green standards for office products and construction materials, as well as cleaning products and items used in food service.

Thus, the green building has grown in popularity and importance, and has been substantially influenced by non-profit involvement. The grass roots level push for green was heard by politicians and public policy began to take place.

The intent of this paper was to look at how public policy promoted the development of green buildings. There are four levels of public policy to review: federal, state, county, and city. Different levels of public policy are driven by different forces. Within each government level there are two methods to create policy: executive orders and legislation. A combination of the two works best. Executive orders get the ball rolling. Legislative processes involve more people in the commitment to green.

From a private (developer or building operator) viewpoint, there are various motivations for being “Green.” These are in order of importance: cost savings,
public perception, public policy, and “it’s the right thing to do.” How an entity values each of these motivators depends on whether the entity is the operator, tenant, owner, or developer of a building.

There are also various definitions for being green. Under ENERGY STAR, being green means lowering operating energy use. Under LEED, being green means building for operating efficiencies and/or to lower the carbon footprint during the building process.

A reduction in operating costs is the chief motivator to being green. Often companies are motivated to reduce costs without the green label. Studies have shown that having a green label demands higher rents, possibly as an offset to lower operating costs for the tenant. Studies have also shown that large companies value the perception of green. Larger companies often appeal to public opinion as part of their image. Particularly in today’s markets, consumers are interested in whether companies “do the right thing” as an overall reflection of the entities moral compass.

The question that this paper addresses is: How does public policy encourage building (or converting an existing building to) green? In areas of the country where green makes economic sense (dry and sunny primarily), there is less need for public policy. Perhaps there is also less need for public policy in large cities where public image is important. But in smaller communities or those in weaker economies that compete with each other for businesses, there is a reluctance to implement any policy that would discourage building by making it more expensive. For ease of use and staffing efficiencies, is it better to implement public policy at the state or local level? Policy at the federal level, while helpful, does not take into account regional differences related to climate, water resources, and economic difficulties.

Previous Studies on Green Buildings

May and Koski (2007) divided state level green policies into two sub categories: policies that have been mandated by gubernatorial executive orders and those that have been subject to legislative enactment. Nine states including New York, New Jersey, and California have policies mandated by executive orders, while six states including Oregon and Washington have policies subject to legislative enactment. According to May and Koski, the provisions include state incentives for constructing green buildings, mandates for adherence to LEED provisions for new facilities, and requirements for LEED provisions for renovated buildings that meet specified size or value requirements. The authors also analyzed factors that affect adoption of a green building requirement, and whether the state adopts it through executive orders or legislative enactment. Their findings suggest that political issues such as interest-group opposition and governors’ strong political powers affect adoption of green building requirements.

The National Association of Industrial and Office Properties (NAIOP, 2007) research foundation recently surveyed about 100 its members about green
buildings. It classified green building requirements into several sub-categories: policies, programs, incentives, and evaluation. According to the NAIOP classification, policies refer to regulation to meet LEED or equivalent; programs refer to technical support and training for developers; incentives refer to financial and administrative supports; and evaluation refers to performance monitoring and to disciplinary action. The survey had recommendations for facilitating private sector-driven green new construction.

Other studies on green buildings can be divided into three themes: better indoor environmental quality than conventional buildings (Paul and Taylor, 2008); barriers to the construction of green buildings (Richardson and Lynes, 2007); and the price or rent differences between green buildings and conventional buildings (Fuerst and McAllister, 2008; and Miller, Spivey, and Florance, 2008).

Paul and Taylor (2008) compared occupant comfort and satisfaction between a green building and a conventional building. To test this, they enumerated the comfort and satisfaction perceptions of the occupants of a green university building and two conventional university buildings with a questionnaire that asked occupants to rate their workplace environment in terms of aesthetics, serenity, lightning, acoustics, ventilation, temperature, humidity, and overall satisfaction. They found no evidence to believe that green buildings are more comfortable.

Richardson and Lynes (2007) explored the barriers and motivations to the construction of green buildings at the University of Waterloo in Canada. To test this, the authors conducted 13 in-depth interviews with key university individuals. Based on interviews, the authors found that a lack of internal leadership amongst stakeholders with decision-making power, a lack of quantifiable sustainability targets, an operational structure that does not reward building design with lower energy costs, and lack of communication between professional designers, facilities management, and faculty were barriers to constructing a green building at the university.

Two papers address whether there is a price or rent difference between ENERGY STAR or LEED designated buildings (green buildings) and conventional buildings (Fuerst and McAllister, 2008; and Miller, Spivey, and Florance, 2008). The authors of these two papers used the large commercial property dataset provided by the CoStar Group. Using hedonic regression models, they both found that there are green building premiums in terms of rents and building prices. These findings are promising because they indicate markets can price the benefits of investment in ENERGY STAR and LEED certification.

In addition to these papers, Clemens (2006) investigated the relationship among green performance, financial performance, and green economic incentives for small firms. He suggests that firms, especially small firms, could benefit from increased consideration of the environment and from developing and proposing green economic incentives.
Search Process

Based in part on information derived from a review of the academic literature, the research team looked at websites for the leading states and cities mentioned. The intent was to investigate government websites as an indicator of how easily green building information is to gather. The search phrase used was State/City “Green Building Government.” In most instances, the information on government websites is not user-friendly—dates are missing and the policy proposed is not necessarily the policy approved. While governor or mayor websites like to feature green news, actual assistance for building green is often not available.

We gathered data on the following categories: financial inducements (tax credits, feasibility studies, grants, low interest loans, and “feebates”), a green office with staff, stated guidelines for building, requirements that school and public buildings be green, green policy on non property matters like car fleets and purchasing, mandates on energy use saving with specific date, and performance bonds for LEED. The presence or absence of these items was noted, at the state level. We then searched at the city level for the same factors. Refer to the Appendix for the search results presented by state and city.

Findings from the Website Research

Green is becoming more important as the cost of energy increases and our dependence on foreign energy sources pose security risks. The U.S. Department of Energy and the U.S. Environmental Protection Agency both promote energy efficiency. Many local governments have started green policies at the residential level, as well as for schools, public buildings, and commercial buildings. The most common form of green policy is LEED for publicly financed buildings in programs labeled “Lead by Example.” ENERGY STAR is more common in the western states. Examples of states that use the LEED rating system are New York, New Jersey, Pennsylvania, Maryland, Connecticut, California, Massachusetts, and Rhode Island. Examples of municipal governments that feature and use LEED are Seattle, Washington; Portland, Oregon; Chicago, Illinois; Fairfax, Virginia; Arlington, Virginia; Austin, Texas; and Santa Monica, California.

California was on the forefront of green with policy in 2004. It was the first state to propose green building guidelines, adopting LEED and ENERGY STAR guidelines in 2004. As a result, there is relatively little redundancy at the local level. Hawaii, being a relatively uniform market, also has statewide guidelines.

A factor in building green buildings is the availability of information on green criteria. Making this information readily available to help educate the building industry, as well as the general public is of paramount importance. Government assistance, particularly at the local level, is key. Financial assistance at any level is helpful. Offices of Environment or other dedicated personnel can help a builder navigate technical and financial hurdles.

Various climate environments serve as motivators for green as well. Cities that experience may days of sunshine can utilize solar panels. Cities with less water
access have higher water costs, which motivate water conservation. Warmer climates use more electricity for air conditioning, motivating building users to provide shade and green roofs.

Among cities, Chicago stands out as having a substantial number of green buildings. After reviewing literature on green building concentrations, a focal point of this research addressed why Chicago ranked 6th in the number of green buildings and 16th in green building market penetration. Certainly, the climate in Chicago did not lend itself so easily to obtaining a Green LEED rating: what Chicago has is public policy. Specifically, Chicago has a Department of Environment, with a green agenda established in the 1990s and that moved to the next level in 2005.

**CoStar Data and Results**

The main focus of this paper is to link public policy with the presence of green buildings, calculated as a market penetration rate (green buildings/total buildings in the market). To do this, we used CoStar, Inc.’s database system (www.costar.com). CoStar provided the number of commercial green buildings by U.S. states and markets. The data sets collected from CoStar, Inc. include: (1) the number of commercial green buildings by state; (2) the number of commercial green buildings and the number of commercial buildings constructed or renovated in a particular year; (3) commercial green buildings in California; and (4) market penetration in Chicago. The green status was determined by identification of properties with checked boxes for “LEED or ENERGY STAR” in the property search.

We developed market penetration results for commercial green buildings in 138 U.S. city markets by collecting the total number of office and retail buildings from CoStar. A total of 112 markets have at least one green building and 47 markets have more than 10 green buildings. We focused on the smaller group for our analysis. City results were aggregated up to the state.

Exhibit 1 shows the top 20 states, by number of green buildings. We found 3,112 green office or retail buildings in the CoStar database in the U.S., as of March 26, 2009. Each building was in the CoStar database as having rental vacancy and “green” status. California was ranked as the top state followed by Texas, Colorado, Illinois, and Pennsylvania. California has 746 commercial green buildings, including 691 office and 55 retail buildings. This figure is not the market penetration rate, but rather shows concentrations of green buildings in various markets.

Exhibit 2 shows more detail of the same data, breaking green out into its subcomponents of ENERGY STAR (focused on building operations) and LEED (focused on building construction) in the top 20 U.S. states. There are 664 ENERGY STAR-labeled commercial buildings in California, which is approximately 90% of the total number of green buildings in California. Among other top states, Michigan, Maryland, and Oregon are the only three states where
**Exhibit 1** | Top 20 States by Number of Green Buildings

<table>
<thead>
<tr>
<th>Ranking</th>
<th>State</th>
<th>Office Number</th>
<th>Valid %</th>
<th>Retail Number</th>
<th>Valid %</th>
<th>Office + Retail Number</th>
<th>Valid %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CA</td>
<td>691</td>
<td>26.53%</td>
<td>55</td>
<td>10.87%</td>
<td>746</td>
<td>23.97%</td>
</tr>
<tr>
<td>2</td>
<td>TX</td>
<td>285</td>
<td>10.94%</td>
<td>90</td>
<td>17.79%</td>
<td>375</td>
<td>12.05%</td>
</tr>
<tr>
<td>3</td>
<td>CO</td>
<td>155</td>
<td>5.95%</td>
<td>21</td>
<td>4.15%</td>
<td>176</td>
<td>5.66%</td>
</tr>
<tr>
<td>4</td>
<td>IL</td>
<td>113</td>
<td>4.34%</td>
<td>22</td>
<td>4.35%</td>
<td>135</td>
<td>4.34%</td>
</tr>
<tr>
<td>5</td>
<td>PA</td>
<td>73</td>
<td>2.80%</td>
<td>35</td>
<td>6.92%</td>
<td>108</td>
<td>3.47%</td>
</tr>
<tr>
<td>6</td>
<td>MA</td>
<td>96</td>
<td>3.69%</td>
<td>10</td>
<td>1.98%</td>
<td>106</td>
<td>3.41%</td>
</tr>
<tr>
<td>7</td>
<td>WA</td>
<td>88</td>
<td>3.38%</td>
<td>16</td>
<td>3.16%</td>
<td>104</td>
<td>3.34%</td>
</tr>
<tr>
<td>8</td>
<td>VA</td>
<td>78</td>
<td>2.99%</td>
<td>19</td>
<td>3.75%</td>
<td>97</td>
<td>3.12%</td>
</tr>
<tr>
<td>9</td>
<td>FL</td>
<td>88</td>
<td>3.38%</td>
<td>7</td>
<td>1.38%</td>
<td>95</td>
<td>3.05%</td>
</tr>
<tr>
<td>10</td>
<td>MN</td>
<td>81</td>
<td>3.11%</td>
<td>12</td>
<td>2.37%</td>
<td>93</td>
<td>2.99%</td>
</tr>
<tr>
<td>11</td>
<td>OH</td>
<td>48</td>
<td>1.84%</td>
<td>41</td>
<td>8.10%</td>
<td>89</td>
<td>2.86%</td>
</tr>
<tr>
<td>12</td>
<td>GA</td>
<td>73</td>
<td>2.80%</td>
<td>13</td>
<td>2.57%</td>
<td>86</td>
<td>2.76%</td>
</tr>
<tr>
<td>13</td>
<td>NY</td>
<td>80</td>
<td>3.07%</td>
<td>6</td>
<td>1.19%</td>
<td>86</td>
<td>2.76%</td>
</tr>
<tr>
<td>14</td>
<td>OR</td>
<td>64</td>
<td>2.46%</td>
<td>20</td>
<td>3.95%</td>
<td>84</td>
<td>2.70%</td>
</tr>
<tr>
<td>15</td>
<td>DC</td>
<td>80</td>
<td>3.07%</td>
<td>2</td>
<td>0.40%</td>
<td>82</td>
<td>2.63%</td>
</tr>
<tr>
<td>16</td>
<td>MI</td>
<td>63</td>
<td>2.42%</td>
<td>16</td>
<td>3.16%</td>
<td>79</td>
<td>2.54%</td>
</tr>
<tr>
<td>17</td>
<td>NC</td>
<td>51</td>
<td>1.96%</td>
<td>24</td>
<td>4.74%</td>
<td>75</td>
<td>2.41%</td>
</tr>
<tr>
<td>18</td>
<td>NJ</td>
<td>50</td>
<td>1.92%</td>
<td>21</td>
<td>4.15%</td>
<td>71</td>
<td>2.28%</td>
</tr>
<tr>
<td>19</td>
<td>AZ</td>
<td>57</td>
<td>2.19%</td>
<td>4</td>
<td>0.79%</td>
<td>61</td>
<td>1.96%</td>
</tr>
<tr>
<td>20</td>
<td>MD</td>
<td>43</td>
<td>1.65%</td>
<td>10</td>
<td>1.98%</td>
<td>53</td>
<td>1.70%</td>
</tr>
</tbody>
</table>

Notes: The source is CoStar. N = 2,801 buildings.

LEED-certified buildings are more numerous than ENERGY STAR-labeled buildings.

Exhibit 3 shows the top 20 U.S. markets by green market penetration as of January 2009. For green office buildings, Hawaii is ranked at the top, with a 3.5% green market penetration rate followed by Houston, San Francisco, Orange, CA, and Denver, which all had green market penetration rates between 2.0% and 3.3%. For green retail buildings, Austin is ranked at the top, with 0.7% green market penetration rate followed by Charlotte, Erie, Portland, and Cleveland. In terms of its green market penetration rate, Chicago was ranked as the 16th highest for green office buildings. Chicago is an anomaly because it is a northern market. Chicago has 130 total commercial green buildings, which ranks it 6th in the number of green buildings.

Exhibit 4 shows the percentage of ENERGY STAR and LEED buildings in the top 20 markets. Orange County, San Francisco, and Los Angeles (all in California)
Exhibit 2 | Percentage of ENERGY STAR and LEED in Top 20 States

<table>
<thead>
<tr>
<th>State</th>
<th>ENERGY STAR</th>
<th>LEED</th>
<th>Both</th>
<th>Total</th>
<th>ENERGY STAR (%)</th>
<th>LEED (%)</th>
<th>Both (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA</td>
<td>664</td>
<td>66</td>
<td>16</td>
<td>746</td>
<td>89.01%</td>
<td>8.85%</td>
<td>2.14%</td>
</tr>
<tr>
<td>TX</td>
<td>333</td>
<td>39</td>
<td>3</td>
<td>375</td>
<td>88.80%</td>
<td>10.40%</td>
<td>0.80%</td>
</tr>
<tr>
<td>CO</td>
<td>130</td>
<td>37</td>
<td>9</td>
<td>176</td>
<td>73.86%</td>
<td>21.02%</td>
<td>5.11%</td>
</tr>
<tr>
<td>IL</td>
<td>104</td>
<td>24</td>
<td>7</td>
<td>135</td>
<td>77.04%</td>
<td>17.78%</td>
<td>5.19%</td>
</tr>
<tr>
<td>PA</td>
<td>55</td>
<td>51</td>
<td>2</td>
<td>108</td>
<td>50.93%</td>
<td>47.22%</td>
<td>1.85%</td>
</tr>
<tr>
<td>MA</td>
<td>76</td>
<td>22</td>
<td>8</td>
<td>106</td>
<td>71.70%</td>
<td>20.75%</td>
<td>7.55%</td>
</tr>
<tr>
<td>WA</td>
<td>70</td>
<td>32</td>
<td>2</td>
<td>104</td>
<td>67.31%</td>
<td>30.77%</td>
<td>1.92%</td>
</tr>
<tr>
<td>VA</td>
<td>73</td>
<td>22</td>
<td>2</td>
<td>97</td>
<td>75.26%</td>
<td>22.68%</td>
<td>2.06%</td>
</tr>
<tr>
<td>FL</td>
<td>78</td>
<td>16</td>
<td>1</td>
<td>95</td>
<td>82.11%</td>
<td>16.84%</td>
<td>1.05%</td>
</tr>
<tr>
<td>MN</td>
<td>81</td>
<td>10</td>
<td>2</td>
<td>93</td>
<td>87.10%</td>
<td>10.75%</td>
<td>2.15%</td>
</tr>
<tr>
<td>OH</td>
<td>67</td>
<td>19</td>
<td>3</td>
<td>89</td>
<td>75.28%</td>
<td>21.35%</td>
<td>3.37%</td>
</tr>
<tr>
<td>NY</td>
<td>63</td>
<td>22</td>
<td>2</td>
<td>87</td>
<td>72.41%</td>
<td>25.29%</td>
<td>2.30%</td>
</tr>
<tr>
<td>GA</td>
<td>66</td>
<td>18</td>
<td>2</td>
<td>86</td>
<td>76.74%</td>
<td>20.93%</td>
<td>2.33%</td>
</tr>
<tr>
<td>OR</td>
<td>37</td>
<td>44</td>
<td>3</td>
<td>84</td>
<td>44.05%</td>
<td>52.38%</td>
<td>3.57%</td>
</tr>
<tr>
<td>DC</td>
<td>72</td>
<td>9</td>
<td>1</td>
<td>82</td>
<td>87.80%</td>
<td>10.98%</td>
<td>1.22%</td>
</tr>
<tr>
<td>MI</td>
<td>34</td>
<td>44</td>
<td>1</td>
<td>79</td>
<td>43.04%</td>
<td>55.70%</td>
<td>1.27%</td>
</tr>
<tr>
<td>NC</td>
<td>64</td>
<td>11</td>
<td>0</td>
<td>75</td>
<td>85.33%</td>
<td>14.67%</td>
<td>0.00%</td>
</tr>
<tr>
<td>NJ</td>
<td>42</td>
<td>29</td>
<td>0</td>
<td>71</td>
<td>59.15%</td>
<td>40.85%</td>
<td>0.00%</td>
</tr>
<tr>
<td>AZ</td>
<td>51</td>
<td>8</td>
<td>2</td>
<td>61</td>
<td>83.61%</td>
<td>13.11%</td>
<td>3.28%</td>
</tr>
<tr>
<td>MD</td>
<td>23</td>
<td>25</td>
<td>5</td>
<td>53</td>
<td>43.40%</td>
<td>47.17%</td>
<td>9.43%</td>
</tr>
</tbody>
</table>

Notes: The source is CoStar. N = 2,801 buildings.

were ranked at the top, where the percentage of ENERGY STAR is higher than LEED rank. Only Portland, Oregon has a higher percentage of LEED buildings. This underscores the dominance of California in the green area.

Moving along to the market penetration of green buildings over time, Exhibit 5 is a graph that indicates the year of designation of green buildings as a percentage of the total number of green buildings. The darker line indicates the designation trend in the U.S. and the lighter line indicates the designation trend in California. Overall, the trends are quite similar. From the table, it can be observed that there many designations in the U.S. and California since 1997. However, designations in California have sharply decreased since 2004. It may be that other economic conditions are in play, or that a saturation point has been reached. More research is needed here.

The remainder of this paper examines California and Chicago in more detail.
### Exhibit 3 | Top 20 Markets by Market Penetration as of January 2009

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Office Markets</th>
<th>Green</th>
<th>Total</th>
<th>Green/Total</th>
<th>Retail Markets</th>
<th>Green</th>
<th>Total</th>
<th>Green/Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hawaii</td>
<td>19</td>
<td>539</td>
<td>3.53%</td>
<td>Austin</td>
<td>26</td>
<td>3682</td>
<td>0.71%</td>
</tr>
<tr>
<td>2</td>
<td>Houston</td>
<td>140</td>
<td>4256</td>
<td>3.29%</td>
<td>Charlotte</td>
<td>13</td>
<td>2507</td>
<td>0.52%</td>
</tr>
<tr>
<td>3</td>
<td>San Francisco</td>
<td>116</td>
<td>3695</td>
<td>3.14%</td>
<td>Erie</td>
<td>3</td>
<td>612</td>
<td>0.49%</td>
</tr>
<tr>
<td>4</td>
<td>Orange (CA)</td>
<td>138</td>
<td>5245</td>
<td>2.63%</td>
<td>Portland</td>
<td>26</td>
<td>5718</td>
<td>0.45%</td>
</tr>
<tr>
<td>5</td>
<td>Denver</td>
<td>146</td>
<td>6139</td>
<td>2.38%</td>
<td>Cleveland</td>
<td>22</td>
<td>7700</td>
<td>0.29%</td>
</tr>
<tr>
<td>6</td>
<td>Washington D.C.</td>
<td>165</td>
<td>8538</td>
<td>1.93%</td>
<td>Denver</td>
<td>20</td>
<td>7941</td>
<td>0.25%</td>
</tr>
<tr>
<td>7</td>
<td>Portland</td>
<td>67</td>
<td>3792</td>
<td>1.77%</td>
<td>Pittsburgh</td>
<td>17</td>
<td>7432</td>
<td>0.23%</td>
</tr>
<tr>
<td>8</td>
<td>Minneapolis/St. Paul</td>
<td>77</td>
<td>4837</td>
<td>1.59%</td>
<td>San Antonio</td>
<td>19</td>
<td>8662</td>
<td>0.22%</td>
</tr>
<tr>
<td>9</td>
<td>Los Angeles</td>
<td>244</td>
<td>15335</td>
<td>1.59%</td>
<td>Washington D.C.</td>
<td>20</td>
<td>10897</td>
<td>0.18%</td>
</tr>
<tr>
<td>10</td>
<td>New York City</td>
<td>50</td>
<td>3556</td>
<td>1.41%</td>
<td>Hampton Road</td>
<td>10</td>
<td>6553</td>
<td>0.15%</td>
</tr>
<tr>
<td>11</td>
<td>Dallas</td>
<td>111</td>
<td>7922</td>
<td>1.40%</td>
<td>Nashville</td>
<td>9</td>
<td>5983</td>
<td>0.15%</td>
</tr>
<tr>
<td>12</td>
<td>Charlotte</td>
<td>34</td>
<td>2463</td>
<td>1.38%</td>
<td>Bakersfield</td>
<td>2</td>
<td>1567</td>
<td>0.13%</td>
</tr>
<tr>
<td>13</td>
<td>East Bay/Oakland</td>
<td>68</td>
<td>5070</td>
<td>1.34%</td>
<td>Sacramento</td>
<td>8</td>
<td>6576</td>
<td>0.12%</td>
</tr>
<tr>
<td>14</td>
<td>Seattle</td>
<td>79</td>
<td>6099</td>
<td>1.30%</td>
<td>Bremerton</td>
<td>1</td>
<td>835</td>
<td>0.12%</td>
</tr>
<tr>
<td>15</td>
<td>Duluth</td>
<td>4</td>
<td>339</td>
<td>1.18%</td>
<td>Kansas City</td>
<td>5</td>
<td>4413</td>
<td>0.11%</td>
</tr>
<tr>
<td>16</td>
<td>Chicago</td>
<td>112</td>
<td>10696</td>
<td>1.05%</td>
<td>Houston</td>
<td>12</td>
<td>10848</td>
<td>0.11%</td>
</tr>
<tr>
<td>17</td>
<td>Sacramento</td>
<td>47</td>
<td>4668</td>
<td>1.01%</td>
<td>Cincinnati/Dayton</td>
<td>12</td>
<td>10921</td>
<td>0.11%</td>
</tr>
<tr>
<td>18</td>
<td>Boston</td>
<td>95</td>
<td>9671</td>
<td>0.98%</td>
<td>Northern New Jersey</td>
<td>18</td>
<td>16729</td>
<td>0.11%</td>
</tr>
<tr>
<td>19</td>
<td>South Bay/San Jose</td>
<td>39</td>
<td>4393</td>
<td>0.89%</td>
<td>Columbus OH</td>
<td>5</td>
<td>4740</td>
<td>0.11%</td>
</tr>
<tr>
<td>20</td>
<td>Austin</td>
<td>22</td>
<td>2855</td>
<td>0.77%</td>
<td>Louisville</td>
<td>3</td>
<td>3050</td>
<td>0.10%</td>
</tr>
</tbody>
</table>

Notes: The source is CoStar. $N = 2,024$ buildings.
### Exhibit 4 | Percentage of ENERGY STAR in the Top 20 Markets (by Total Green Buildings)

<table>
<thead>
<tr>
<th>Market</th>
<th>ENERGY STAR</th>
<th>LEED</th>
<th>Both</th>
<th>Total</th>
<th>ENERGY STAR (%)</th>
<th>LEED (%)</th>
<th>Both (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Los Angeles</td>
<td>236</td>
<td>18</td>
<td>4</td>
<td>258</td>
<td>91.47%</td>
<td>6.98%</td>
<td>1.55%</td>
</tr>
<tr>
<td>Washington D.C.</td>
<td>144</td>
<td>34</td>
<td>7</td>
<td>185</td>
<td>77.84%</td>
<td>18.38%</td>
<td>3.78%</td>
</tr>
<tr>
<td>Denver</td>
<td>122</td>
<td>35</td>
<td>9</td>
<td>166</td>
<td>73.49%</td>
<td>21.08%</td>
<td>5.42%</td>
</tr>
<tr>
<td>Houston</td>
<td>137</td>
<td>13</td>
<td>2</td>
<td>152</td>
<td>90.13%</td>
<td>8.55%</td>
<td>1.32%</td>
</tr>
<tr>
<td>Orange (CA)</td>
<td>131</td>
<td>9</td>
<td>0</td>
<td>140</td>
<td>93.57%</td>
<td>6.43%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Chicago</td>
<td>101</td>
<td>22</td>
<td>7</td>
<td>130</td>
<td>77.69%</td>
<td>16.92%</td>
<td>5.38%</td>
</tr>
<tr>
<td>San Francisco</td>
<td>109</td>
<td>7</td>
<td>3</td>
<td>119</td>
<td>91.60%</td>
<td>5.88%</td>
<td>2.52%</td>
</tr>
<tr>
<td>Dallas</td>
<td>101</td>
<td>16</td>
<td>1</td>
<td>118</td>
<td>85.59%</td>
<td>13.56%</td>
<td>0.85%</td>
</tr>
<tr>
<td>Boston</td>
<td>76</td>
<td>21</td>
<td>8</td>
<td>105</td>
<td>72.38%</td>
<td>20.00%</td>
<td>7.62%</td>
</tr>
<tr>
<td>Portland</td>
<td>38</td>
<td>52</td>
<td>3</td>
<td>93</td>
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Notes: The source is CoStar. N = 2,156 buildings.

### California

In the 1980s, California went through a process to site landfills. Public awareness was heightened to the growing need to handle California’s increasing population’s waste needs. In 1989, state landfills were at capacity. Thus, the motivation for green in California partly grew out of the need to reduce waste. Over 22% of the material going into landfills was construction and demolition debris (Dick, 2009). The green movement in cities was moving concurrently with the state. California put executive orders in place in 1999 requiring the reduction in landfill waste. The state then worked with cities on how to implement this requirement. Using LEED building standards was the natural choice to have an immediate positive impact on landfill capacity. Using recycled content products was also encouraged.

Green building codes were established and mandated for publicly funding projects. Local jurisdictions are encouraged to modify these building codes to adapt for...
seismic, climate or resource differences. Some financial incentives were established at the beginning, but these programs are no longer funded.

Mandates were not required for private developers in the beginning. Rather, private developers were encouraged to follow suit. California provides technical assistance. California websites include contact names and information about all aspects of green. The recent state climate reduction bill AB32 (2006) mandates carbon emission limits. Green buildings are expected to meet these carbon limits.

California is not only motivated to go green to decrease waste but also to reduce energy consumption. Over the last 30 years, California has led the nation with energy policy. It has been successful: state energy use is flat despite a large rise in population (Dick, 2009). This has been accomplished through green education. Building owners have been taught to tighten up their buildings and use efficient HVAC systems.

State Green Building Codes are coming. It took 20 years for the green standard to be common for new construction. Green is fairly common in new residential, although we did not address residential green in this paper. Rehabbing buildings to green standards is also a common practice in California (Dick, 2009).

Exhibit 6 shows market penetration of green buildings in each market in California. The ratio of green buildings and total commercial buildings in Orange County is 1.3%, indicating that this percentage of total buildings has been designated as ENERGY STAR or LEED. Just for offices, however Orange County follows San Francisco (3.1%) with 2.6%.

**Chicago**

In Chicago, the Department of Environment was established in 1992 as a regulatory arm to address brownfields, illegal dumping, etc. In 1999, executive
<table>
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<th>Markets</th>
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<td>681</td>
<td>44174</td>
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Notes: The source is CoStar.
orders mandated that publicly-financed buildings be LEED silver certified. In 2001, Chicago built the first LEED platinum municipal building and the third LEED platinum building in the U.S. Chicago felt strongly that they needed to lead by example, and that this would help others follow their lead.

In 2004, Chicago developed the Green Building Agenda. Chicago encourages LEED design for all new buildings. But since green does not stop at new buildings, Chicago works with existing building owners and operators to rehab buildings to incorporate ENERGY STAR efficiencies.

In 2009, the Department of Environment helps developers and citizens build and operate green. Citizens are shown how to disconnect downspouts and install rain barrels. Businesses are directed through technical programs. People in the office are trained to work with all questions and problems. A hotline number is available to direct all calls. The City of Chicago does not believe in large financial incentives. They encourage green by offering technical assistance, faster permitting, density bonuses and green roof grants. As we have seen elsewhere, when financial incentives are offered, the change desired is not long lasting unless the financial incentives are retained. Current Chicago standards are LEED silver plus.

Chicago is looking beyond the buildings to operation and maintenance of the businesses in these buildings. Chicago is working with a new concept, Green Seal, on the greening of products and business operations. Green Seal is a non-profit that sets standards for products and services. Green Seal has established green criteria or products such as paint, paper, cleaning supplies, office supplies, construction materials, and more. Green Seal sets standards for services such as food preparation, lodgings, and construction. Chicago is currently working with Green Seal to green 13 hotels in the downtown area.

Other green focal areas for Chicago are a Climate Action Plan, related to infrastructure and transit. Chicago has recently passed legislation to reduce carbon emissions. Infrastructure projects include greening of alleys and driveways with permeable pavements and French drains. Better coordination is being sought with MPOs to direct transportation dollars in efficient ways.

According to Chicago Energy Czar Sadhu Johnston, it helps that Mayor Daley had been in office since 1988. Without term limits, the mayor can put energy into long-term issues. This has certainly paid off for Chicago. Chicago has a reputation for green. Companies with ties to green technology want to locate there or hold conferences there. Chicago’s commitment to green can be a lesson to other cities looking to grow and expand (Johnston, 2009).

In the context of these policies, Exhibits 7 and 8 show the trend of market penetration of green buildings in Chicago since 1990. The table and the graph show that between 1990 and 1997 the increase rate was almost flat. However, the market penetration had been slowly increasing after 1998, and sharply increased since 2003. This implies that the green policies have been effective in inducing green buildings in the Windy City.
## Exhibit 7 | Market Penetration in Chicago since 1990

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<td>931</td>
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<tr>
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<tr>
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<tr>
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<tr>
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<td>2</td>
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</tr>
<tr>
<td>1998</td>
<td>648</td>
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<tr>
<td>1999</td>
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<td>2002</td>
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<tr>
<td>2008</td>
<td>82</td>
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<td>1.22%</td>
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Notes: The source is CoStar. N = 79 green buildings.

### Exhibit 8 | Green Building Market Penetration in Chicago

(green / total constructed, by year)

Note: There are 130 green buildings in Chicago. Of these, the designation year could only be inferred for only 79 green buildings. This graph is based on these 79 buildings, so some data are missing.
Conclusion

The green movement started with U.S. Green Building Council (USGBC), a non-government agency. The development and promotion of LEED standards by USGBC has influenced public policy. More cities and states cite LEED standards as their definition of green. Only recently have local governments started to look at their regional needs, strengths, and weaknesses to help develop individualized standards. The western states, i.e., California, Colorado, and Arizona, place water conservation as an equally high or higher priority than other energy-saving criteria.

The most common form of public policy is to require LEED for all public buildings. Several states call this “Lead by Example” and specify that government buildings and/or school buildings be LEED certified or ENERGY STAR rated or both.

For ease of use and staffing efficiencies, it is perhaps better to establish public policy at the state level and enforce it at the local level. Virginia cites the Dillon Rule, which states that building codes are exclusively the providence of state government.

Movements are often from the bottom up (USGBC and LEED) but policy is influential wherever it comes from (federal, state to local).

Executive orders are a quicker method for encouraging green. Legislation gets bogged down in politics. Working through different political agendas often results in green legislation going nowhere.

Starting with publicly financed new buildings including schools is the best way to ‘Lead by Example’ and gain knowledge about the green building process. This knowledge is valuable when working with businesses and developers. Change is hard and having the regulators hands to hold makes going green easier. New buildings offer more positive public relations. Work with rehabs and renovations by pointing out cost savings demonstrated in the new buildings.

Bucking the current political trend, it appears that longer term limits for politicians may encourage a longer range outlook for policy and change.

Financial incentives should be for new buildings only and carefully written legislation. Las Vegas wrote legislation in 2005 that benefited special interest groups. The dollars for green in Las Vegas were so oversubscribed that the law was rewritten in 2007. Financial incentives cannot always be maintained and the changed behavior is not permanent.

Non-profits play an important role in education and outreach. The USGBC is an important creator of LEED guidelines. Local builders associations provide updates on new green technologies and opportunities. The aforementioned NAIOP survey included a summary of city and state green building policies. These non-profits serve their constituents and members by providing the latest information on this niche and growing market (NAIOP, 2007).
Governments need to “LEED” by example and set high standards. They should ideally incorporate green into every aspect of the government agency—fleets, cleaning products, operations, etc. Green Seal can provide guidelines for this area of operations. A better source for green building criteria is the USGBC websites at either the national or local level. Often local builder association websites offer green building guidance as this is a competitive edge for its members. USEPA and DOE both offer information on green initiative linking a searcher to the state or local source. The information on ENERGY STAR is largely at the consumer level.

Under the assumption that requiring public buildings and schools to be green is the most common form of public policy, future research should focus on how local or state governments have encouraged these buildings, and the role of financial incentives. Moreover, future research should include detailed and valuable datasets of green public buildings and schools.
## Appendix

<table>
<thead>
<tr>
<th>State or City</th>
<th>State or City Government</th>
<th>Mar-08</th>
<th>URL</th>
<th>Financial Incentives</th>
<th>Building Code Guidelines</th>
<th>School Buildings</th>
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The Effect of State and City Green Policies
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<td></td>
<td>Department of Environment 312-744-7606</td>
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<td>Executive Order to establish energy efficient state building guidelines</td>
<td>LEED, Green Globe, ENERGY Star or ANSI</td>
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<td>Environmental Commission—Advisory</td>
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<td>Portland</td>
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<td>Leading by Example</td>
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<tr>
<td>Minnesota</td>
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<td>Pollution $</td>
<td>yes</td>
<td></td>
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<tr>
<td>Minnesota</td>
<td>Minneapolis</td>
<td></td>
<td>LEED silver 2006</td>
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<tr>
<td>Nebraska</td>
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<td>Homes Nebraska Energy Office</td>
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<tr>
<td>New Jersey</td>
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<td></td>
<td></td>
<td></td>
<td>Bill</td>
<td>introduced–2004</td>
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<tr>
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<td>Monroe County</td>
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<td></td>
<td></td>
<td></td>
<td>Fleet, purchasing</td>
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<td>Nevada</td>
<td>Las Vegas</td>
<td></td>
<td>Written in 2005 and modified in 2007</td>
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<td></td>
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<td>Franklin County</td>
<td><a href="http://www.co.franklin.oh.us/fc/">http://www.co.franklin.oh.us/fc/</a></td>
<td>Energy Conservation Proposed</td>
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<td>State</td>
<td><a href="http://www.oregon.gov/ENERGY/CONS/BUS/tax/sustain.shtml">http://www.oregon.gov/ENERGY/CONS/BUS/tax/sustain.shtml</a></td>
<td>Tax credits</td>
<td>Oregon Housing and Community Services</td>
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<td>Portland</td>
<td><a href="http://www.portlandonline.com/">http://www.portlandonline.com/</a></td>
<td>Performance Green Building Policy–2007</td>
<td>GIF grant and fee-bate</td>
<td>Bureau of Planning and Sustainability</td>
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<td>Texas</td>
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<td><a href="http://www.seco.cpa.state.tx.us">http://www.seco.cpa.state.tx.us</a> / re. sustain_links.htm</td>
<td>Up to $400,000</td>
<td>Voluntary</td>
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<td>Texas</td>
<td>Dallas</td>
<td><a href="http://www.greendallas.net">http://www.greendallas.net</a> /</td>
<td>Citywide Green Building Program– 2008</td>
<td>1.5% better than 2006 IECC &amp; Cool roofs</td>
<td>Recycling</td>
<td>Green Office to be established in FY08 / 09</td>
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<tr>
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<td>Fairfax County</td>
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<tr>
<td>Washington Kitsap County</td>
<td></td>
<td><a href="http://www.seattle.gov/environment/">http://www.seattle.gov/environment/</a></td>
<td>Reduce greenhouse emission to 7% below 1990 levels</td>
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<td></td>
<td></td>
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</tbody>
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References


Johnston, S. Chief Environmental Officer, City of Chicago. Telephone interview March 25, 2009.


Sustainable Real Estate Development: The Dynamics of Market Penetration

Author John Goering

Abstract This paper uses three different data sources to examine the rate of growth of sustainable development practices. Research analyses of the economic outcomes of green building are linked to short case studies of green building in New York. The concluding data address macro level limitations on the rate of diffusion and acceptance of green building technologies and costs. Limited and recent governmental policies are suggested as the core method to increase the rate at which green building becomes a national rather than an exclusive and limited method of growth. The preliminary nature of these data sources and analytic methods suggest the need for far more research and evaluation studies on the causes and outcomes of sustainable development in the United States.

Developing green or sustainable buildings is one critical component of the larger sustainability movement in the United States. This paper is an exploration of dispersion, or market penetration, of sustainable building standards in the operation of for-profit and not-for profit development of commercial and residential properties (Freeman, 2008). We explore the basis and conditions for a large-scale expansion of green building so that it becomes the predominant, not exclusive, format for the construction and rehabilitation of residential and commercial properties in the U.S. within the near term of the next two decades. This analysis is motivated by the seeming paradox that while environmental or green issues have become more politically and policy salient within the past several years, it is not at all clear that these issues have sufficient demand-side and business-sector momentum for them to become central to the process of rebuilding our cities in a more energy efficient and sustainable manner (Barringer, 2008; Friess, 2008; Nelson, 2008; Peters, 2009; Broder, 2009a; and Liptak, 2009).

To accomplish this analysis, we use mixed-methods triangulation of three sources of data and information that help in appreciating the options for growing the green building movement in the U.S. to something like full scale. We explore key social science and policy complexities and limitations associated with deciding what ‘green building’ means, how it is measured, including an assessment of how its costs and impacts are separately evaluated by economists and by developers. The divergence between the latter two assessments suggest a strategic gap in providing clearer evidence of effects and costs that would be central to the momentum of green building.

The paper is organized as follows. It begins with a brief discussion of the relevance of green building and the methods currently used to measure and report sustainable
real estate development. We then focus on the question of the absolute and relative scale or size of the current green building operations to raise questions about the determinants of further increases in sustainable building. The core of the paper includes data from recent economic research assessing the rent and sales price returns from green versus non-green properties, followed by short case illustrations of the motivations of for-profit and not-for-profit developers. The final section of the paper assesses national, macro-level obstacles and options affecting further growth of green building including possible roles for governmental intervention.

Why Study Green Buildings?

The basic canons of social science perpetually caution us against readily validating popular support and enthusiasm before there is evidence on the costs, benefits, and outcomes of the various policies and programs, including an assessment of winners and losers. This caveat applies to evaluating various formats for developing green buildings, whether commercial or residential. Given the slight to modest additional cost for building new or rehabilitating buildings in American cities, and the long-term durability of these structures, there needs to be care in assessing who are the winners and losers in any drive to establish new sustainable building code requirements upon office and residential markets, most especially at a time when their financing sources are either unclear or have become critically limited (Kats, 2003; Davis Langdon, 2007).

As in any new arena of policy analysis, there are a range of reasons why the study of green buildings is beneficial to policy makers and social scientists. The simplest is that new ideas and policy emphases are seldom born in a perfected state and require constant monitoring, evaluation, and management for their improvement and scaling up to encompass increased shares of the development process. We may also learn much about how human behavior adapts to, and in the longer term benefits from, such innovations. Finally, because fashionable or trendy ideas can trigger selectivity problems or biases, the issue of carefully controlling how research evidence is gathered and analyzed becomes central.

More pragmatically, the importance of sustainability to the world of real estate is due to the simple fact that buildings, residential and commercial, consume 40% of the energy used in this country and are “responsible for more than a third of our total carbon dioxide emissions,” (Holness, 2009). The analysis of the policy consequences and impacts of sustainable real estate development cannot logically ignore such a major source of environmental impacts.

The evaluation of how well new standards for building green help in achieving benefits for more people at comparable or lower costs is central for both commercial and not-for-profit builders. There has, however, to date been very little data assembled on the costs associated with the design, construction, and operation of new or remodeled office or residential buildings using differing green certification requirements, such as LEED, ENERGY STAR, or competing formats (see Davis Langdon, 2007).
The issue of the costs and benefits of sustainable development is then central to any sensible long-term planning, research, and evaluation agenda most especially one that aims to focus on the transferability of development standards to low-income housing and community development. If a policy goal emerges to adapt costly technologies into more usable and affordable techniques for addressing large scale environmental risks, the issue of environmental equity and the rapid dispersion of green building methodologies would be resolved, although at present there does not appear to be momentum in this direction.

**Measuring 'Green'**

The gradually emerging popularity of green building has been facilitated, and partially captured, by a variety of green measurement tools established in the U.S. over roughly the last decade that have offered operational definitions of what it means to build sustainably (Miller, Spivey, and Florance, 2008). There are currently five major national certification formats for defining what green building means in the U.S., all of which are currently voluntary. In Exhibit 1, we list the major systems currently used for defining the component parts of a green building. Some of these standards may in turn become potential measures of green energy and water savings for individual consumers or to building developers and managers. We list them in rough order of their chronological development although there has been an almost continual process of adapting and changing the standards to address the concerns of “stakeholders.”

Prior to the recent evolution of these rating systems, the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) standards were the first, now oldest of the building engineering measurement systems that have had a major focus on existing buildings and their sustainability. But because they apply only to a limited set of engineering issues, they are included as part of the background evolution of formal green building measurement tools that are now being adopted and used by the development community. Their relevance would however be central to the evolution of building codes that may be applied to the rehabilitation or construction of future buildings. They do not offer a simple unified rating system for new and existing buildings that have achieved the degree of usage in the real estate community comparable to LEED.

**Exhibit 1** | U.S. Systems for Defining & Measuring Green Building

<table>
<thead>
<tr>
<th>Organization</th>
<th>Time Frame</th>
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<tbody>
<tr>
<td>ASHRAE</td>
<td>1970s and evolving</td>
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<tr>
<td>ENERGY STAR</td>
<td>1992</td>
</tr>
<tr>
<td>LEED</td>
<td>1998 (evolving)</td>
</tr>
<tr>
<td>Green Globes (Global Environmental Method)</td>
<td>2000 (initially UK &amp; Canada)</td>
</tr>
<tr>
<td>Ad Hoc</td>
<td>No-rating; individual projects</td>
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</table>
Another early green rating system, the ENERGY STAR system, was developed by the U.S. Environmental Protection Agency or EPA in 1992 as a voluntary labeling program for new sustainable products. With the exception of ENERGY STAR ratings, the alternative rating formats have been developed by groupings of industry sponsors working with various coalitions of interested organizations and agencies. Some have included non-profit organizations as part of their network of sponsors or stakeholders. They are all, including ENERGY STAR ratings, voluntary and most entail some cost to an applicant for applying for certification as a “green” building.

Leadership for Energy and Environmental Design or LEED is by most accounts the most complex and time-consuming certification to apply for, as well as the best known and accepted by a range of industry actors. LEED building standards continue to evolve and range from basic approval to the top platinum rating.  
LEED and Green Globes in Canada have been adapting their requirements for existing building approvals or certification over the last few years (Gowri, 2004; Miller, Spivey, and Florance 2008; Moore, 2008). The current uncertainty about these standards has resulted in some building owners electing to develop their own sustainable building practices due to the high degree of variability in the age and cost of adapting their buildings.

Green building systems in the U.S. are, then, relatively new with virtually all evolving since 1990, with the latest from the National Association of Home Builders being copyrighted in 2006. We include in Exhibit 1 a sixth category of ad hoc implementation to capture those building and non-profit building sponsors who decide they cannot, for example, take advantage of LEED because that system’s certification requirements are cumbersome and costly. This final category captures interest in non-certified forms of sustainable building practices that are also evolving in tandem with formalized systems for accreditation and certification of greenness. This includes firms such as Time Equities Inc., profiled in the case studies below, which has focused on the net greenhouse gas emissions from their national portfolio of buildings as the centerpiece of their evolving plans to convert their existing building inventory to a more energy-efficient status. They view LEED certification as largely a tool for the marketing of their assets.

It is essential to note at this point that many of the construction and building technologies that are referenced in the above standards apply most directly and readily to the development of new buildings, with a growing focus on adapting existing buildings. The bulk of commercial and residential buildings in the U.S. as elsewhere are, however, pre-existing and the technologies for modifying older existing buildings are both more complex, case specific, and even more costly. Among the complexities in adapting older buildings is that they may contain asbestos, lead-based paint, or other environmental hazards, which must be abated at the same time that energy saving and sustainable systems are installed.

It is also important to note that these rating systems have until recently focused on the front-end of the design and development process in the U.S. These are front-loaded rating systems with much less focus upon the methods for sustaining energy savings and for training staff to manage new technologies optimally.
ENERGY STAR and LEED for Existing Buildings are focused on the on-going performance of the buildings or homes after construction (Jones and Vyas, 2008; p. 66). This is important as there are data that suggest that there is some loss or atrophying of energy savings over time (Jones and Vyas, 2008).

**Uncertainty about Bringing Green Building to ‘Full-Scale’**

Among the central evaluation issues affecting any relatively new program or initiative, such as green building, is the question of how quickly a successful or effective program can be brought to full or national scale or to achieve nearly complete market penetration (Crane, 1998; p. 6). An early problem is, then, the puzzle of how to bring sustainable building practices to something like full-scale or full market penetration.

Because of the recency of green building standards, the bulk of buildings in the U.S. are not energy efficient or sustainable. There are roughly 72 million owner-occupied buildings in the U.S., another 7.6 million attached homes, and then 6.9 million mobile or manufactured homes, very few of which were constructed using a sustainable set of guidelines or building technologies. And of the nearly 5 million commercial buildings, with over 70 million square feet of space, most have not been adapted to or built with energy or environmental issues in mind.7

Recent research indicates that for a number of larger real estate developers in the U.S., none have built or adapted more than 20% of their total inventory and most have built out less than 2% of their owned stock (Miller, Spivey, and Florance, 2008). In part this may be due to the costs associated with the development of new buildings and the retrofitting of older ones, or to knowledge gaps on the part of owners unaware of their technological and maintenance options. Owners may also feel that tenants will not pay more for a green space when faced with ample vacant space at lower rents, as under 2008–2009 market conditions.

A related concern for developers and investors is that the multiplicity of green building standards and certification programs have not yet been shown to have clear links to assessed values and longer term rents. As Nelson (2008; p. 14) comments: “Without a common standard, compiling assets for a green building fund is daunting.” Increasing the pool of investors, nationally and globally, will then require new strategies to standardize and solidify the meaning and potential benefits for building or investing in green. Until this occurs, green building systems may well be a small-scale, unsecuritizable niche.

There may however be a problem of undercounting buildings that have made some green adaptations. Some owners who have used green building systems may not wish to be bothered with the time and paperwork seeking green certification. Using LEED or ENERGY STAR ratings as the basis of calculating energy-efficient building practices may also undercount buildings adapted at an earlier point in time. One analyst notes: “Meaningful building counts are ...elusive because most green certification programs have been adopted only in the last few years—well
after the industry began constructing more sustainable projects, and many owners resist the expense of seeking certifications retroactively.\textsuperscript{8} There are currently no means to sensibly correct for such undercounting.

\textbf{An Infinitesimal Number of Buildings—A Rapid Rate of Growth}

Although LEED first began pilot efforts in 2000, there has been only slow growth in the absolute number of certifications and registrations.\textsuperscript{9} In July 2002, for example, there were only 22 buildings certified and another 465 registered (Scheuer and Keoleian, 2002). By 2005, only 300 buildings had been certified with another 2,200 registered (Schendler and Udall, 2005). By fall 2008, a total of 2,151 buildings in the U.S. had achieved some level of LEED certification, with another 16,000 registered. More recently, in April 2009, there were a total of 2,476 buildings certified and another 19,524 registered of which the bulk (60\%) were in new construction and only 12\%, or fewer than 2,700 buildings, rated or registered in the LEED Existing Building category. Indeed, as of 2009, only 200 buildings nationwide had been certified in the new EB category.\textsuperscript{10} The bulk of the certified and registered buildings are therefore in the new construction category rather than modifications of the huge portfolio of existing buildings.

Therefore with a total of 22,000 certified and registered buildings as of 2009, some of which are schools and hospitals, out of a total inventory of 5 million commercial office buildings, the U.S. has achieved a penetration rate of 0.004\% in the nine years since 2000. Using a more conservative calculation including only certified buildings, the penetration rate would be 0.0005\%. However, despite the low absolute numbers, there has been a rapid rate of growth in the numbers of certified and total properties rated or registered with LEED since 2002. The rate of growth in the number of certified buildings has been over 11,000\% and the growth rate of both registered and certified has been over 4,000\% in the seven-year period.\textsuperscript{11} If we select the time period of 2005 to 2009, the rate of growth was still impressive at 780\% but notably lower than the first comparison, suggesting some diminution in the explosive initial growth.

The comparison of absolute and relative change should not be seen solely as a judgment call of whether this glass is half-full or empty, but rather a matter of appreciating what the dynamics are that may have led to the adoption of LEED principles and whether those adoption dynamics are rapidly replicable. To date, we have no research that can establish what those causal adoption dynamics may be, how the USBGC or other entities can influence them, or how the current recession may have affected them. The rate of adoption problem is very much a black box.

The decline in the rate of development of new additional office properties due to the market recession will of course necessarily mean a reduction in the rate of growth in the adoption of LEED building principles. Older, existing building owners will also hesitate to convert to more sustainable methods of operation for at least the short term unless they, like the Time Equities case described below, can be certain of relatively low costs for conversion and rapid rates of return or payback, as well as some assurance about the rate of decline in office vacancies.
So for LEED, while there has been a rapid relative rate of adoption mostly for new buildings, there have been a quite small absolute number of buildings “converting” to sustainable LEED formats, and the majority of those users are not private sector developers. The low penetration rate for existing buildings (only 200 certified as of 2009), means that a great deal additional effort will be needed to move green building to anything like full penetration of the A, B, and C class office, retail, and other property segments.

**Mostly Governmental and Non-Profit Users of LEED**

More than one report has noted that the majority of those who make use of LEED to date have been federal, state, or local government agencies and non-profits, which constitute nearly two-thirds of users/adaptors as of 2008 (Wiley, Benefield, and Johnson, 2009). Only one-quarter of users of LEED, according to Clevenger (2008), are for-profit corporations. This low level of take up by the commercial real estate market is, of course, an important opportunity for growth in the number of LEED certifications but also a clear suggestion that the diffusion and acceptance of green building has been muted even in the up-market conditions that existed up through 2008. It then adds additional reasons for concern about the trends toward the large scale adoption of green building standards.

There were, at the same time, 5,700 buildings that were rated using ENERGY STAR (Eichholtz, Kok, and Quigley, 2009). In all of New York City, there are only 41 LEED-rated buildings out of a total of 3,565 office building as of April 2009 (Center for an Urban Future, 2009; CoStar Office Market Report, New York City; first quarter 2009). Although roughly 50 cities in 15 states have incorporated LEED standards into legislation and building codes, the number of buildings currently rated green, under this format, seems quite small; even infinitesimal. Even if the trajectory of growth has been rapid since the inception of LEED, there appears no certainty as to how to move certification from being an occasional practice into the required mainstream of construction.

Local building and zoning codes appear certain to play a major part in determining what types of sustainable building standards are imperative rather than the current preference for voluntary, industry-led green building codes. This potential melding of green with pre-green codes has already begun although it is unclear how fast the pace of code integration will be. Some local jurisdictions are moving to incorporate sustainable building techniques into their building codes. New York City, for example, has had a large task force examining the issues in this area for over one year, with a report expected in 2009. It is, however, unclear what the social and political dynamics under-girding these code transformations are and thus unclear what the rate at which jurisdictions are moving to adopt green building policies covering all structures.

Relatively recent initiatives in federal agencies, including at the Government Services Administration, the Environmental Protection Agency, the Department of Housing and Urban Development, the Department of Energy, and the Department of Defense, suggest some reason for modest growth in the number of sustainable buildings sponsored by these agencies. However, the future evolution of
government regulation in this area is currently uncertain due to the downturn in construction and the lack of needed incentives and financing that could help encourage the development of green projects.

The move from small-scale and voluntary to nationally applicable and incentive-based seems a long way off. Given the traditional reluctance of the federal government to intervene into local building and zoning codes to help solidify the green building momentum started by the rating systems, it appears risky to predict massive, comprehensive adaptations of building codes in the immediate future.

Studying the Trajectory of Green Building: A Triangulation of Data Sources

This paper makes use of three types of data regarding green buildings. The first is research by economists focused upon the measurable economic benefits of green building. These data are intended to show that there are clear, measurable economic outcomes that may help convince the hesitant or skeptical that green building makes good economic sense. We use recent social science research assessing the cost, economic returns, and social benefits of green building to raise questions about what we know and how much more we should learn. As would be expected of any new field of analysis, we find limited data on core issues of concern, as well as confusion as to the applicability of research to policy debates over large-scale, city or metropolitan-wide plans for managing energy savings and global warming (Weisman and Hughes, 2009; Broder, 2009b).

Short case studies of several for-profit and non-for-profit developers located within the New York City area highlight the varying views of what it means to build green and how well or poorly social science research evidence is currently related to developer’s intentions. These cases illustrate the gap between the analyses of economists and for-profit and not-for-profit developers who share in common a desire to bring down energy costs. Issues of social equity or affordability associated with building green in the residential rental market are suggested as a critical missing piece in understanding the market penetration options for green building addressed below.

The paper then introduces key macro-level constraints and processes that appear likely to inhibit or facilitate these adoption dynamics for bringing green building ‘to scale’ in the foreseeable future. Such macro level constraints appear to collectively limit the diffusion or mass production of sustainable buildings and suggest reason for concern about a wholesale movement to develop green buildings unless significant legislative and funding options emerge. The rate of market acceptance and penetration by the green building movement may well benefit from legislative and funding options currently being debated in Congress. An appreciation of such options can help shape the policy conversation that needs to occur to extend the modest green building movement in the U.S. into a larger, more inclusive force in reshaping the landscape of our neighborhoods and cities into the next century.
Research Analyses of Green Buildings: The Hammer of CoStar Data

The bulk of research on the economic effects of green building standards in the U.S. has mainly occurred within the last several years (Segerson, 2001). This has been largely true because there have been very limited sources of U.S.-wide quantitative data available to sensibly evaluate the costs and impacts of various green building rating systems. Within the last three years, industry-based and academic research has made use of a national database on key parts of the office market to study major economic effects. The central source has been the CoStar Group. CoStar states that it gathers data on over 66 billion square feet of office space as well as 1.2 million for sale or lease property listings. Beginning in 2006 they began to add data on the properties in their system that made use of either LEED or ENERGY STAR ratings.

Most of this recent research has focused on evaluating the rents and sales prices of green buildings to learn if the “market” places a significant economic value upon these structures (Jones and Vyas, 2008). These studies typically compare rent levels, occupancy, and sale values of a range of green office buildings compared to a set of somewhat comparable properties that are not green and whose information has been captured by CoStar. Exhibit 2 highlights the results from this recent research.

**Exhibit 2** | Key Research Studies on Economic Impacts of LEED and ENERGY STAR-Rated U.S. Office Buildings

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<thead>
<tr>
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<tbody>
<tr>
<td><strong>LEED</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rent gain</td>
<td>36%</td>
<td>NS</td>
<td>15.2%–17.3%</td>
</tr>
<tr>
<td></td>
<td>($11.33/sq. ft./yr)</td>
<td></td>
<td></td>
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<tr>
<td>Sales price gain</td>
<td>64%</td>
<td>9.94%</td>
<td>NS</td>
</tr>
<tr>
<td></td>
<td>($171)</td>
<td></td>
<td></td>
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<tr>
<td><strong>ENERGY STAR</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Rent gain</td>
<td>9%</td>
<td>3.3%</td>
<td>7.3%–8.6%</td>
</tr>
<tr>
<td></td>
<td>($2.40/sq. ft./yr)</td>
<td></td>
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<tr>
<td>Sales price gain</td>
<td>27%</td>
<td>5.3%</td>
<td>19%</td>
</tr>
<tr>
<td></td>
<td>($61)</td>
<td></td>
<td>NS</td>
</tr>
</tbody>
</table>

*Note: NS = Not statistically significant.*
In 2008 CoStar, writing with an academic co-author, issued several closely related reports describing substantial economic benefits from building green that were promptly criticized by industry sources for their methodological shortcomings and overstatement (Miller, Spivey, and Florance, 2008; Muldavin, 2008).

The basic CoStar report, labeled the first systemic study of the economic benefits of green building, created a relatively major impact when it reported that there was a 36% improvement in rents for LEED buildings compared with a comparison sample and a 9% improvement in rents for ENERGY STAR buildings. It also reported a striking increase in sale prices with prices reportedly $171 or 64% higher for LEED buildings. The selling price advantage for ENERGY STAR buildings was $61 a square foot or a 27% price advantage over comparables (CoStar, 2007, 2008a). Without much explanation, they also presented regression results that revealed notably lower returns. It is the latter result that is central to the on-going story of whether and to what degree green building ‘pays off’ for owners. The level of explained variance was 0.48, meaning that there was an important level of unexplained variance that was not captured by their regression model.

These studies were first released in on-line format, with a revised version of the initial CoStar report by Miller, Spivey, and Florance (2008) appearing later in 2008 in journal format. In this and earlier reports they released, the results of a regression-based, hedonic analysis lowered the sale price advantage from $171 to $24 a square foot or a decline from a 64% to a 9% advantage. This is a huge negative differential that has attracted major concern from analysts and appraisers. Among the first criticisms was an on-line report issued by the U.S. Green Building Finance Corporation (Muldavin, 2008).

The report’s author usefully gathered additional methodological details from CoStar about their study. They then identified a number of major limitations of the CoStar report that undercuts its ability to serve as a convincing guide to potential price advantages of building green. The major issues, in brief, were:

1. **Small Sample Sizes:** Although CoStar had a potential universe of over 1,300 LEED-certified buildings, they limited the study to only office buildings constructed after 1990. This left them with a population of only 218 structures. They were, however, unable to find sensible ‘peer’ comparables for this entire group and could match only 77 buildings within the local sub-market of the base office buildings. They then expanded the market area for the selection of comparable properties to five miles, thereby adding another 89 LEED buildings for a final sample size of only 166 LEED buildings. Of this group, there were only 15 to a maximum of 20 sales from which to calculate values at sale.

2. **Variability of Sales Prices at a Market Peak:** The sales price data provided were a potentially volatile set of sales at the high point of property valuations; 2007 office prices were at their market peak after which rents, occupancy levels, and values have declined in most major U.S. markets. They were also compared with a heterogeneous and variable set of comparables. Using a five-mile radius for selecting comparable
sales properties for either the New York or San Francisco office markets would, for example, place those properties far into either New Jersey or Oakland suburbs; markets distinctly non-comparable for a host of reasons.

3. **The Validity of the Hedonic Results is Limited.** The low level of explained variance in their study (an R-squared of roughly 48%) means that additional unexamined variables are likely causing the level and dispersion of values.

The limited sample sizes of the first two web-based studies therefore limit anyone’s ability to be able to firmly assess social and economic costs and benefits.

Also, in 2008 Good Energies released a report that they identify as “the largest international study of its kind” based upon an analysis of data on 150 to 160 buildings in the U.S. and in foreign countries. They suggest that there were major health and social benefits from such buildings but the full details of the study are not expected to be released in book form until later in 2009.

Another study not yet formally published is a 2009 working paper by economists at the University of California (Eichholtz, Kok, and Quigley, 2009). They too assert that their analysis is the “first systematic analysis of the impact of environmentally sustainable building practices upon economic outcomes measured in the market place.” It is to date the most statistically and methodologically careful with data from a sample of 694 buildings for which they were able to gather rent and sales data from CoStar. They also gathered sales data from green office buildings (Class A, B, and C) that were sold between 2004 and 2007. Unlike the CoStar report, which selected comparable buildings from up to 5 miles away, this analysis limited their comparables to within 1,300 feet or one-quarter of a mile. However, even by narrowing their geospatial net for finding comparable office buildings, they wound up with a sample of ENERGY STAR and LEED-certified buildings that were larger in square footage, newer, more likely to be rated A-class buildings, with more building amenities then those they classified as comparable. Their set of “comparables” was also not fully comparable.

After controlling for a range of variables, they find a positive 3.3% increase in rents for ENERGY STAR buildings, and a 19% improvement in sales prices for ENERGY STAR-rated buildings sold between 2004 and 2007. There is no statistically significant effect for LEED-rated buildings for either rents or sales value (see Exhibit 2). The best returns, they note, are for larger and better quality buildings. The statistical models they use explain roughly 70% of the variance on key metrics for rents but only half of that in explaining sales price differentials.

They then offer a major caveat by telling the reader that the strongest effects are localized in smaller markets, at the periphery of larger metropolitan areas, and where rents in general are set lower. Prime locations and cities, like New York, would benefit relatively less. This constraint suggests that the newer buildings constructed using ENERGY STAR ratings command better rents and sale prices, mainly in second tier and marginal markets. Premium rents may also be achievable to larger markets but the largest differentials will be in slower, weaker, and less central places.
The absence of any effect for LEED buildings can be attributed to any number of market or sampling issues; it is simply not clear which bears greater weight. Also, the sales price effects they report are an artifact of an exceptional market upturn that has since dissipated. A longer period of performance is essential before reaching a clear conclusion that investors value green buildings under all market circumstances. This caveat is especially important because of the limited nature of the comparables they used, many simply are not in fact comparable, and to the fact that their strongest effects are for small, less major markets. A finding that suggests that green building has little sustained economic value in the country’s major markets would be a considerable set-back from the perspective of those financing green development.

It is important to point out that this last study found that the degree of energy improvements made by the building owners translated into proportionately higher rents. That is, tenants do discriminate in rental prices when it comes to key features associated with energy savings (Eichholtz, Kok, and Quigley, 2009).

The final study we cite is by Wiley, Benefield, and Johnson (2009), who also make use of CoStar data but only for Class A office properties. Their rent data cover over 7,300 LEED or ENERGY STAR-rated properties and their sales data are from 1,151 sales. The methodological and statistical design for this study is notably different from the prior studies to which we referred. They did not select or use a set of comparable properties but rather rely on a hedonic regression control for each market in their sample.

Wiley, Benefield, and Johnson (2009) report that ENERGY STAR-rated properties have a 7.3% to 8.6% improvement in rent and LEED buildings have a larger advantage of 15.2% to 17.3%, depending on which of their two regression models is used. They found no statistical effect for a direct comparison of sales data (see their Table 4). They, however, used a new hedonic variable that combines building square footage with green ratings and find a significant sales price premium of roughly $30 a square foot for ENERGY STAR buildings and $129 for LEED buildings.26 This suggests that the largest Class A-rated buildings in a market can sell at higher values when compared to every other A-rated non-green building within the region, at least up through the current market downturn. This method then leaves the reader unclear as to whether the green rating or building size is the stronger factor in causing these higher sales prices. Large “trophy” properties in a local market will, for example, have unique economic locational advantages that cannot be accounted for in this method.

As this study does not permit an estimate of within market differences in rents or pricing, all Class-A properties within a metropolitan area are treated as if they are equivalent for the purposes of estimating economic outcomes. The effect then of comparing all non-LEED office buildings located anywhere throughout a metropolitan market with LEED office buildings is quite likely to overstate the rent and sales value advantages. There simply was insufficient data available and used to control for within-market pricing disadvantages.

The early results from the three major regression studies we list suggest, then, that ENERGY STAR-rated buildings have a variable rent advantage from 3% to
9% and may also have a sale value premium under the market conditions prior to the current recession. LEED-rated building performance is less certain, with one study suggesting a rent advantage and another indicating there has been none. On sale, the best quality, largest LEED-rated buildings may be able to be sold for more but the absence of any sales effect in the Eichholtz, Kok, and Quigley (2009) study suggests hesitancy about concluding that LEED is everywhere and under all conditions a selling advantage.

The variability in the methods used in these studies also prompts nervousness about any effort to readily convince the real estate investment and development community that there are unambiguously positive and specific outcomes in store for them. The absence of any analysis of green rating advantages for retail, residential, and hotel properties also limits the ability to convincingly argue that all green-rated buildings outperform their peer properties. Lastly, the fact that the majority of green-rated properties have been developed by governmental and non-profit agencies, where rents and sales prices can be artificially set, suggest that it may be some time before there is ample data to carefully measure green development impacts upon private market commercial real estate.

In addition, the lack of attention to the measurement of the human or personal impacts or outcomes of sustainability performance systems also appears to be one of the critical shortcomings in this area of policy analysis. For example, while local developers are confident that their buildings can have important, positive impacts on the productivity and health of the employees working in their buildings, to date there have been very few formal, carefully controlled studies of the longer-term health and productivity impacts of new building systems built to U.S. green rating standards (Loftness, Hartkopf, and Pho, 2006; Loftness, Hakkinen, Adan, and Nevalainen, 2007; Loftness, 2008). For example, it was only in 2002 that a major report recommended a process for providing better advice about building technologies as they relate to and affect worker productivity (Kumar and Fisk, 2002). In no small part this is due to the recency of the entire field of sustainability measurement and standardization. It is no doubt also due to the complexity of arranging to have corporations agree to have their employees studied if the results of the analysis might imply liability for some degree of prior unhealthy working conditions.

The process of carefully measuring the impacts of green building is then only in its infancy with only one useful methodological hammer, CoStar data, currently available to identify rents and returns. Given that green measurement tools, like LEED, are also in the early years, we are watching an important and interesting policy research ‘experiment’ slowly evolve and improve.

Case Studies: Commercial and Residential Building in New York

We briefly describe four cases from New York City to highlight the fact that developers use differing definitions of why it is important for them to build and operate green buildings and that these expectations differ notably from the issues
focused upon by researchers. While simple expectations about the benefits of green building come from the developers of affordable housing, more complex justifications emerge from the two for-profit developers. These differences highlight some of the reasons for concern about eventual full market penetration.

**Case Study: One Bryant Park, New York City**

The first case, of One Bryant Park, illustrates the intentions and expectations of a major New York area development company as they approached the question of how to build the best quality, green, Class-A office building in Manhattan. The developer, the Durst Organization, provides a clear set of performance expectations for their new building that is currently, in summer 2009, almost completed construction and is nearly fully leased.

The Durst Organization, founded in 1915, has been at the forefront of the environmental movement in New York. According to key leaders in the firm, they initially began to focus on green technology as a tool to reduce energy cost but soon made use of more costly sustainable systems as they both improved the marketability of their properties and added to the history of the company’s public sector commitments. In 1999, they completed 4 Times Square, which was recognized as the first “green” high-rise office building in the U.S. They now have four buildings that are counted as LEED ‘green.’ They own 9 million square feet of commercial office space, as well as four rental properties.

Most recently, they built the Bank of America Tower at One Bryant Park. The building was co-financed and is co-owned with the Bank of America. The bank was a founding sponsor of the United States Green Building Council and they occupy roughly 50% of the total 2.1 million square foot building. The new building incorporates innovative, high-performance environmental technologies that the Durst Corporation states will promote the health and productivity of tenants, reduce waste, and assure environmental sustainability. The identify it as the world’s most environmentally responsible high-rise office building, focusing on sustainable sites, water efficiency, indoor environmental quality, and energy and atmosphere, as well as it being the first high-rise to obtain a LEED Platinum designation.

The specific goals stated by the developers for the building were to: reduce energy consumption by a minimum of 50%; reduce potable water consumption by 50%; reduce stormwater contribution by 95%; use 50% recycled material in building construction; and obtain 50% of building material within 500 miles of the site. They also argue that the building’s improved lighting and ventilation will improve worker productivity.

The newness of the building means we only know that it is now over 90% leased up, with posted rental rates that are among the highest in the U.S. Its LEED Platinum rating was partly the basis for former Vice President Al Gore’s offices to move there. Their co-generation plant is fully operational, as is their rainwater capture system. There are no reported building performance data available or any current measures of worker productivity. They have also made some capital
improvements in their other properties that qualify many, although not all, as ENERGY STAR rated. They are as well considering whether and how to obtain LEED EB ratings for their older portfolio. It has been in some ways easier, if more costly, to build new green buildings than it is proving to retrofit their older stock—the core of the problem affecting the trajectory of moving green building into something like full scale. This conversion problem is illustrated more clearly in the second case.

Case Study 2: Alternative Standards for Existing Buildings

The second case is of a large scale national and international developer and building operator, Time Equities Inc, which owns and manages office and residential buildings in the U.S., Germany, and Canada. They created a new office of sustainability in 2007 for the corporation and have begun a careful process of planning how to cost effectively retrofit their existing inventory of buildings for more energy-efficient operation.

This firm has elected to develop its own format for promoting sustainability within its existing building inventory. The firm, founded in the mid 1960s by Francis Greenburger, has established the reduction of greenhouse gases as its leading operational indicator for measuring the effectiveness of its program to support sustainability. Unlike a pure LEED-first and only method, their sustainability office has spent the last several years focused on learning how to best measure greenhouse gas emissions from their inventory and then reducing it as cost effectively as possible. Their goals are: “As a real estate owner with significant size and presence, we... recognize that climate change is a major economic, social and environmental challenge globally, and as a company we are taking voluntary action to address it. From the business perspective, we are striving to hedge climate-related risks, prepare for regulatory change, and address financial opportunities associated with green market trends.”

They were among the first commercial firms to create their own sustainability department to manage their sustainability programs, training, and funding. The goals of this new department of sustainability are to “...create healthier, more sustainable environments for the occupants of our buildings while lowering operating costs. Our experience has shown us that the cost of reducing our environmental impact is low and often aligns with cost savings.”

The energy saving or cost side of the real estate business appears a paramount metric within their goal of reducing the corporations’ total carbon footprint. They assert low costs to build green and some reduction in energy costs. They intend to seek LEED certification as, and after, they adapt their existing building portfolio of 20 million square feet. Again, their target measuring tool is to measure the aggregate carbon footprint of all of the properties using utility resource accounting techniques.

In comparison to the Durst Organizations’ shorter public statement, Time Equities has made a more formal public announcement of its goals and plans for all of its buildings. The Durst group has remained silent on the conversion of the balance of their building portfolio into green operation.
Time Equities major strategy for adapting their 20 million square feet of office and residential space is to first learn what the bench-line energy uses of their buildings are, and then to use outside experts to estimate what would be required to reduce those costs. The core goal is to learn what are the carbon footprint, or greenhouse gas emissions, of their entire portfolio, and then to finance those retrofits if they are cost-effective. They obtain and then track energy and often water use using utility resource accounting software now commercially available. These “phase 1 and 2 audits,” as they are called, are apparently in the process of being completed.

Pay-back in Two Years: In one case for which we have some data, a building located on West 10th Street in New York City, would have required roughly $340,000 in repairs to create an annual energy savings of $65,000. The firm proposed to obtain $55,000 in state agency rebates and savings. They initially estimated that they could recover those costs in less than five years of building operation at the current rate of energy costs. Because of financing limitations, these retrofits were not completed. The building changes would not have achieved their payback for roughly five years while the firm needed the returns in roughly two. Under this payback rule, a large number of their buildings could never become green unless new sources of subsidy are identified.

A completed project for Time Equities is located in Montreal, Canada (4200 St. Laurent St.). They spent $538,000 for this 321,000 square foot office building to add a systematic set of building controls addressing energy use, retrofitted the building’s lighting, and added heat exhaust recovery equipment. They received roughly $160,000 in Canadian governmental incentives and calculate energy savings of $115,000 a year. From their perspective, the crucial calculation was that they could expect payback of their net costs in a little over three years. They have begun, in spring 2009, to apply for LEED certification for this building. Time Equities conservatively expects an annual saving of 20% on their electricity costs, largely through a reduction of peak hour rate usage.

Time Equities estimates that it may require seven to ten years before they are able to achieve a substantial reduction in the energy use and to train their management staffs for their entire portfolio to operate them as efficiently as possible.31 There has necessarily been some slowing of the rate at which they can convert their buildings due to the limitations on deal or construction financing that is affecting all aspects of U.S. real estate. They view LEED as one useful tool for brokering vacant space to tenants but do not view this measurement tool as the core of their corporate sustainability strategy.

Market conditions, however, matter for the viability of green retrofit programs. Because of the market downturn, the firm has experienced staff layoffs, pay reductions, and the possibility that the sustainability office may be closed.

Cases 3 & 4: Building Green & Affordable?

The last case is about two builders of affordable rental housing. The companies operate in lower cost areas, mainly in the South Bronx section of the city. This
case highlights the interaction of the cost for building any affordable project in a high cost city like New York, and the manner in which they promote sustainable energy conservation initiatives.

Being able to afford to become green has been a modest focus of policy makers and policy analysts in recent years (Seessel, 2008). There is at this point in time an uncertain policy link between building affordable housing and sustainability. The linkages may well evolve and grow to a larger scale especially if it is proven to funders, sponsors, and insurers that sustainable building technologies require little additional construction costs and lower on-going building operational costs compared to other building methods.

To date, not-for-profit and for-profit developers of affordable housing are fully absorbed in arranging complex financing packages, with little encouragement and no additional margin of funding of non-essentials when all unit amenities have already been cut to the bone. For such developers, finding multiple sources of funding for a project to become affordable is hard and stressful enough given the collapse of many traditional forms of financing. Finding willing sources of sustainable and affordable rental housing is still an uphill fight. It is, for example, only recently that state housing finance agencies have begun to include green factors in their scoring of application for annual Low Income Housing Tax Credit financing.32 If this constraint remains constant, there is little chance that the existing stock or lower-rent and affordable residential housing can be converted into a more sustainable format in anything like a short-to-medium time frame.

For New York, we focus on the green developments of Jonathan Rose Associates and Nancy Biberman’s Women’s Housing and Economic Development Corporation.33 The Jonathan Rose companies began operation as a for-profit builder, planner and investor in affordable and environmentally responsible projects. They have a national scope rather than the New York only focus of WHEDCo.

The Rose companies’ mission, more social than business oriented, states that they “plan and develop diverse, mixed-use, transit-accessible, mixed-income communities ...where the result is equitable, and supports the cultural, environmental and biological health of the bioregions we work in.” Unlike private sector developers they begin with ecologically framed site selection. As they state: “... environmentally responsible development begins by choosing the right place to build and only then proceeds by being thoughtful about how we build. No single act has a greater positive or negative impact on the environment, on community and on the quality of the resident’s lives than the selection of where one chooses to build.”

In December 2008, Rose acquired nearly 200 units of affordable housing in Harlem and will make use of a range of incentive programs to create a “more energy efficient and healthier community.” Their projects typically report high levels of energy savings, up to nearly a 40% cost reduction. For a major planned development in the South Bronx, the 139 affordable rental unit and the 63 unit cooperative Via Verde, they state an expected 37.3% energy savings compared to
projected energy costs without the green building adaptations. This project, to be completed in 2010, draws on wide-ranging sources for its financing.\textsuperscript{34} Their plans for this project include the following LEED goal oriented innovations: “Passive, low-tech strategies include cross ventilation in all apartments, solar shading, and planted green roofs to provide insulation and control storm water. High-efficiency mechanical systems, energy-conserving appliances, and renewable energy strategies, including solar voltaic canopies, smart material choices, including non-toxic paints and rapidly renewable wood products.”\textsuperscript{35}

Nancy Biberman created her women’s collective in 1991, before ENERGY STAR or LEED ratings, with simple goals: “WHEDCo offers interconnected, innovative, and high quality solutions—including the building of healthy, affordable homes—and because of this, the Bronx is a more beautiful, more equitable, and more economically vibrant place to live and raise a family.”

WHEDCo completed in 1997 a green retrofit for an affordable rate residential building with 132 units, labeled Urban Horizons. Their major operational goal was to lower escalating energy costs for themselves, as property mangers, and the utility cost for their tenants. The building opened in 1997 and has offered apartment to 32 families from the homeless shelter system. They report impressive, roughly 30% savings, in their energy costs compared to comparable non-green buildings but have not found financing for other aspects of their sustainability plans. The later non-profit offers a more modest scale of projects compared to the Rose Companies, limited largely by the lack of funding initiatives that can help finance a more ambitious rebuilding agenda.

It Saves on Energy Costs: The one clear place where there is agreement between data-based reports and developers is that there is a considerable savings on the cost of energy for both building operators and residents or tenants as a result of many forms of sustainable development. Even though there are still relatively few buildings from which data can be drawn, there appears to be a rough consensus that energy savings range from a 20% to 35% reduction in annual energy costs as a result of building in differing green formats. The savings for example of Time Equities (Case 2) from their conversion are quite pronounced after a non-LEED set of building adaptations. The energy savings reported by the Bronx affordable housing developers Rose and WHEDCo are in the 30% range as well (Turner and Frankel, 2008).

Also, in 2008 an analyst for the firm, Good Energies, released a report that they self-identified as “the largest international study of its kind” based upon an analysis of data on 150 to 160 buildings. They reported that the cost of building a green building on average added only an additional 2% to total development costs while the energy savings from the operation of “green vs. conventional buildings” was roughly 33%. (The full details of this study are expected to be released in book form later in 2009.)

The short-to-medium term advantages to green building may then simply boil down to the fact that it saves tenants and landlords money on their costly utility bills. It’s the energy savings that matter. The simplest set of adaptations save tenants and owners money on their utility costs; a major outcome by itself.
Summary

Our review of research evidence shows only limited, robust data gathered on the full set of social, economic, and health benefits ascribed to green building systems in the U.S. The evidence on economic benefits is being debated but is clearly lower than initial estimates made in 2008 by industry analysts. Central to future research in this area, which may affect the adaptation momentum of green building, will be longer term studies of the health, social, and productivity impacts on workers and tenants, who are exposed to varying levels of new sustainability protocols. On health and productivity benefits, for example, there is currently only anecdotal evidence, as well as some summaries of evidence drawn mostly from non-U.S. sources. Central to an appreciation of how effective green building strategies may become is a longer term assessment of their costs and their net economic, social, and health-related outcomes. Such an assessment has barely begun.

The cases we studied highlight the complex of motives associated with building green for differing types of developers. Developers have differing motivations for selecting a green format for their buildings that have had, of course, nothing to do with research evidence. The developers studied neither directly used expected rents nor near-term calculations of expected sale returns to base their decisions on whether and in what format to go green. The Durst’s began with energy efficiency in mind decades ago and adopted LEED Platinum as a hallmark of their company and as a major advantage in leasing. Time Equities’ motives were to try to support greenhouse gas reduction but only if the cost and returns were low and fast. Both affordable housing developers see energy savings as absolutely central to their success. Jonathan Rose adds to this his firm’s additional engagement with national and international green design and planning operations that are more broad-spectrum than any of the other cases.

Until there are better measured outcomes on cyclically sustainable improved rents and sales value, as well as better studies linking the productivity and health improvements of tenants to green building design features, there appears little likelihood that research evidence alone will help to dramatically impel geometrically larger increases in the absolute numbers of private sector building owners’ and operators’ progress engaged with sustainable building. Growth in relative terms will then continue to depend on the commitments of developers like the Durst’s, Francis Greenburger, and Jonathan Rose and upon the simple fact that building green saves on utility costs. However the price sensitivity and range of their motivations for building green suggest inherent limitations in extending the green building momentum without clearer incentives, more formalized building code requirements, or more innovative educational and training programs for stimulating the movement of commercial and affordable properties into sustainability.

Evolving Constraints and Contexts

The process of evaluating how well or poorly the sustainable development movement for commercial and residential buildings can evolve into something
like full scale is complicated by any number of structural and political factors. Below are a number of factors that likely condition or constrain how well or poorly sustainable building will advance in the U.S. Not listed but assumed are the complexities imposed by the world economic recession and budget problems that greatly limit all development options. For example, there are clear indications of a pull back in the rate of new construction, based in part on the lack of financing, rising vacancies, and declining rents. This macro-market recession will result in a decline in both green and non-green building for the short term (Heschmeyer, 2009).

The following then is a sketch of probable influences on the future trajectory of green building. There appears to be no means to assess their interactions or complicity in affecting the trajectory of green and affordable building and therefore no reasonable means to predict the rate of transformation of U.S. commercial and residential markets into something approaching full sustainability.

**Uncertain Popular Support for Sustainability Initiatives and the Willingness to Pay (something) for Them.** There are a variety of survey data and opinion polls that document increased popular support for varying green initiatives, most especially those easier to comprehend and implement. This evolution of views and support has of course been heavily affected by the relatively recent rise in energy costs.

There is also evidence of the volatility of public enthusiasm especially when they are juxtaposed against other pressing political or economic choices. Survey results released in spring 2009, for example, reveal that the U.S. public considers the economy its top concern with only 2% rating energy issues as the “most important problem facing the country today,” (Stolberg and Connelly, 2009). Despite such lower positioning of energy issues in the public frame of current anxieties, environmental issues have nonetheless become a more abiding source of concern in the U.S. and globally.

An opinion that most publics throughout the world share is that they know of the issue of global warming. This abstract information question conceals a wide range of knowledge about and evolving, even mercurial, support for green policy issues. The public’s average views change. From 2004 to 2008, for example, there were large percentage point increases in public support for “dealing with global climate change (+7) and for ‘reducing energy dependence (+13),” (Pew, 2008). By 2009 however, under the pressure of a worldwide economic slowdown, this had translated into lower rankings for energy issues. A Pew Center poll released in 2009 revealed that global warming ranked last for the American public out of 20 items and “energy” issues ranked only 6th (Pew, 2009). Moreover from January 2008 to January 2009, there was a major 15 percentage point decline in the number of people rating environmental protection as a top priority. Such shifts in support have occurred before and may well happen again, raising questions about how well elected officials will prioritize needed legislation and funding for reforms in this area.

There are also persuasive arguments that there is no simple or direct correlation between the in-principle support for green policies and actual changes in behavior
or in action in support of environmental causes (Kollmuss and Agyeman, 2002). There needs to be some care as policy makers and advocates attempt to leverage public engagement with specific actions so that any social marketing program is geared towards a sensible set of action targets.

If green initiatives are considered cost or tax free, for example, there may be a different level of popular commitment then when the budgetary and tax consequences are spelled out for individuals and corporations. By pricing the cost of various green policy adaptations in survey questions, it might be possible to tap into a clearer sense of the degree of tangible popular support for specific green programs. How much would better health outcomes be worth for an office tenant if they were asked to pay part of the installation costs? How many employees would insist upon sustainable building technologies as a condition for employment at a firm? What would owners pay for better worker productivity? How much would governmental agencies pay to lower health care costs for their citizens or reduce their own energy bills? How much can low income renters value sustainability given the other constraints on their choices and resources? This is of course an on-going, slowly evolving story (Friedman, 2008; Wald, 2009).

One recent example of how the value of green buildings has not yet been firmly established or proven is a current effort by a Long Island real estate broker who is paying tenants to adapt their building’s interiors to a sustainable standard (LEED CI). This broker will provide up to $30,000 in matching funds if a firm signs a 10-year lease for roughly 10,000 square feet of space and agrees to include green interior finishes. This form of a tenant improvement allowance may be used for green finishes and to apply for LEED certification (Burr, 2009). But it means the tenants must be paid to turn green.

Building owners too have been surveyed and report that they are heavily likely (69%) to support some form of sustainable building construction and maintenance. This study however points out that in 2008 fewer corporate executives were willing to pay a premium to retrofit a property “to gain sustainability benefits.” Also, while in 2007, during a boom period, 77% stated their support for retrofitting cost, this number plunged to 53% in the next, down cycle year (Krieger, 2009). This evidence suggests that sustainability might be among those great ideas that are widely espoused but weakly held and therefore thinly funded. There is, however, little data that can be used to estimate the demand, at varying rent levels, for specific forms of sustainable building designs and operations. It is very much a black-box in estimating future trends and policy choices for the private and governmental sectors.

_Evolving Technology._ A key to the improved scalability of green building is the ready availability of the appropriate cost-effective technological choices provided for varying for-profit and not-for-profit building options. There is a circular path here of note: with increased demand, costs for building materials and systems will decline, and as the technology improves, its efficiency and prices may decline. Demand might also increase to the point that the public and developers have enough data and accept that building green adds few additional new costs and almost certain, clear returns.
Evidence on the rate and components of technological innovation, and associated pricing changes, is unclear especially in the comparatively recent field of LEED and ENERGY STAR-rated building systems. Two examples help illustrate this complex issue.

In 2009, the New York City Housing Authority was in the final stages of selecting a contractor for the installation of green roofs for a number of their project buildings. At virtually the last minute, a new bidder submitted information about the lower cost and weight of installing green roofs using an artificial, lighter weight alternative to the required earth roofing the Authority had previously believed was their only choice. This improvement in technology would reduce considerably the worries NYCHA staff had over the weight of any new green roofs on buildings whose average age was 47 years, and whose roofing had never been installed with an expectation of installing hundreds to thousands of pounds of additional weight (Piscopia interview, 2009).

Years earlier, when the private developer Douglas Durst sought technology for the installation of major banks of solar paneling for a new building they were planning in Times Square, the only builder of these systems they could identify used a small garage in New Jersey as his fabrication site (Durst interview, 2008). Since that time in the early 1990s, solar technologies have evolved significantly, lowering costs and their potential utility for residential and commercial projects (Gold, 2009; Sweet, 2009). It is however unclear, and outside the scope of this paper, to evaluate the rate at which the costs for various green building features and technology can drop as a result of market demand or as a result of various governmental research subsidies or tax benefits.

This paper is not the correct setting to assess the evolution of green building technologies except to note that any reduction in the cost of production and operation of major green systems, such as cooling, air filtration, water treatment, and heating, may significantly assist in reducing the negative equity impacts of technologies currently too costly to afford for either existing office buildings or for most low-income residential developments (Friedman, 2008; Eisenberg 2009; Lohr, 2009; Rosenthal and Barringer, 2009). Presumably the inclusion of solar panels, green roofing, and even wind power can become increasingly mainstreamed for all general contractors and architects as buildings are designed, costed, and built (Galbraith, 2009a).

Indeed as technology improves, it will likely affect the ways in which rating systems, like LEED, evaluate building conversion plans. Should rating systems stress lower cost technologies, and should government programs help support cost reductions, then the spread of green buildings will be vastly faster and easier. This appears critical to related assessments of the evolving costs of varying green requirements and a system for efficiently reporting and popularizing technological improvements that can result in lowering existing costs. Innovations in building technologies may well offer substantial cost savings especially for the inventory of old, subsidized, and affordable housing.\textsuperscript{36}

\textit{Flawed Rating Systems.} U.S. rating systems, most importantly LEED, are as we have noted voluntary. Their core limitation then in projecting the growth of a
larger number of sustainable buildings is whether and how a move towards code-based regulations or incentive-based mandates for building green that will improve the rate and volume of compliance and use of sustainable building technologies.

The relevance of LEED in establishing a credible, widely usable set of building standards has not been comprehensively or carefully evaluated. That is, there are no independent evaluations of the mechanics and costs to builders of implementation or a careful assessment of a full range of costs and benefits of various levels of LEED approval. There is no sense of whether all of the required components of LEED capture essential elements of sustainability or which are most central, say, to the health of tenants.

There have been though, as context for any evaluation, a relatively constant set of criticisms (Schendler and Udall, 2005). This includes concerns that LEED is a moving target, with an on-going set of adaptations of standards by the USGBC. While it is clear that standards have been changed to enable and encourage greater inclusiveness (Friess, 2008), the effect means that LEED certification can vary in its content over any specific time period.

There are also frequent comments that the certification process is time consuming, costly, as well as rigid and cumbersome to use. One commentator, for example, stated: “LEED has become costly, slow, brutal, confusing, and unwieldy, a death march for applicants administered by a soviet-style bureaucracy,” (Schendler and Udall, 2005). Another’s opinion is: “You’re happy when you’re released from the US Green Building Council’s Abu Ghraib—you typically end up with a delightful building,” (Barringer, 2008; p. A1).

ENERGY STAR (ES) ratings also have limitations. Since ENERGY STAR only awards a rating to the top 25% of buildings that are being evaluated, they necessarily create a relative ranking system with the remaining buildings left out in the cold. Without any system of incentives or subsidies to encourage the lowest performing buildings to adapt more efficient technologies, the ES rating has an in-built disincentive against the bottom tiers making an effort to fight their way into the top quarter. They would have no assurance that their efforts might feasibly pay off. In 2009, ES has also been criticized by the EPA as “too weak” and requiring “updating based on current technology,” (Ball, 2009).

Social Equity or Affordability. While not a formal obligation of LEED administrators, there is a contextual issue of how the benefits of green building certification can be applied to the work of affordable housing developers who have little time or funding to seek such certificates when they have no apparent benefit in their search for financing sources. Absent some form of a mandate to build more sustainably, or increased willingness of state and federal housing finance agencies to support any additional costs, it would appear unlikely that green building standards will become ubiquitous for lower-income communities. Sustainable building runs the risk of being an elites-only program.

A necessary part of the environmental building green movement is, then, the need to address both sustainable and affordable processes and products. The question of whether sustainable building technologies and practices can be made inclusive
and affordable, rather than costly and exclusive, is among the central issues affecting the longer term policy viability and impacts of this component of the green movement. If policies and building codes are developed that require sustainable building techniques, then the issue of opting into or out of green building format becomes moot (Seessel, 2008).

Given the comparatively high cost of building any affordable rental product within larger cities in the U.S., adding additional costs for green appears more optional rather than necessary. It is unclear when green building practices would be included as a mandatory feature for all HUD, CDBG, HOME, or tax credit financed affordable housing, when leases might include green building issues for residents, and when building managers will be trained to operate their buildings with an eye focused on energy, water, and other forms of conservation. Given the inertness of U.S. rental housing policy over the last couple decades (Schwartz, 2006; Glaeser and Gyourko, 2008; Retsinas and Belsky, 2008), it appears timely to rebuild affordable rental housing with the building code features and funding incentives that can ensure sustainability and reduced costs for tenants and managers.

The issue then of the degree to which building green saves money for non-profit building operators and lower-income residents figures prominently in the analysis of the longer-term replicability and viability of sustainable development practices. It is also a critical test for the inclusivity of the green movement.

This issue has received some recent attention. Hammer (2009), for example, argues that social equity developments need to include the participation of tenant beneficiaries in the planning and implementation of such projects. She argues that, “Engagement with community members is appropriate to the type and scale of the project and fosters productive participation by diverse stakeholders, including people traditionally marginalized by imbalances in access to power and capital,” (Hammer, 2009; p. 3). Community participation has for decades been a marginal goal for most urban planning choices but becomes more critical should non-profit developers expect to pass on electrical and water costs to tenants before they have become accommodated to the management of those extra costs.

The processes by which green building can become ubiquitous rather than a costly experiment of the well-off has just begun. The U.S. has not, so far, proven adept at reducing income and other forms of inequality; perhaps building sustainably will be an exception (Massey, 2007).

*Weak Links to ‘Smart Growth’ Planning.* The consensus among most experts focused on green building technologies is that building-by-building adaptations are ultimately doomed to limited impacts unless that is a concurrent alteration in the planning of future larger-scale developments to be more sensitive to issue of transportation, traffic congestion, and urban sprawl (Cole, Lindsey, and Todd, 2000; Katz, 2002; Bengston, Fletcher, and Nelson, 2004; Loftness, Hakkinen, Adan, and Nevalainen, 2007). This is another large, important issue outside the scope of this paper but is, nonetheless, central to being able to incorporate mass transit facility accessibility as one of the features for building green. The U.S.
green building movement and its rating systems need to become fully integrated into the planning momentum for smarter, more compact and energy efficient cities.41

Sweden’s Sewco sustainable city and Shanghai’s Dongtan Island “eco-city” help illustrate the planning and policy advantages of building-in sustainable design components from the first stages of planning the allocation of transit, commercial, and residential land uses.42 Dongtan’s 20,000-acre site, for example, has been planned to incorporate urban design and sustainable initiatives that make their construction more effective than retrofitting, which is occurring in cities like New York.

Conclusions

The U.S. is in the infancy of efforts to both define green building and to study its costs and effects. We are only beginning to formulate a coherent agenda of research that can sensibly measure and track human and economic outcomes for residential and office properties in a rigorous and long-term manner.

This newness is manifested most clearly in the notable disconnects between what for-profit and not-for-profit developers see as the critical benefits of green building and what researchers have so far been able to document. Given how mixed recent research results have been, the development community will be unable to rely on research to guide their choices and planning in the near term. Limited research and demonstrations as to how sustainable building practices can be cost-effectively transmitted into the large-scale production of affordable, sustainable housing is also lacking.

There will need to be better evidence gathered on the cost and benefits of various green building rating systems and their long-term effectiveness in lowering costs and improving the lives of tenants. The relative newness and changeableness of the rating formats themselves increases the problem of establishing direct links from programs to outcomes. This coupled to the absence until quite recently of reasonable data sources for measuring green building outcomes necessarily means we lack the time-series data to assess stabilized economic outcomes. CoStar data and the handful of research studies have become then a necessary but insufficient basis for judging benefits and costs.43 The errors and differing methodologies of these initial analyses suggest the need for caution in drawing firm conclusions about net economic and social benefits of green building. While it appears certain that initial outlays on new green building features save on energy costs at least in initial years, it is too early in the life cycle of green building measurement and much too early in measuring a comprehensive set of health and productivity outcomes of green building to be certain of much else. While developers, such as the Dursts’, make the case that there are health impacts, for example, none of the studies to date has presented clear evidence of the health and productivity benefits from specific formats for green development. There is then an imbalance in what research reports have found and what for-profit and not-for profit firms stress as critical.
Again, the clearest place where there is agreement between most data-based reports and developers is that there is a considerable savings on the cost of energy for both building operators and residents or tenants as a result of many forms of sustainable development. At this point in the evaluation of outcomes, this is the key area that helps demonstrate the effectiveness of green building strategies. It too provides a necessary but insufficient basis for pressing for additional green adaptations.

What are most embryonic are serious and significant governmental commitments to reinforcing, mandating, or directing current voluntary schemes for providing sustainability in office, residential, and other real estate complexes (Jordan, 2008; Turnpenny, 2009). Until governmental incentives, tax policy, and regulations act to coherently support both innovation and technological improvements, it appears certain that social equity gaps will remain, and green building will remain more fashion than necessity for longer than is necessary.

Federal efforts, for example, to initiate a large-scale demonstration aimed at fostering major technological and training breakthroughs in affordable green building appear one logical next step (Friedman, 2008). Also, a bill approved in June 2009 in the U.S. House of Representatives includes a requirement that the federal government press states to alter their building codes to require a 30% improvement in all new or remodeled buildings and to offer the financial incentives and training to enable this to occur (Fleming, 2009). It has been criticized as offering too little budgetary support for critical innovations and thus its passage in the U.S. Senate is uncertain (Muro, 2009; White, 2009; Galbraith, 2009b). Its passage would however help to significantly standardize building codes, which can now vary considerably across jurisdictions, making it harder for developers to develop large-scale construction solutions for multiple markets. Rather than there being just voluntary industry-led programs, like LEED, the standardization of local codes would ease the development process rather than making it harder and idiosyncratic.

If we follow the encouragement of those who wish to push the envelope of sustainable planning to incorporate more than individual properties, we then encounter a useful dynamic for causing a potential reevaluation of long-standing methods of building American communities; sprawled and costly. We may be at the forefront of testing the linkages among our environmental commitments, human community planning, social equity, and technological innovations in reshaping the viability, health, and long-term competitiveness of cities in the U.S. (Friedman, 2008; PricewatershouseCoopers, 2009). Recent agreements among several of the world-wide green building rating systems to coordinate and promote international consistency is a much needed if modest step in developing common metrics and agreed upon social and economic outcomes (Baker, 2009). But it seems clear, we have a long way to go before we live in fully sustainable offices, housing, and cities.
Endnotes

1 While the author uses the terms green and sustainable as relatively synonymous for the purposes of this paper, he notes that there are clear distinctions that should sensibly be drawn between the two concepts (Cole, Lindsey, and Todd, 2000).

2 “The current information stream has become polluted with advocacy and lobbying rather than useful metrics,” (Vyas and Cannon, 2008; p. 4).


4 ASHRAE is the American Society of Heating, Refrigerating, and Air-Conditioning Engineers. See their website at: http://www.ashrae.org/aboutus/.

5 “The LEED System is a point-based system. The building projects earn points based on their satisfying Green building criteria. They must satisfy certain prerequisites and earn credit points based on six different categories. The six categories are: sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, and innovation and design processes. Depending on the number of points the building project earns, it is awarded a certification level. There are four LEED certification levels—Certified, Silver Gold and Platinum,” (Copperwiki accessed May 2009; see http://www.copperwiki.org/index.php/Main_Page).

6 Other countries maintain their own green building rating systems, including Japan’s more developed CASBEE format. See: http://www.ibec.or.jp/CASBEE/english/document/CASBEE_brochure.pdf.


8 Nelson 2008; p. 4.

9 LEED registration includes firms/buildings that have applied for but not yet been certified within a LEED rating. There are no data to show what proportion of registered buildings fail to achieve eventual certification, nor on the time delay between the two stages.


11 For the seven-year period, the percentage change annually would be 631% for all buildings, while for those certified, the annual rate of change would be 1,593%.

12 It is critical to recall that there have been prior guidelines aimed at improving building occupants health and productivity, such as the National Construction Goals issued by the National Science and Technology Council (see Hodgson et. al. 2000).


14 This is then a mixed-methods study making use of a secondary analysis of economic data, coupled to qualitative interviews with key informants and web-based research for the case studies. The final method makes use of macro-level trend data including trends in public attitudes, public policies, and technology, all tied to the dispersion of green building innovations.
CoStar is the largest provider of commercial and multifamily information in the U.S., covering 66.6 billion square feet of space and 1.2 million for sale and lease property listings (as of April 2009). See: http://www.costar.com/?src=ppcg&s_kwcid=costar2987601259.

Fuerst and McAllister (2008) also made use of CoStar data in their unpublished “preliminary” regression study of the effects of LEED and ENERGY STAR. They used a non-comparable set of comparison properties with no attempt to locate comparables within the same micro market; they selected their comparables throughout the metro area. As they only identified 4-5 LEED platinum-rated buildings, they apparently excluded them from their analysis. They apparently compared newer Class A-rated buildings with older A and B buildings, further limiting their results. They report a roughly 12% positive rent improvement combining both LEED and ES-rated office buildings, with a number of the cities for which they have data reporting negative rents. They too find that the bulk of the rent improvement is found for ES-rated buildings. They report a 31% price premium for LEED buildings and a 10% premium for ES buildings.

McCormick (2008) reports 2.6% to 3% higher rents. A central issue will be as LEED ratings become more popular and common, will this ‘exclusivity’ rent benefit decline.

McCormick (2008) also reports a 3.5% higher occupancy, but such a small differential could be the result of sampling and selectivity issues.

Among the well-known problems associated with using asking rent data is that there are often differences in the final or effective rent. Also rent concessions are often used to attract tenants, which are seldom revealed in the initial asking rent. Vacancy rate data also may not capture shadow rental or sub-lease space offered for rent for current tenants seeking to lease out part of the floor space.

CoStar generated a 61-page report in which more details of their sampling and analysis strategy were presented (CoStar, 2008b).

Kats (2008). In a telephone interview on May 4, 2009, Mr. Kats confirmed the study sample was only roughly 160 buildings and that the full methodology and findings from this study will be published by Island Press this year.

They began with a potential pool of 5,709 ENERGY STAR-rated buildings and 1,703 LEED-certified buildings. A matching process for rent and sales values reduced that pool to only a total of 286 LEED and 1,045 ENERGY STAR buildings. They note the fact that the CoStar data series fails to include much data on older and smaller buildings in the U.S. (p. 11, note 3).

The comparative analysis they conducted did not include the types of variables that would be used by a professional appraiser to establish a clear set of similar properties. They did not, for example, have data on tenant mix in the buildings, the size of space leased, which often affects price rents, how close the buildings were to mass transit, nor did they take into account that rental prices can vary as much as 2% a month in an up or down market, thus making their year dummies a crude proxy for time-sensitive returns. Telephone interview with Scott Muldavin, May 5, 2009.

In their May 2009 version of this paper, the authors report a sales value benefit of from 15.8% to 16.8%. The only statistically significant effect when breaking out results for LEED versus ENERGY STAR buildings is for the later at 19.1%. See their Table 4.

“...the premium for a green building, relative to nearby buildings, tends to be larger in smaller markets and regions and in the more peripheral parts of larger metropolitan areas, where location rents are lower,” (p. 24).

The paper’s senior author, Jon Wiley, indicated in an interview on August 6, 2009 that they elected not to use the appraisal-like comps method of other researchers and thus
have no intra-market controls or estimates. The price differentials included in Table 4 of their paper, of $30 for ENERGY STAR and $129 for LEED, are not directly comparable to the sales pricing estimates provided in other studies because of their unique hedonic estimation techniques. His construction of a measure of green linked to building square footage was their effort to measure “economies of scale” rather than a direct fixed-effect. He agrees that his findings justify further research.

27 Loftness (2006), for example, summarizes ten case studies that suggest productivity improvements of 18% and reductions of absenteeism up to 71%. The studies are not tied to specific rating systems.

28 It will be difficult to establish long-term data on health impacts and tenant retention information that will separate on-going tenant health issues and medical care from the independent, immediate impacts of spending roughly 8 hours a day, 5 days a week in a different, ‘healthier’ environment. Also, some tenants will likely refuse to allow surveys of employee health and performance in a green environment because of a risk of liability for demonstrating that their prior space was unhealthier and damaging.


30 One illustration is the following company: http://www.utilityaccounting.com/. See also: http://earthtrends.wri.org/features/view_feature.php?theme=5&fid=50 and http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V2W-40YYFVT-3&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&_docanchor=&_view=c&_searchStrId=951905553&_rerunOrigin=google&acct=C000050221&version=1&_urlVersion=0&userid=10&md5=eddd82c3462061bb99792a1cb6d6c4f.

31 Improved management issues have centered on the front end with careful commissioning of new systems. For a useful report on this see: http://www.oregon.gov/ENERGY/CONS/BUS/comm/docs/commintr.pdf.


34 They include Federal Low Income Housing Credits, NYS Low Income Housing Credits, NYC Housing Development Corporation Affordable Cooperative Program, the NYS Affordable Housing Corporation, New Market Tax Credits, an Enterprise Green Community Grant, as well as funding from NYSERDA and a Home Depot Grant.


36 Davis Langdon’s Matthiessen and Morris (2007) report no major difference in building costs (0%–5%), although note that LEED platinum costs more. They however had a limited number of commercial and residential buildings in their study sample. CoStar data suggest that a LEED platinum rating costs 7% more.

37 The PDF version of this report can be found at: http://ecow.engr.wisc.edu/cgi-bin/get/cee/698/1hanna/homework/renewablee/schendler_leedbroken.pdf.

38 The US EPA states: “Projects must achieve an EPA energy performance rating of 75 or higher. A rating of 75 means that the proposed design is intended to perform in the top 25 percent of similar operating buildings.” http://www.energystar.gov/ia/business/tools_resources/new_bldg_design/App_Instructions.doc. For criticism of the ES system, see Aston (2008).

39 I am indebted to Michael Bobker, director of CUNY’s Building Performance Laboratory, for pointing this out.

40 Jersey City, New Jersey proposed in spring 2009 to build an “affordable” LEED silver project in which only 5 of the total 45 condo units would be for low-income
41 Some progress on this front has been achieved by the Clinton Climate Change Imitative which, in May 2009, announced models for sustainable urban growth in ten countries, and with the LEED Neighborhood Development (ND) rating system, which is nearing its final stages.


43 Adding a battery of additional variables onto the CoStar database could, for example, be one simple beginning in tracking a wider range of important outcomes.

44 The U.S. Department of Energy in June 2009 announced tougher rules for lighting systems that are intended to cut energy use by 15% to 25% (Galbraith, 2009c). This was their first revision since 1992.

45 The UN’s Environment Program states: “Despite efforts over the past decades to demonstrate the inter-dependency between the environment and human well-being, the environment continues to receive marginal attention in economic policymaking.” See: http://www.unep.org/greeneconomy/index2.asp?id=ger.

46 It has been announced in Washington DC, that the U.S. housing and energy agencies will collaborate over the next several years in developing synchronized programs that can assist green growth strategies at the municipal and neighborhood level. It is as of this writing uncertain the level of funding that these initiatives will command and how much more than small scale demonstrations will be implemented in the next several years. See: http://www.hud.gov/offices/cpd/library/energy/index.cfm and http://www.hud.gov/energy/.

47 This bill, Waxman- Markey’s “The American Clean Energy and Security Act,” was passed by the U.S. House of Representatives on June 26, 2009. As it includes other more controversial provisions, including a cap-and-trade provision, its passage into law cannot be estimated. There are also no apparent commitments for the necessary appropriations. The proposed 30% energy improvement would be benchmarked against current national model building energy codes. There is funding proposed for assisting owners of multifamily and single family residential units to adapt, with higher incentive payments for greater proven energy savings. The draft bill also requires the Secretary of Energy, “to otherwise promote the design and construction of energy-efficient buildings.” See: http://energycommerce.house.gov/Press_111/20090331/acesa_discussiondraft.pdf.

48 There is an in tandem need for international action in this area as well, including international measurement (Investment Property DataBank: Lim, McGreal, and Webb, 2008).

References

Aston, A. ENERGY STAR Doesn’t Mean Your Fridge is Green. Business Week, October 2, 2008.


The Dynamics of Market Penetration


Friess, S. Las Vegas Bets on Environmentalism. USA Today, August 4, 2008, 5D.


**Background Sources/URLs**


The author would like to express considerable thanks to a number of individuals who have helped in this analysis: Douglas Durst, Chairman of the Durst Organization (http://www.durst.org/master.htm), Helena Durst, and Eric Engelhardt of the Durst Organization. Alice Cooper of Time Equities; Nancy Biberman, director of the Women’s Housing and Economic Development Corp.; Mr. Anthony Piscopia, on April
16, 2009; Scott Muldavin, Jonathan Wiley, Michael Bobker, and anonymous reviewers also offered valuable advice and comments. An earlier draft of this paper was presented at the APPAM-KDI Conference on “Environmental Policy and Teaching,” Seoul, South Korea, June 2009.

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Sustainability of Sustainable Real Property Development

Authors
Kwame Addae-Dapaah, Liow Kim Hiang, and Neo Yen Shi, Sharon

Abstract
The paper investigates commercial buildings users’ perception of the benefits of green buildings and how this perception influences their decision to occupy and/or invest in them. A survey of 400 commercial real estate users in Singapore reveals that they are aware of, and appreciate the benefits of green buildings. However, they are not willing to occupy and/or invest in green buildings as they are concerned with monetary returns. Price, reliability, and effectiveness of green features, as well as apathy towards environmental issues, are impeding the sustainability of sustainable commercial real estate in Singapore. Notwithstanding, since it was found that cost saving and higher property value benefits statistically influence respondents’ willingness to invest in, or occupy green buildings, turning the sustainability advocacy into realistic economic advocacy could ensure sustainability of sustainable real estate development.

The concern about the ability of the land resource base to meet, indefinitely, the ever increasing demand for “land” because of the rapid pace of technological advancement and socio-cultural and economic developments, vis-à-vis global warming, has made sustainable development a hot topic worldwide. Environmental concerns have plagued mankind for ages. As early as the nineteenth century, Marsh (1864:36) made this telling observation: “Man everywhere is a disturbing agent. Wherever he plants his foot, the harmonies of nature are turned to discord.” The Ecologist (1972:15) states:

“The principal defect of the industrial way of life with its ethos of expansion is that it is not sustainable...We can be certain, however, that sooner or later it will end (only the precise time and circumstances are in doubt) and it will do so in one of two ways: either against our will, in a succession of famines, epidemics, social crises and wars; or because we want it to—because we wish to create a society which will not impose hardship and cruelty upon our children—in a succession of thoughtful, humane and measured changes.”

The world has gradually woken up (by, among other things, environmentalists, scientists, natural disasters, and Al Gore’s Academy Award-winning documentary, “An Inconvenient Truth”) to the harsh truth that unless itbridles its insatiable quest for the “good life,” which manifests itself in the unwonted exploitation of the ecosystem at a faster rate than can be replenished, its very existence could be
in jeopardy. This awakened consciousness has swelled the green tidal wave for sustainable development. However, the critical question that needs to be addressed is whether the increased tempo in sustainable real estate development is itself “sustainable.” In other words, the consumer’s acceptance and patronage of sustainable real estate development is fundamental to its success and thus, demands more thorough studies to ensure that resources are efficiently deployed, rather than misused, in sustainable real estate development.

This is underscored by the fact that although some progress has been made, and people laud the virtues of sustainable development, rhetoric on sustainability has not often been backed with action. This is true of Singapore (and other parts of the world) where, despite the government’s efforts to push the green agenda, the private sector appears to be relatively slow in warming up to the green revolution. Thus, this paper is motivated by the fact that sustainability and thus, sustainable real estate development, is a survival imperative for mankind. The sustainability (i.e., success) of sustainable real estate development could make a significant contribution towards the fight against global warming to promote the continued survival of mankind. This makes it worthwhile to investigate the ways and means of making sustainable real estate development “sustainable.”

Secondly, Singapore has become an important financial center in Southeast Asia. Prospective multi-national companies for the Singapore market may like to know the market’s perception of green buildings. Thirdly, Singapore is a cosmopolitan city. Thus, any insight into green building based on a study in Singapore may have a cosmopolitan flavor to appeal to a wide audience. The paper therefore explores the market’s perception of the benefits of green buildings and the impact of these benefits on commercial building occupier’s willingness to occupy and/or invest in green buildings; and the factors that are militating against mass development of green buildings in Singapore.

The rest of the paper proceeds as follows. The next section provides a brief review of the relevant extant literature. This is followed by data sourcing and management after which the results of the data analysis are presented and discussed. The last section is devoted to concluding remarks. It is found that environmental and unquantifiable benefits, though lauded by the market, are less important in influencing occupiers’ decision-making. Price, reliability, and effectiveness of green features, as well as apathy towards environmental issues, slow the acceptance of green buildings in Singapore. Benefits that will directly impact the business’ economic performance have a significant influence on commercial building occupiers’ willingness to invest in, and occupy, green buildings. Profitability, rather than mere environmental concern, is the main priority.

**Literature Review**

Porter (2000) aptly remarks that sustainable development is a two-word phrase with a thousand meanings. According to Porter (2000:1), sustainable development “speaks of balancing economic and social forces against the environmental imperatives of resource conservation and renewal for the world of tomorrow.”
This is in consonance with the Brundtland Commission, which defines sustainable development as “development which meets the needs of the present without compromising the ability of future generations to meet their own needs,” (World Commission on Environment and Development, 1987). In other words, sustainable development should safeguard and perpetuate the harmonies of nature (i.e., preserve ecological balance). It would appear, however, that current definitions of sustainable development (i.e., green buildings), water down this idea of preservation of the ecological balance to ensure that the needs of future generations are not compromised.

According to the white paper on green buildings presented at the Green Building Congress 2001, a green building is one that incorporates several green features, such as:

- Use of energy-efficient and eco-friendly equipment (e.g., low energy consumption achieved by a range of techniques including the use of natural ventilation rather than air-conditioning, heat recovery systems, and the use of thermal mass, careful orientation, and low-energy lighting design).
- Use of recycled and environmentally-friendly building materials (e.g., careful specification of lower environmental impact building materials).
- Quality indoor air for human safety and comfort.
- Use of renewable energy (e.g., maximum use of natural day-lighting).
- Effective controls and building management system.
- Efficient use of water (e.g., use of gray-water recycling for landscape irrigation and WCs).
- Use of non-toxic and recycled materials.
- Effective use of existing landscapes (e.g., minimizing site impact through sensitivity to site ecology and careful landscaping).
- Adoption of cost-effective and environmentally-friendly technologies.

The emergence of worldwide rating systems such as the Building Research Establishment Environmental Assessment Method in the United Kingdom (BREEAM), Leadership in Energy and Environmental Design in the United States (LEED), and Green Globes and Green Mark in Singapore (all of which are in consonance with the white paper on green buildings) is giving impetus to sustainable real estate development. These rating systems, with virtually similar objectives, are pushing the green agenda by encouraging environmentally and socially responsible building practices, and distinguishing between sustainable real estate and conventional properties by awarding “badges” for buildings’ different degrees of “green.” In effect, green buildings are aimed at reducing the negative impact of real estate development on both the environment and human health to promote the sustainability of life. However, it is doubtful whether the extant green machinery will lead to sustainability as defined by the Brundtland Commission, i.e., renewal that ensures continuity of matter, resources, populations, and cultures (Porter, 2000). In mathematical form, sustainability implies the following equation:
where $EC \leq ER$, (1)

where $EC$ stands for environmental/ecological consumption/degradation and $ER$ for environmental/ecological renewal. Regardless of one’s stand in the definitional thicket, the extant literature on green buildings mainly revolves around the benefits of, and barriers to, sustainable development. The benefits of green buildings are categorized as economic, social, and environmental.

**Economic Benefits**

It is argued that “greening” increases property value via lower running cost and risk, gains in productivity and reduced construction cost, and financial incentives. According to Wasiluk (2007), sustainable commercial buildings have a competitive advantage over traditional commercial buildings because of their ability to attract higher profile tenants to command above-market rentals and thus, capital values. Furthermore, green buildings command a premium by virtue of the “badge of honor,” which is awarded by the rating systems, and the concomitant brand name, which investors use in marketing (e.g., Shiers, 2000; Holmes and Hudson, 2001; Jones Lang LaSalle, 2006; Reed and Wilkinson, 2006). These findings have been replicated by Miller, Spivey, and Florance (2008), who conclude that ENERGY STAR-rated and LEED-certified office buildings in the U.S. have a competitive advantage over their non-rated counterparts.

In addition, energy efficiency and good indoor environmental quality in green buildings translate into lower operating cost and thus, higher net operating income, capital value, and productivity relative to conventional buildings (Roper and Beard, 2006). According to the Leadership Roundtable moderated by Cannon and Vyas (2008), McCabe argues that green buildings inherently have lower risk of exposure to volatility in price and resource availability, which should logically result in lower capitalization and discount rates.

Energy efficiency resulting from “greening” is certainly a welcome benefit to both real estate investors and tenants. However, its impact on property value needs to be carefully studied and documented to substantiate the claim as, according to Jevons Paradox, the more efficient we become in using a given resource, the more we consume of that resource (Bezdek in Leadership Roundtable moderated by Cannon and Vyas, 2008). This supposition is supported by the fact that there has been a dramatic increase in energy efficiency in the U.S. over the past 30 to 40 years but energy consumption per capita over the period far outstripped the efficiency of use (Rubin and Tal, 2007). For example, air conditioning efficiency in the U.S. has risen by 17% since 1990, while the number of air conditioning units in the residential sector has increased by 36% (Rubin and Tal, 2007). What has happened in the residential sector in relation to energy efficiency vis-à-vis energy usage could resonate in the commercial real estate sector as well. As noted by Rubin (2007), the legacy of energy efficiency improvements is ever greater energy consumption. This implies that energy efficiency may not necessarily lead
to a reduction in operating expenses to increase net income and capital value if all other things are held constant.

Furthermore, Shiers (2000) and Robinson (2005) state that savings in running cost [which may be lower than projected (see Cannon and Vyas, 2008)] are often of little interest to many tenants as many of them adopt a financial “short term” view of their business, rather than focusing on long-term savings or investment opportunities. Investors tend to be more concerned with the business activities of the tenants in the buildings rather than the effect of the building on the environment. Tenants tend to view their office occupation costs as being dominated by salaries, rent, and rates, while service charges are deemed to be negligible in comparison to these major items. The insignificance of service charges, as a proportion of overall business cost, casts doubt on occupiers’ willingness to pay a premium rent for green buildings.

Another economic benefit that has been attributed to green real estate is reduction in construction cost. Lucuik, Trusty, Larsson, and Charette (2005) state that savings from the elimination of unnecessary systems, or the downsizing of systems through better design, offsets the increased costs resulting from implementing more advanced systems. Construction costs savings can arise from a low-impact approach to the use of the site and taking advantage of a site’s natural features such as daylight, shading, and landscape (Hydes and Creech, 2000). Optimization of building layouts, simple and efficient planning of buildings due to requirements and constraints of natural ventilation systems, and more careful specification practices also contribute to cost savings in construction (Shiers, 2000). Whether these cost savings make green buildings less costly and/or less expensive than conventional buildings is debatable.

According to Shiers (2000), there are inherent problems in making meaningful comparisons on a like-for-like basis with regards to the construction cost and performance of buildings of different ages, design, and functional characteristics. A 2004 study by Davis Langdon found that the cost of constructing a sustainable building tends to match or only slightly exceed those of comparable non-green buildings. Taking into account a range of construction factors including climate, location, market conditions, and local standards, the study found that for many of the green projects, pursuing LEED certification had little or no budgetary impact. In addition, Roper and Beard (2006) state that some green buildings may indeed be less expensive than their conventional counterparts but may be significantly different in both concept and in terms of detail in design. Further, the paucity of market evidence, sales data, and lease transactions of sustainable buildings have left many in the industry wondering whether sustainable buildings are feasible (Lutzkendorf and Lorenz, 2005a & b). All these may imply that the economic benefits attributable to green buildings could be exaggerated.

Financial Incentives

Another economic advantage that green buildings enjoy is financial incentives and tax concessions. Often, the economic-price model does not adequately value social and ecological attributes in the decision-making process (Chua, 2007). Thus, few
developers in the private market would adopt green technologies. Governments therefore have to provide incentives to induce market decision-making in accommodating and incorporating green attributes in buildings.

In Singapore, the Building and Construction Authority (BCA) has created a $20 million Green Mark Incentive Scheme for private sector developers, in an attempt to encourage private developers to build green buildings. The scheme is to provide cash incentives to developers for meeting Green Mark Gold rating or higher and to create demand in green building technologies so as to lower costs in the long run (http://www.bca.gov.sg). Further proposed financial incentives include boosting the availability of funds by involving banks in providing preferential loan rates for Green Mark projects. This works in Japan, where banks make ‘green loans’ for buildings that aim for higher environmental ratings (Cheam, 2008).

**Social Benefits**

A green building provides a healthier working environment. Improved indoor air quality helps to reduce the health and safety risks to occupants from Sick Building Syndrome (SBS) and Legionnaire’s Disease (Shiers, 2000). Fisk (2002) estimates that improved heating, ventilating, and air conditioning (HVAC) systems, which limit the spread of contaminants and pathogens, could reduce respiratory illnesses by 9%–20%. Better indoor air quality can also reduce asthma attacks and allergies. Health and comfort are becoming increasingly important with the growing concern about staff welfare. Through sustainability, companies can improve their competitive advantage in the recruitment and retention of talent. Paevere and Brown (2008) note that green building can be used as an employee ‘benefit’ to attract and retain high quality workers. Scholars also suggest that initial applicant attraction to a firm is based on perceptions of the firm’s image, which is thought to be influenced by the firm’s corporate social performance (Turban and Greening, 1996). For example, certain companies, such as IBM, General Motors, and Microsoft, are sending out brochures to prospective applicants promoting their companies’ philanthropic and environmental programs. This implies that some firms are using social responsibility as a recruitment tool (Turban and Greening, 1996; ASHRAE, 1998; Leaman, Thomas, and Vandenberg, 2007).

Notwithstanding the use of green buildings as a recruitment ploy by some employers, factors such as improved health and productivity in green buildings may not be quantifiable and thus, are subject to a higher degree of uncertainty (Roper and Beard, 2006). Amidst the hype about sustainability, high performance, and green buildings, the meaning or definition of “building performance” is vague. Each of those descriptors alludes to some improved building performance over a baseline or reference, which is seldom defined in measurable or verifiable terms. As a result, accountability is seldom realized for delivering or operating buildings that meet objective, measurable criteria that are of primary importance to the building owner or tenant (Woods in Leadership Roundtable moderated by Cannon and Vyas, 2008). Moreover, tenants are not clear as to what constitutes green and thus, are rarely able to venture past the (green) trophy sticker mentality.
Environmental Benefits

Real estate contributes to the environment through resource depletion, energy consumption, air pollution, and creation of wastes that are not easily assimilated by the environment. In Singapore, commercial and industrial buildings alone have been estimated to contribute about 15% of the total carbon emission, largely from electricity consumption, half of which goes towards air conditioning (Chua, 2007).

Green buildings offer a lower level of environmental risk by helping to minimize the environmental footprint of the real estate industry on the environment. The rational use of natural resources and appropriate management of the building stock will contribute to saving scarce resources, reduce energy consumption, and improve environmental quality (Roper and Beard, 2006). However, reduction in energy consumption due to green buildings may be difficult to achieve, given the Javons Paradox, which has been shown to be true in the U.S. (see Rubin and Tal, 2007). Thus, the expected improved environmental quality resulting from green buildings via energy efficiency and its corollary reduction in the greenhouse gas effect may not materialize. Furthermore, the reliability of renewable energy sources to provide sufficient energy to mitigate the reliance on fossil fuel (the source of the greenhouse effect) has been questioned (Cannon and Vyas, 2008).

The foregoing discourse shows that notwithstanding the hype about the benefits of green real estate, there are questions and barriers (e.g., lack of faith in the green system to deliver the touted benefits, unquantifiable benefits, etc.), which impede the development of green buildings in the market. Moreover, the vast majority of consumers proxied by 93% of respondents to a survey conducted by Jones Lang LaSalle and CoreNet Global (2007) feel that sustainable solutions are patchy or limited. Thus, given the prospects of green real estate vis-à-vis the challenges that militate against its widespread adoption, it is anybody’s guess whether sustainable real estate development is sustainable in Singapore.

Data Sourcing and Management

The study is based on primary data collected through a survey (see the Appendix) of 400 commercial building occupiers in Singapore. The sample size is a function of the method of analysis (factor analysis) used for the study. As a general rule, there must be at least five times as many observations (respondents) as there are variables to be analyzed, with the more acceptable range being a ten-to-one ratio (Hair, Anderson, Black, and Tatham, 1998). Since there are 29 benefits (variables)—extracted from the extant literature—in the questionnaire, a ten-to-one ratio gives a more acceptable sample size of 290. This makes the sample size of 400 sufficiently large enough for statistical inferences to be made.

The survey, which was randomly administered, was conducted in Jurong East, Raffles Place, Woodland, Harbour Front, and Tampines to ensure as wide a representation of commercial building occupiers as possible. The questionnaire comprises four sections. Section one solicits information on the respondents’ perception of the benefits of green buildings. Questions in this section relate to...
29 benefits (based on extant literature). The respondents were asked to rate (on a 5-point rating Likert scale, with 1 being “Not important” and 5 being “Very important”) the level of importance they (as individuals) attach to each benefit. This method ensures that evaluation categories can easily be compared and response categories can be collapsed into positive and negative response groups with an intervening neutral category between the two poles.

Section two of the questionnaire seeks to ascertain the respondents’ willingness to invest in and/or occupy green buildings given that the green buildings provide all the benefits that the respondents consider to be of importance. The respondents were given a 5-point rating Likert scale with 1 being “Strongly disagree” and 5 being “Strongly agree” to state their level of agreement to statements in the section. These statements are aimed at ascertaining the respondents’ acceptance of green buildings.

Section three of the survey explores the potential barriers to green buildings. Once again, the respondents were asked to rate the level of significance of each barrier on a 5-point Likert scale with 1 being “Not important” and 5 being “Very important.” The last section, section four deals with the respondents’ demographic profile.

The respondents’ ratings for the benefits of green buildings were factor-analyzed using principal component analysis (PCA), followed by varimax rotation. These analytical tools were employed after verifying the appropriateness of the dataset for factor analysis through the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy, Bartlett’s test of sphericity, and the determinant of correlation matrix. A high KMO value (between 0.5 and 1.0) is considered appropriate while a KMO value below 0.5 is not appropriate for factor analysis (Kline, 1994; Malhotra, 1996). Similarly, a low Bartlett’s test of sphericity value less than 0.05 and a determinant of correlation matrix value close to 0 indicate that factor analysis is appropriate (Kline, 1994; Malhotra, 1996). Thus, the figures in Exhibit 1 attest to the appropriateness of the dataset for factor analysis.

Furthermore, the widely used Cronbach’s alpha as a diagnostic measure for consistency of the entire scale is adopted. The generally accepted lower limit for Cronbach’s alpha to yield reliability is 0.70 (Hair, Anderson, Black, and Tatham, 1998). The correlation between the respondents’ willingness to invest in and/or occupy green buildings and the “important” variables is evaluated via bi-variate correlation.

**Exhibit 1 | Results of KMO and Bartlett’s Test**

<table>
<thead>
<tr>
<th>Kaiser-Meyer-Olkin Measure of Sampling Adequacy</th>
<th>0.734</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bartlett’s Test of Sphericity</td>
<td>Approx. chi-square 6,090.199</td>
</tr>
<tr>
<td></td>
<td>df 406</td>
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<tr>
<td></td>
<td>Sig. 0.000</td>
</tr>
</tbody>
</table>
Results

Relevant Demographic Details of Respondents

Most of the respondents, of which 58% and 42% are male and female respectively, hold a diploma (37%), first degree (41%), and a master’s/doctorate degree (7%). The remaining 15% comprises Institute of Technical Education (ITE) certificate holders (11%) and people with up to secondary education (5%). The relatively high proportion of male respondents reflects the labor force participation rate of males and females in Singapore. Furthermore, about 85% of the respondents are between age 21 and 49 inclusive, with age group 30–39 accounting for 43.3% of all the respondents. Moreover, 58% of the respondents hold executive and managerial/professional positions (see Exhibit 2).

Benefits of Green Buildings

The results of the survey relating to the benefits of green building are presented in Exhibit 3. Out of 29 variables (i.e., benefits), 27 are reported in Exhibit 3; the variables “Accelerates jurisdictional approval” and “Reduced societal costs of landfill creation and maintenance” had insignificant factor loadings and thus, were sifted out of subsequent analysis. The latent root criterion suggests an eight-factor solution, which accounts for 69.92% of the variance within the original variables in Exhibit 3.

The four highest ranking factors (benefits), each of which accounts for more than 10% of the variance, are environmental, productivity gains, improved internal conditions, and cost savings in descending order (see Exhibit 3). Environmental factors, which comprise five variables (Exhibit 3, Factor 1), account for 11.40% of the variance. The results clearly attest to the respondents’ acknowledgement of environmental benefits of green buildings. Green buildings use more
**Exhibit 3 | Benefits of Green Buildings**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Component</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
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</thead>
<tbody>
<tr>
<td>Factor 1: Environmental (Cronbach alpha: 0.85)</td>
<td>Sustainability</td>
<td>0.824</td>
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<td></td>
<td>Less pollution</td>
<td>0.788</td>
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<td></td>
<td>Fight global warming</td>
<td>0.807</td>
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<td></td>
<td>Waste minimization</td>
<td>0.815</td>
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<td></td>
<td>Minimized site impact</td>
<td>0.745</td>
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<tr>
<td></td>
<td>Variance (%)</td>
<td>11.396</td>
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<tr>
<td>Factor 2: Productivity Gains (Cronbach alpha: 0.86)</td>
<td>Reduced absenteeism</td>
<td>0.756</td>
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<tr>
<td></td>
<td>Reduced health and safety risks</td>
<td>0.833</td>
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<td></td>
<td>Less claims made on health costs</td>
<td>0.847</td>
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<td></td>
<td>Boosts creativity</td>
<td>0.748</td>
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<td></td>
<td>Higher morale</td>
<td>0.710</td>
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<tr>
<td></td>
<td>Variance (%)</td>
<td>11.248</td>
<td></td>
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<tr>
<td>Factor 3: Improved Internal Conditions (Cronbach alpha: 0.90)</td>
<td>Improved indoor air quality</td>
<td>0.886</td>
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<td></td>
<td>Less complaints on comfort-related problems</td>
<td>0.883</td>
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<td></td>
<td>User satisfaction</td>
<td>0.866</td>
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<tr>
<td></td>
<td>Users have more control over their environment</td>
<td>0.839</td>
<td></td>
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<tr>
<td></td>
<td>Variance (%)</td>
<td>11.103</td>
<td></td>
<td></td>
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<tr>
<td>Factor 4: Cost Savings (Cronbach alpha: 0.88)</td>
<td>Water conservation</td>
<td>0.842</td>
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<tr>
<td></td>
<td>Energy efficiency</td>
<td>0.881</td>
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<tr>
<td></td>
<td>Lower services maintenance costs</td>
<td>0.822</td>
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<td></td>
<td>Secure grants</td>
<td>0.784</td>
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</tr>
<tr>
<td></td>
<td>Variance (%)</td>
<td>10.770</td>
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<td>Factor 5: Higher Building Value (Cronbach alpha: 0.84)</td>
<td>Secure higher rents</td>
<td>0.845</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Faster tenants lease-up</td>
<td>0.868</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Valuation premiums</td>
<td>0.737</td>
<td></td>
<td></td>
<td></td>
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<td>Variance (%)</td>
<td>8.037</td>
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<tr>
<td>Factor 6: Lower Risks (Cronbach alpha: 0.75)</td>
<td>Lower risk of exposure to volatility in prices</td>
<td>0.790</td>
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</tr>
<tr>
<td></td>
<td>Lower risk of exposure to resource availability</td>
<td>0.877</td>
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<td></td>
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<td></td>
<td>Reduced liability risks</td>
<td>0.729</td>
<td></td>
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<td>7.249</td>
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<tr>
<td>Factor 7: Branding (Cronbach alpha: 0.82)</td>
<td>Better market distinction</td>
<td>0.885</td>
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<tr>
<td></td>
<td>Higher prestige</td>
<td>0.920</td>
<td></td>
<td></td>
<td></td>
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<td>Variance (%)</td>
<td>6.073</td>
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<td></td>
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<tr>
<td>Factor 8: Workforce Turnover (Cronbach alpha: 0.85)</td>
<td>Lower workforce turnover</td>
<td>0.706</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Variance (%)</td>
<td>4.039</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>Total variance (%)</td>
<td>69.915</td>
<td></td>
<td></td>
<td></td>
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</table>
environmental-friendly materials; generate less waste and pollution, thereby reducing the carbon footprint caused by the property sector. This is crucial not only to Singapore but to all major world cities where commercial buildings consume large amounts of electricity due to massive air-conditioning and/or heating. In consonance with governmental efforts in promoting sustainable development to combat climate change, green buildings promise to offer environmental benefits that are well-aligned with governmental agendas to go green.

The next most important benefits of green buildings are productivity gains (11.25% of the variance). The variables in this factor include “reduced absenteeism,” “reduced health and safety risks,” and “less claims made on health costs.” These items can be costly enough to affect the profit margins of business in commercial buildings. Notwithstanding the relative importance of productivity gains as a benefit, it is questionable whether all, or a statistically significant proportion of, such gains are solely attributable to green buildings. This should positively influence respondents’ decisions to invest in, or occupy, green commercial buildings if the benefits are deemed to be attributable to green features.

Improved internal conditions (Factor 3) account for 11.10% of the variance. This could be attributed to the fact that commercial building occupiers value comfort and well-being and that employers are also increasingly concerned about staff welfare. Better indoor air quality helps to reduce the susceptibility of office buildings to diseases such as Sick Building Syndrome (SBS) and Legionnaire’s Disease. Providing a comfortable and pleasant internal working environment can be a key differentiator (Paevere and Brown, 2008) when recruiting talent, particularly in an increasingly challenging labor market. Hence, creating healthier and more user-oriented working conditions becomes an important factor.

The next benefits of importance are cost savings (10.77% of variance) and higher building value (8.04% of variance). Respondents favor the potential of green buildings to offer cost advantages, particularly in terms of operating costs relating to “water conservation,” “energy efficiency,” and “Lower services maintenance costs.” This is not surprising as the heavy reliance on air-conditioning, vis-à-vis a relatively high electricity tariff, and the levying of water conservation tax (30% of water bill) could mean that “energy efficiency” and “water conservation” could lead to substantial savings in utility bills (and thus, operating expenses) to increase the profits of businesses operating in green commercial real estate, as well as the net operating income and capital values of green commercial buildings.

The variables under Factor 5, “higher building value,” are “faster tenants lease-up,” “secure higher rentals,” and “valuation premiums.” Improved tenant attraction and retention is pivotal to lowering vacancy rates in buildings. This reduces the time and cost for securing new tenants to increase property value as “space-time” implies that time is “value” for real estate. Similarly, “secure higher rentals” and “valuation premiums” increase, all other things being equal, the market value of the building. The underlying implication of both Factors 4 and 5 is that the respondents are aware that green buildings are not merely an
environmentally responsible alternative, but could be a smart, financially responsible business strategy to increase economic bottom line.

The remaining benefits are: lower risks (7.25% of variance), higher marketability (6.07% of variance) and workforce turnover (4.04%).

On the whole, the robustness of seven of the identified factors, Factors 1–7, is attested by the Cronbach’s alphas, which range from 0.75 (Factor 6: lower risk) to 0.90 (Factor 3: improved internal condition). Therefore, we test the impact of each benefit on the willingness of the respondents to invest in and/or occupy green commercial buildings.

### Respondents’ Willingness to Invest In and/or Occupy Green Buildings

The effects of green benefits on respondents’ willingness to invest in and/or occupy green buildings is tested through correlation analysis of the relationship between the variables under each factor and respondents’ willingness to invest in and/or occupy green commercial buildings. The null hypothesis (at the 0.05 level of significance) is that green benefits have significant impact on the willingness of respondents to invest in and/or occupy green commercial buildings.

The results presented in Exhibits 4–10 reveal that only two of the green benefits have statistical significant effect (at the 0.05 level of significance) on the respondents’ willingness to invest in and/or occupy green commercial buildings. It appears paradoxical that the three highest ranking green benefits—environmental, productivity gains, and improved internal conditions—generally have no significant impact on the respondents’ willingness to invest in and/or occupy green commercial buildings (Exhibits 4–8). This implies that although

### Exhibit 4 | Environmental Benefits & Willingness to Use Green Buildings

<table>
<thead>
<tr>
<th>Benefit</th>
<th>I Would Occupy Green Building</th>
<th>I Would Invest in Green Building</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainability</td>
<td>Pearson Correlation -0.052</td>
<td>-0.077</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed) 0.301</td>
<td>0.123</td>
</tr>
<tr>
<td>Less pollution</td>
<td>Pearson Correlation -0.002</td>
<td>-0.085</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed) 0.966</td>
<td>0.090</td>
</tr>
<tr>
<td>Fight global warming</td>
<td>Pearson Correlation 0.023</td>
<td>0.041</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed) 0.649</td>
<td>0.412</td>
</tr>
<tr>
<td>Waste minimization</td>
<td>Pearson Correlation -0.011</td>
<td>-0.013</td>
</tr>
<tr>
<td></td>
<td>Sig. (2 failed) 0.822</td>
<td>0.790</td>
</tr>
<tr>
<td>Minimized site impact</td>
<td>Pearson Correlation -0.035</td>
<td>0.031</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed) 0.480</td>
<td>0.534</td>
</tr>
</tbody>
</table>
### Exhibit 5 | Productivity Gains & Willingness to Use Green Buildings

<table>
<thead>
<tr>
<th></th>
<th>I Would Occupy Green Building</th>
<th>I Would Invest In Green Building</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced absenteeism</td>
<td>Pearson Correlation 0.132</td>
<td>0.113</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed) 0.008</td>
<td>0.024</td>
</tr>
<tr>
<td>Reduced health and safety risks</td>
<td>Pearson Correlation 0.085</td>
<td>0.091</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed) 0.076</td>
<td>0.130</td>
</tr>
<tr>
<td>Less claims made on health costs</td>
<td>Pearson Correlation 0.090</td>
<td>0.096</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed) 0.071</td>
<td>0.055</td>
</tr>
<tr>
<td>Boosts creativity</td>
<td>Pearson Correlation −0.012</td>
<td>0.017</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed) 0.818</td>
<td>0.731</td>
</tr>
<tr>
<td>Higher morale</td>
<td>Pearson Correlation 0.087</td>
<td>0.093</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed) 0.082</td>
<td>0.063</td>
</tr>
</tbody>
</table>

### Exhibit 6 | Improved Internal Conditions and Willingness to Use Green Buildings

<table>
<thead>
<tr>
<th></th>
<th>I Would Occupy Green Building</th>
<th>I Would Invest In Green Building</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved indoor air quality</td>
<td>Pearson Correlation 0.003</td>
<td>−0.017</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed) 0.946</td>
<td>0.731</td>
</tr>
<tr>
<td>Less complaints on comfort-related problems</td>
<td>Pearson Correlation 0.064</td>
<td>0.016</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed) 0.200</td>
<td>0.743</td>
</tr>
<tr>
<td>User satisfaction</td>
<td>Pearson Correlation 0.040</td>
<td>0.041</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed) 0.427</td>
<td>0.415</td>
</tr>
<tr>
<td>Users have more control over their environment</td>
<td>Pearson Correlation 0.039</td>
<td>0.024</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed) 0.431</td>
<td>0.626</td>
</tr>
</tbody>
</table>

### Exhibit 7 | Lower Risk and Willingness to Use Green Buildings

<table>
<thead>
<tr>
<th></th>
<th>I Would Occupy Green Building</th>
<th>I Would Invest In Green Building</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower risk of exposure to volatility in prices</td>
<td>Pearson Correlation 0.020</td>
<td>0.022</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed) 0.696</td>
<td>0.666</td>
</tr>
<tr>
<td>Lower risk of exposure to resource availability</td>
<td>Pearson Correlation 0.146</td>
<td>0.141</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed) 0.003</td>
<td>0.005</td>
</tr>
<tr>
<td>Reduced liability risks</td>
<td>Pearson Correlation 0.036</td>
<td>0.015</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed) 0.472</td>
<td>0.763</td>
</tr>
</tbody>
</table>
people laud the environmental benefits of green commercial buildings, these benefits do not hold enough inducement to make them invest in and/or occupy such buildings. Environmental benefits avail to all—a public good that no self-centered, profit-motivated individual is willing to pay for.

The only variable under productivity gains that is of statistical significance (at the 0.05 level) is “reduced absenteeism.” This factor (productivity gain) is virtually
of no statistical significance at the 0.05 level. The factor generally becomes of marginal statistical significance only when the level of significance is raised to 0.1. This could be attributed to the fact that people are skeptical of the effectiveness of green features in providing productivity gains. The complexity of human health and performance issues, the large range of human reactions to indoor environmental quality changes, and the large range of ways that improvements can show up make it difficult to attribute productivity gains solely to green buildings.

The statistical insignificance of “improved internal conditions,” though inconsistent with previous studies, may be understandable in the Singapore context as the impression that green buildings equate to more use of day lighting and less use of air-conditioning could cause respondents to fear that green buildings may lead to uncomfortable internal conditions. Similarly, the statistical insignificance of marketability is contrary to previous studies. However, the finding shows that the respondents are not easily swayed by “branding” and that a “green” rating may not be having the desired impact on commercial building users’ decision-making.

**Significant Green Benefits**

The two benefits that are of statistical significance are: cost savings (Factor 4) and higher building value (Factor 5)—see Exhibits 9 and 10. It is worth noting that all the variables (i.e., green benefits) under both factors are statistically significant at the 0.05 level. In other words, both factors induce respondents to be willing to invest in and/or occupy green commercial buildings. It seems obvious from the above discourse that the only green benefits that hold sway on commercial building users in Singapore, and perhaps the world at large, are those benefits that are discernibly translatable into dollars and cents.

**Potential Barriers to Green Buildings**

Exhibit 11 reveals that the main barriers to the acceptance of green commercial buildings are price (mean rating 4.14), lack of interest (mean rating 3.79), lack of faith in effectiveness of green features (mean rating 3.97), reliability of using renewable energy sources (mean rating 3.83), and uncertain returns (mean rating 3.41). About 90% of the respondents consider price to be a great deterrent from choosing green building over conventional buildings. The respondents think that green buildings are more expensive than conventional ones. They are not willing to pay a premium for green features with no verifiable tangible benefits. Similarly, 72% of the respondents indicated a “lack of interest” as the overriding consideration for not choosing green buildings.

Furthermore, a large majority of the respondents (83%) do not have faith in the effectiveness of green features. Moreover, 74.8% and 54.8% of the respondents are concerned about the reliability of using renewable energy sources, and uncertain returns respectively. These may be due to the fact that there are no
The respondents also specified other barriers that they believe to be important factors in holding them back from choosing green buildings. One factor is the unquantifiable nature of the benefits such as improved workers’ productivity and user satisfaction. Such benefits are often perceived rather than measured and therefore subject to a much higher degree of uncertainty. Furthermore, some respondents highlighted that factors such as location and accessibility are still their primary consideration and whether the building has green features is of secondary concern.

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**Note:** The Likert scale is 1 (Not important) ... 5 (Very important).

---

<table>
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<tr>
<th>Likert Scale</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
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<td>Price (Mean = 4.14)</td>
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<tr>
<td>Frequency</td>
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<td>0</td>
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<td>261</td>
<td>98</td>
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<td>Percentage</td>
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<td>0.0</td>
<td>10.3</td>
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<tr>
<td>Lower than Expected Savings from Green Features (Mean = 3.08)</td>
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<tr>
<td>Frequency</td>
<td>4</td>
<td>138</td>
<td>93</td>
<td>151</td>
<td>14</td>
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<tr>
<td>Percentage</td>
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<td>34.5</td>
<td>23.3</td>
<td>37.8</td>
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<tr>
<td>Lack of Interest (Mean = 3.79)</td>
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<td>Frequency</td>
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<tr>
<td>Percentage</td>
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<td>9.0</td>
<td>18.5</td>
<td>55.5</td>
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<tr>
<td>Lack of Faith in Effectiveness of Green Features (Mean = 3.97)</td>
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<td>Percentage</td>
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<td>13.3</td>
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<tr>
<td>Unwillingness to Change (Mean = 3.30)</td>
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</tr>
<tr>
<td>Frequency</td>
<td>14</td>
<td>74</td>
<td>106</td>
<td>191</td>
<td>15</td>
<td>400</td>
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<tr>
<td>Percentage</td>
<td>3.5</td>
<td>18.5</td>
<td>26.5</td>
<td>47.8</td>
<td>3.8</td>
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<tr>
<td>Limited Options (Mean = 3.01)</td>
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<tr>
<td>Frequency</td>
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<td>87</td>
<td>198</td>
<td>102</td>
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<td>400</td>
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<td>Percentage</td>
<td>2.3</td>
<td>21.8</td>
<td>49.5</td>
<td>25.5</td>
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<td>Reliability of Renewable Energy Sources (Mean = 3.83)</td>
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<tr>
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<td>23</td>
<td>76</td>
<td>238</td>
<td>61</td>
<td>400</td>
</tr>
<tr>
<td>Percentage</td>
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<td>19.0</td>
<td>59.5</td>
<td>15.3</td>
<td>100</td>
</tr>
<tr>
<td>Uncertain Returns (Mean = 3.41)</td>
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<tr>
<td>Frequency</td>
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<td>70</td>
<td>107</td>
<td>195</td>
<td>24</td>
<td>400</td>
</tr>
<tr>
<td>Percentage</td>
<td>1.0</td>
<td>17.5</td>
<td>26.8</td>
<td>48.8</td>
<td>6.0</td>
<td>100</td>
</tr>
</tbody>
</table>
Policy Implications: Is Sustainable Real Estate Development Sustainable?

A world that acknowledges and very much appreciates the virtues of green buildings is not swayed by these virtues to invest in and/or occupy green buildings. Even the highest ranking benefit of green buildings (environmental benefit) does not in any way induce “consumers” of commercial buildings to go green. The only two green benefits that statistically significantly tilt the will of “consumers” towards investment in and/or occupation of green buildings are “cost savings” and “higher building value.” Thus, only green benefits that can be quickly and verifiably translated into “cash” are of significance to decision-makers. The philosophy appears to be: “the benefits must be in cash now or never as businesses are under pressure to perform (in terms of profit) now. Economics reign supreme in the business world. Medium to long term benefits are important but businesses must survive in the short term to enjoy the medium to long-term benefits.

Thus, the emphasis on quantifiable, verifiable monetary benefits of sustainable real estate development in the short term is understandable. This implies that all the hullabaloo about sustainable development would be just music to the ear unless the economic benefits are realizable in the short term too. People want to talk about it, get excited about it but are reluctant to “commit” to it. The short-term view of business (in terms of performance as measured by profitability) may seriously undermine sustainability of sustainable development unless it is satisfactorily addressed.

One way to tackle this issue may be for governments to offer tax and/or financial incentives over a period of about two to five years (instead of just one-off financial incentives, which have been found to be ineffective in endearing green buildings to consumers) to encourage people to invest in, and/or occupy green buildings. Such incentives could bolster the “bottom line” of business to make green buildings appealing to investors given customers’ general unwillingness to pay premium rent for green features, the benefits of which are yet to be proven.

Furthermore, the most effective way to ensure the sustainability of sustainable real estate is to demonstrate, beyond reasonable doubt, that green benefits equate to monetary returns, not only in the medium to long term, but now. For example, actual cost savings from green buildings (Factor 4), which can be realized both now and in the future, and which have statistical influence on people’s willingness to invest in/occupy green buildings should be collated and made known to consumers. This is very crucial as “lack of interest” and “lack of faith in the effectiveness of green features” to deliver the touted benefits are among the barriers to the acceptance and thus success of sustainable real estate development. The fact that “price” emerged as the barrier that is most prejudicial to the acceptance of green buildings implies that quantifiable, realizable economic benefits are the key to the sustainability of sustainable real estate development. Moreover, the perception that green buildings are more expensive than conventional buildings, vis-à-vis unquantifiable and uncertain green benefits,
underscores the need to turn green advocacy into economic advocacy. Competitive pricing of green buildings relative to conventional buildings could endear sustainable real estate to consumers.

According to the respondents, location and accessibility are their primary consideration in the choice of commercial buildings—green features are of secondary importance. This may imply that location and “green features” could be a winning combination. Thus, the way to promote sustainable real estate may be to provide green features (with government subsidies via tax and/or financial incentives) in existing commercial buildings in prime locations. In addition, it is necessary that all new undeveloped commercial sites in good locations (in particular but not exclusively) be developed as green commercial enclaves. To achieve this, it may be necessary for governments to make it mandatory for all new real estate developments to be “green” as sustainability is a survival imperative for mankind; and thus, should not be left solely to the whims and fancies of individuals.

**Conclusion**

The paper explores the market’s perception of the benefits of green buildings and the impact of these benefits on commercial building users’ willingness to occupy and/or invest in green buildings. Furthermore, the paper is aimed at ascertaining the factors that are militating against mass development of green buildings in Singapore. The results show that the respondents are very much aware of the benefits of green buildings. Environmental benefits are ranked first amongst the green benefits. However, awareness and appreciation of green benefits (apart from cost savings and higher building values) virtually have no influence on respondents’ choice of commercial buildings as the benefits are considered to be remote, unquantifiable, and uncertain. Green buildings are, at the moment, suffering from “credibility” stigma in Singapore and perhaps, the whole world. Unless the credibility gap is quickly addressed, sustainable real estate may prove to be unsustainable. This may prove suicidal for mankind. Mankind is beset with a stark choice: To make sustainability work for its own survival, or to make it fail for its extinction in the long run. Mankind has vested interest in the success of sustainable real estate and thus, sustainable advocacy as a whole. To this end, there is an urgent need to grapple with the barriers to sustainable real estate to ensure its success.

The results of the study, among other things, offer some hope that success is achievable. The implications of Factors 4 and 5 (cost savings and higher building value) being statistically significant factors in commercial buildings users’ willingness to invest in/occupy green buildings is that consumers are aware that green buildings are not merely environmentally and socially responsible alternatives, but that they also could be a prudent financially responsible business strategy to increase the economic bottom line. Developers may capitalize on this sentiment to develop sustainable commercial buildings in good locations at...
competitive prices relative to existing conventional buildings. Such an initiative, coupled with empirical evidence to demonstrate to consumers the effectiveness of green features to deliver competitive monetary benefits, and government’s financial and/or tax incentives to developers and investors in the short term to encourage green development could be pivotal in making sustainable real estate development sustainable.

Appendix
Questionnaire Survey
Part 1: Importance of Green Building’s Benefits

How important is each of the following benefits as an attribute of Green Building? (Please rank the factors according to the level of importance: 1 for least important to 5 for most important).

<table>
<thead>
<tr>
<th>Factors</th>
<th>Not important (1)</th>
<th>Not so important (2)</th>
<th>Neutral (3)</th>
<th>Important (4)</th>
<th>Very important (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher Building Value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1) Secure higher rents</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(2) Faster tenants lease-up</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(3) Valuation premiums</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(4) Better market distinction</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(5) Higher prestige</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Cost Savings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6) Water conservation</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(7) Energy efficiency</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(8) Lower services maintenance costs</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(9) Secure grants/subsidies</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(10) Accelerates jurisdiction approvals</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Lower Risks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(11) Lower risk of exposure to volatility in prices</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(12) Lower risk of exposure to resource availability</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(13) Reduced liability risks</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Productivity Gains</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(14) Reduced absenteeism</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(15) Reduced health and safety risks</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(16) Less claims made on health costs (e.g., medical and litigation costs)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td></td>
<td>Not important (1)</td>
<td>Not so important (2)</td>
<td>Neutral (3)</td>
<td>Important (4)</td>
<td>Very important (5)</td>
</tr>
<tr>
<td>---</td>
<td>------------------</td>
<td>----------------------</td>
<td>-------------</td>
<td>---------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>(17)</td>
<td>Boosts creativity</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(18)</td>
<td>Higher morale</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(19)</td>
<td>Lower workforce turnover</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(20)</td>
<td>Improved indoor air quality for staff welfare</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(21)</td>
<td>Less complaints on comfort related problems</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(22)</td>
<td>User satisfaction</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(23)</td>
<td>Users have more control over their environment</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(24)</td>
<td>Sustainability (Not to jeopardize future generations’ needs)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(25)</td>
<td>Less pollution</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(26)</td>
<td>To fight global warming</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(27)</td>
<td>Waste minimization</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(28)</td>
<td>Reduced societal costs of landfill creation and maintenance</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(29)</td>
<td>Minimized site impact (e.g. Sensitivity to site ecology and careful landscaping)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

**Environmental**

**Part 2: Willingness to Occupy Green Buildings**

If the benefits I deem to be important are provided,

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree (1)</th>
<th>Disagree (2)</th>
<th>Neutral (3)</th>
<th>Agree (4)</th>
<th>Strongly agree (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(30)</td>
<td>I would be an occupier of a green building</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(31)</td>
<td>I would pay premium for green features</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(32)</td>
<td>I would recommend green buildings to others</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>(33)</td>
<td>I would invest in green buildings</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

**Part 3: Potential Barriers to the Growth of Green Buildings**

What are the barriers that are holding you back from choosing green buildings over conventional properties? (Please rank the following barriers according to the level of importance: 1 for Least important to 5 for Most important).
<table>
<thead>
<tr>
<th>Not important (1)</th>
<th>Not so important (2)</th>
<th>Neutral (3)</th>
<th>Important (4)</th>
<th>Very important (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(34) Price</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>(35) Cost savings from green features are lower than expected</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>(36) Lack of interest</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>(37) Lack of faith in effectiveness of green features</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>(38) Unwillingness to change</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>(39) Limited options in the market</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>(40) Reliability of using renewable energy sources</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>(41) Returns are uncertain</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>(42) Others, please specify:</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

Part 4: Demographic Profile

43. Gender
   - Female
   - Male

44. Nationality
   - Singaporean
   - Singapore PR
   - Others

45. Age Group
   - 15–20
   - 21–29
   - 30–39
   - 40–49
   - 50–59
   - 60–69
   - Above 70

46. Qualifications
   - Primary level/Secondary level
   - Diploma
   - ITE
   - Degree
   - Masters/ PhD
   - Others
47. Occupation
- Managerial/Professional
- Executive
- Administrative/Clerical
- Sales Personnel
- Self-employed
- Retired
- Others: please specify: __________

48. Monthly Income
- < S$1000
- S$1001–S$3000
- S$3001–S$5000
- S$5001–S$7000
- > S$7000

References


Robinson, J. Property Valuation and Analysis Applied to Environmentally Sustainable Development. PRRES Eleventh Annual Conference, Melbourne, Australia, The University of Melbourne, 2005


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Liow Kim Hiang, National University of Singapore, Singapore 117566 or rstlkh@nus.edu.sg.

Neo Yen Shi, Sharon, National University of Singapore, Singapore 117566 or sharoneys@yahoo.com.sg.
Step-by-Step to Sustainable Property Investment Products

Authors
Christoph Rohde and Thomas Lützkendorf

Abstract
The interest in more sustainable properties has risen strongly in the recent past. There has been a shift from anecdotal evidence to well-documented case studies and comparative analyses indicating that sustainable building is highly profitable. The development and provisioning of sustainable property investment products and related consulting services offers a major opportunity for property professionals to increase financial returns, as well as their standing within society and the business world. Yet, this opportunity remains largely untapped due to various reasons. This paper sets out a strategy for the development, implementation, and widespread dissemination of sustainable investment products (sustainable property funds) for the property industry. This is seen as an additional and potentially powerful approach to stimulate demand for sustainable buildings.

Status Quo and the Way Ahead
The growing acceptance of the idea of corporate social responsibility by organizations, corporations, and other stakeholders across creates a demand for investment opportunities and products that adhere to the principles of sustainable development. This demand is further strengthened by the growing body of academic research evidencing that socially responsible investing (SRI) and corporate social responsibility (CSR) programs do not result in inferior financial performance compared to conventional investment and business practices (UNEP FI, 2007a). In this context, questions arise as to whether there are any sustainable property investment options available for institutional and private investors and whether these investment options are in line with the Principles for Responsible Investment ruled out by the UN Environment Programme Finance Initiative (PRI, 2006), as well as with the responsible investment guidelines formulated by the European Social Investment Forum (EUROSIF, 2007). Besides the products and services offered by a small number of leaders in the field of sustainable property investment and management (UNEP FI, 2007b), the answer to these questions is, especially for the situation in Germany: not yet. In the United States, a manageable number of sustainable property investments opportunities still exist. Regarding their sustainability verification, their investment strategy, and their investment objects, they are following very different approaches.

Planners, construction firms, and facility managers are able to design, realize, and operate sustainable buildings today. However, it apparently requires innovative approaches to increase the demand for buildings that are at the same time
energy-, resource-, and cost-efficient. Furthermore, they should be healthy, resistant to obsolescence, and offer higher aesthetic urban, technical, and functional qualities. Besides informing and influencing authorities and clients of direct property investments, the development of new products for indirect property investments is seen as an additional approach.

In 2007, about €20 billion was invested in 110 public SRI funds in Germany—with a growing trend. Across Europe, more than €1 trillion is invested in this sector. In the United States, assets under management in the SRI sector amount up to US$2.3 trillion. However, until now property represents an almost entirely neglected asset class within the SRI sector. At the moment, only a very limited number of property investment firms or funds make sustainability an explicit goal; in addition, existing SRI funds in the U.S., as well as across Europe do not offer investors screened and professionally managed property portfolios. If these funds exist, they are simply too hard to find. Given that property improves the risk-return ratio of any mixed-asset portfolio and that an optimal share of property (direct or indirect investment) lies between 10% and 20% (Sirmans and Worzala, 2003; Worzala and Sirmans, 2003), the SRI market as a whole is significantly under-allocated from the perspective of optimal asset allocation. Consequently, the untapped market potential for publicly offered sustainable property investment products is immense. The authors assume that this untapped market potential still exists due to an underdeveloped market for certified sustainable buildings, information and knowledge deficits among private and institutional investors, and a lack of proactive fund developers and initiators. In order to overcome this situation in Germany and for the development, implementation, and widespread dissemination of sustainable investment products for the property industry, the following steps are recommended:

- Description and analysis of relevant constellations of stakeholders;
- Description and analysis of the information and cash flows between these stakeholders;
- Analysis of the interests and motivations on the demand side;
- Estimation of the market potential for sustainable property investment products;
- Discussion of appropriate ‘designs’ and types of investment products;
- Development of suitable assessment, rating, and certification approaches;
- Strategy development for the development of property fund products; and
- Development of appropriate marketing and reporting instruments.

Additionally, first, internationally existing examples should be analyzed. Besides the evaluation of case studies, the following questions should be answered:

- How is the sustainability of buildings proven in the portfolio?
- On which building types do existing examples concentrate on?
- Do the examples concentrate on new buildings or do they also include measures in the building modifications?
Steps to Sustainable Property Investment Products

Stakeholders, Information, and Cash Flows

The stakeholders in financial markets in terms of cash flows and value creation regarding financial products can be—in principle—transferred to both, the processes of value creation regarding sustainable property investment products and the relevant groups of stakeholders in property and construction markets. A core element is the linkage between planners and the construction industry on the one hand (the ‘physical side’) and the financial and banking industry on the other hand (the ‘monetary side’). In value creation, the monetary side is responsible for granting the financial capital required for construction. Identifying incentive structures for allocating further investment capital from the financial market to the funding of sustainable buildings creates additional stimulation for the construction industry. A crucial point, however, is that this stimulation is clearly focused on property project that only adhere to the requirements for sustainable buildings (i.e., ‘additional investment capital for sustainable buildings only’). This can create an additional demand for sustainable buildings. The linkages between the physical and the monetary side are provided through financial intermediaries and service providers, such as product developers and suppliers, rating agencies, and institutional funds that collect capital.

Exhibit 1 provides a simplified description of relevant constellations of stakeholders. The starting point is the demand side (i.e., institutional and private investors interested in SRI products). Stakeholders on the demand side select an appropriate investment product (i.e., a sustainable property investment product) from one of the available suppliers/initiators in the market by relying on consulting service providers and rating results. The supplier/initiator either acts as a property developer or identifies and buys appropriate property assets in the marketplace.

Exhibit 1 shows a ‘product level’ (left side), as well as an ‘assessment/information level’ (right side). It is clear that both investors (e.g., pension funds) and suppliers/initiators can be subject to so-called sustainability reporting requirements. In this regard, labels for SRI products, as well as for sustainable buildings already exist. However, approaches for the certification of sustainable property investment products are yet missing. Nonetheless, such certification schemes would be the logical consequence if property assets are to play a role within the SRI market. Labels and certification schemes for sustainable property investment products would have to combine assessment criteria from the SRI sector with the sustainable building area. In addition, sustainability issues would have to be integrated into accounting and financial reporting requirements for property funds.

Interests and Motivations on the Demand Side

A major problem in property economic research is the unsatisfactory situation regarding data availability; concerning both, transaction data and information and
Exhibit 1 | Stakeholders for the Development of Sustainable Property Investment Products
market participants’ motivations and goals. Empirical surveys investigating the interests and motivations of selected groups of stakeholders regarding the issue of sustainable building and property investment are rare (Pivo, 2007). So it does not come as a surprise that the situation regarding sustainable property investments in Germany has not yet been subject to investigation and inquiry.

Therefore, a survey assisted by the authors, was carried out among German institutional investors in order to gain insight into their interests, motivations, and level of awareness and knowledge regarding SRI products in general, as well as sustainable property investment products in particular (Schäfer, Lützkendorf, Gromer, and Rohde, 2008).

During September and October of 2007, a total of 848 institutional investors were contacted within the scope of a survey; 116 (response rate: 13%) responded either by telephone interview or through a web-based questionnaire to the following topics: organization and financial structures; importance of property assets in general; importance of socially responsible investing; and the importance of sustainable property investment. Among the 116 participants, 59 were precautionary institutions (such as pension funds and life insurance companies), 34 were non-profit-organizations (including foundations, churches, and charities/aid organizations), and 13 were capital investment companies.

Importance of Property within the Portfolio. Capital investment companies usually diversify their portfolios. The survey showed that stocks, bonds, and property make up about one-third of the assets under management each. About 69% of assets under management have a planned holding period of at least five years. The remaining 31% are split between assets with a medium-term (18%) and a short-term (13%) holding period. The inclusion of different asset classes with different holding periods leads to a broad diversification of investment risk, which is typical for capital investment companies. The exact share of property within the surveyed companies’ portfolios is 34%.

Regarding precautionary institutions, the survey revealed a risk-averse and long-term oriented investment strategy. On average, bonds have a 60% share of all assets under management. In the case of pension funds and life insurance companies, the share of bonds is even higher: 70% due to legal requirements. About three-quarters of all assets have a planned holding period of more than five years. The share of property within precautionary institutions’ portfolios is 13%.

Within the non-profit-organizations, the survey showed that they also have a longer-term oriented investment strategy. The share of property within their portfolios is 16%.

Level of Knowledge Regarding SRI. The majority of surveyed investors judged their level of knowledge and awareness regarding socially responsible investments as ‘very good’ or ‘good.’ A particularly high level of knowledge was reported among the capital investment companies of which 45% judged their level of knowledge as ‘very good’ (Exhibit 2). The following relationships have been identified by making use of correlation analysis: (1) The level of knowledge regarding SRI products increases if investors already have SRI assets within their
Exhibit 2 | Investors’ Level of Knowledge Regarding SRI and Sustainable Property Investment Issues

**Socially Responsible Investment (SRI)**

<table>
<thead>
<tr>
<th>Category</th>
<th>Very good</th>
<th>Good</th>
<th>Poor</th>
<th>Very poor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>16</td>
<td>63</td>
<td>19</td>
<td>2</td>
</tr>
<tr>
<td>Non-profit-organisations</td>
<td>12</td>
<td>73</td>
<td>12</td>
<td>3</td>
</tr>
<tr>
<td>Precautionary institutions</td>
<td>7</td>
<td>68</td>
<td>24</td>
<td>2</td>
</tr>
<tr>
<td>Capital investment companies</td>
<td>45</td>
<td>36</td>
<td>18</td>
<td></td>
</tr>
</tbody>
</table>

**Sustainable Property Investment (SPI)**

<table>
<thead>
<tr>
<th>Category</th>
<th>Very good</th>
<th>Good</th>
<th>Poor</th>
<th>Very poor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>10</td>
<td>26</td>
<td>45</td>
<td>18</td>
</tr>
<tr>
<td>Non-profit-organisations</td>
<td>18</td>
<td>70</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Precautionary institutions</td>
<td>2</td>
<td>39</td>
<td>39</td>
<td>20</td>
</tr>
<tr>
<td>Capital investment companies</td>
<td>45</td>
<td>14</td>
<td>23</td>
<td>18</td>
</tr>
</tbody>
</table>
portfolios; (2) the higher the share of SRI assets within the portfolio, the higher the level of knowledge; however, this relationship does not apply to the knowledge regarding sustainable property investments; and (3) the higher the share of property assets within the portfolio, the higher the knowledge regarding sustainable property investments.

Given that the overall share of SRI assets within the surveyed investors’ portfolios is rather low (capital investment companies: 4%, precautionary institutions: 5%, and non-profit-organizations: 13%), the high level of knowledge reported among investors is, indeed, remarkable.

Importance of Sustainable Property Investments. About 50% of the surveyed investors showed a moderate interest in sustainability-oriented open- or closed-end property funds. Among the surveyed investors, the group of capital investment companies showed the largest interest. The remaining half of the surveyed investors stated that sustainable property investment funds are not on their ‘radar’ or that they are not considering this type of investment respectively. Further survey results are as follows:

- The different groups of institutional investors have different perceptions on what product forms would be of interest for sustainable property investment. The preferred forms are direct property investment and closed-end property funds. Capitals investment companies also showed an interest in property stock corporations and real estate investment trusts (REITs). Non-profit-organizations show a tendency to prefer open-end property funds.
- The majority of surveyed investors expect that the rates of return from sustainable property investments are comparable to those of conventional property investments.
- In addition to sustainability certificates for the property assets in question, almost all investors argued that continuous sustainability reporting of fund companies and/or initiators would be an important characteristic of a sustainable property investment product. In this context, it is interesting to note that 31% of the surveyed investors are already subject to sustainability reporting requirements; this means that if those investors would like to engage in sustainable property investments, the availability of sustainability performance information would be a precondition for such engagement.
- Compared to the level of knowledge regarding SRI products and issues in general, the level of knowledge regarding sustainable property investments is judged considerably lower (see Exhibit 2).

In summary, there is moderate interest among institutional investors regarding sustainable property investment options in Germany. Clearly, this interest is greatest among those investors that are already engaged in SRI and that already have larger shares of property assets within their portfolios. However, these investors must be intensively advised and actively provided with detailed information on new SRI options and products in the property sector. This requires the development of appropriate marketing and reporting instruments.
Market Potential for Sustainable Property Investment Products in Germany

The untapped market potential for sustainable property investment products can be estimated by using two different approaches: (1) estimation based on the share of SRI in the total investment universe; and (2) estimation based on optimal asset allocation considerations within the SRI market.

At the moment the share of SRI in total assets under professional management in Germany is roughly 1% (see also Schäfer, 2005). In 2006, the total volume of property assets under professional management of institutional investors in Germany has been on the order of €394.8 billion. Consequently, it can be argued that the market potential for sustainable property investment products is about 1% of the volume of property assets of institutional investors; this corresponds with a market potential of about €4 billion in Germany.

The second approach for calculating the market potential is based on the consideration that from the viewpoint of optimal asset allocation the share of property within a mixed-asset portfolio is somewhere between 10% and 20% (Sirmans and Worzala, 2003; Worzala and Sirmans, 2003). In 2007, about €20 billion was invested in 110 public SRI funds in Germany (Imug, 2007). As a result, the market potential for sustainable properties within the public SRI sector is between €2 and 4 billion.

The figure of €4 billion market potential translates into a floor area of about 3 million square meters of office space; this estimate is based on an average price for gross floor area of about 1,400 €/m² for office buildings of average quality (BKI, 2007). For reasons of comparison, the following data are worth mentioning: the market for office space in Frankfurt currently has a size of about 12 million square meters; in Germany, the overall volume for construction works was ca. €237 billion by 2004 and about €5 billion of this sum have been spent for the construction of new office buildings.

Existing Market and Discussion of Appropriate Types of Investment Products

Although a negligible number of sustainability-oriented developments (closed-end property funds with very small volume only) could have been identified within the scope of the research project, the market for sustainable property investment products is virtually non-existent in Germany. Regarding the market in the United States, the Responsible Property Investment Center (see: http://www.responsibleproperty.net) provides an overview on existing products and firms. Additional outstanding examples can be found in a recent publication of the UNEP FI’s Property Working Group (UNEP FI, 2007b). For the German property market, the following types of investment products are recommend (given that the basic framework for the development and establishment of REITs in Germany is not yet fully sorted, the development of a ‘green’ REIT appears unrealistic at the moment).

Development of Smaller Closed-End Property Funds for Private Investors. An appropriate strategy for new fund initiators is seen in the development of closed-end funds. These can comprise one or more property assets that have been certified
with the national sustainable building certification scheme. As this certification scheme is still under development, the idea of developing and marketing ‘hot-topic-funds’ appears attractive: the possibilities include ‘climate-protection property funds’ and ‘energy-efficiency property funds’ comprised of net-zero-emission buildings. The typical fund volume for closed-end property funds in Germany is between €5 and 250 million; the duration usually is between 10 and 20 years.

**Development of Special Open-End Property Funds for Institutional Investors.** Due to distinct reporting requirements towards investors and the possibilities for active portfolio management, the investment type of special open-end property funds particularly lends itself for the development of sustainable property investment products. With this type of investment, the number of investors, duration, and volume is unlimited; typically the volume is at least €250 million. Given the lack of comparability between different sustainability assessment and certification schemes, it is recommended that properties be selected from regions within the coverage of one certification system only (questions concerning comparability and acceptance of different certification systems are currently intensively discussed in Europe).

**Investment Strategies**

Sometimes it is argued that one problem for the development and establishment of sustainable property investment products lies in the difficulty of identifying an appropriate number of property assets that would qualify for such treatment. However, the following investment strategies can be applied.

1. **Project Development.** If there is a shortage of sustainable buildings in the marketplace, fund developers/initiators can act as a project developer and guarantee the way that the property assets are designed, constructed, and subsequently managed according to the requirements of sustainable building.

2. **Improving Sustainability Performance of the Existing Stock.** Investments into the existing building stock can extend or restart the lifecycle of buildings and improve their environmental and social performance. In Europe, carrying out extensive revitalization works is partly regarded as superior to building new.

3. **Fostering More Sustainable Communities and Cities.** This strategy comprises investments in community projects such as affordable housing and urban revitalization in order to foster a more sustainability society.

Pursuing the aforementioned strategies leads to additional demand for more sustainable planning and construction works. An additional investment strategy without this effect is:

1. **Portfolio Optimization.** Comprises the purchase and/or disposal of property assets (e.g., for portfolio selection or portfolio optimization purposes) that meet/do not meet preset minimum environmental and social performance requirements. It also includes active portfolio
management to develop the existing stock towards a more sustainable asset. Almost certainly the quality of the applied management practice will become—besides the quality of the buildings within the portfolio—a criteria for assessing and certifying sustainable property investment products.

**Reporting: Requirements & Possibilities**

An essential feature of a sustainable property investment product is the availability and regular updating of a sustainability report. This is because many institutional investors (in particular, pension funds) are already subject to sustainability reporting requirements. For example, in their statement of investment principles, trustees in the UK must give (according to the Occupational Pension Schemes Regulations) information about (a) the extent (if at all) to which social, environmental or ethical considerations are taken into account in the selection, retention, and realization of investments, and (b) their policy (if any) in relation to the exercise of the rights (including voting rights) attaching to investments. Similar reporting requirements apply in Germany.

Sustainability reporting is a critical area as there is a general 'ethical, social and environmental reporting-performance portrayal gap.' This gap has been identified by Adams (2004) and by Hummels and Timmer (2004). It is argued that current ethical and social reporting practice does not provide investors and other stakeholders with appropriate information to assess the material consequences of company activities and behavior in socially or politically sensitive areas. “Until reports that compare sustainability performance are freely available, as ubiquitous as financial reports, we will remain lost in the quagmire of intriguing anecdotes, unable to determine who performs better [...]. In a world with comparable reports, sustainability reporting can fulfill its true potential: providing concise, transparent information that clearly reflects the reality of environmental and social issues, allows for benchmarking, highlights long-term risk and opportunities, and contributes to improved levels of public and investor confidence. [...] Otherwise sustainability reporting will remain an exercise in creative writing,” (Rogers, 2005, p. 39).

In fact, the reporting requirements for an innovative product with which the market is unfamiliar with are even harder for already established investment products. In this regard, it is important to realize that acceptance of and trust in new property investment products will only be achieved by striving for the highest degree of transparency possible and, in doing so, not only delivering attractive products to investors but also the information necessary to meet investors’ reporting requirements. Thus, a sustainability report for sustainable property investment products should, at least, contain information on the following issues:

- Impacts on the environment through emissions; expressed through the CO₂-equivalent;
- Energetic quality/energy efficiency;
- Amount of drinking and waste water during occupation;
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Waste volume;
User satisfaction; based on post-occupancy evaluations;
Existence of local risks through flooding, extreme weather, large-scale
catastrophes in adjunct industries, etc.; and
Extent and manner of regular inspection and maintenance works.

It has to be note that this information refers to the property assets only; more
general reporting requirements for the fund companies/initiators are laid down in
property-related issues should be expressed (1) in absolute values, (2) as a trend,
(3) in comparison to selected benchmarks, and (4) by indicating appropriate
reference values (such as m², m³, number of occupants/employees, etc.). The
annual sustainability report of the UK-based fund company Hermes serves as an
outstanding example in this regard (Hermes, 2007).

Analysis of Existing Sustainable Property Investment Opportunities

The authors analyzed a number of existing international samples. Exhibit 3 shows
only an extract of a larger table, which was developed with the support of the
Responsible Property Investment Center (RPI List, 2009). Exhibit 3 shows all of
the companies that have a trust in a certification for sustainable buildings.

The results of an analysis of Exhibit 3 can be summarized as follows:

- A standardized method for the evaluation of the sustainability of complete
  portfolios of buildings, as well as the quality of the management of funds
  has not developed yet.
- The predominant assessment system used is LEED but BREEAM and
  Casbee are also featured.
- A range of different types of properties are invested in. Housing
  construction is an area of key focus.
- The companies investigated, responsible property investment focuses on
  “Urban Revitalization” and “Green Building and Maintenance.”

With regard to a standardization of the evaluation of buildings, it is recommended
to actively pursue the developments in the international and European
standardization (ISO TC 59 sc 17 and CEN TC 350), as well as the activities of
the SB Alliance.

Conclusion & Outlook

The interest in socially responsible investment and corporate governance issues
has risen dramatically in recent years; and so has the availability of SRI products.
However, this trend has not yet been matched with corresponding developments
within the property industry. This assertion applies to both the demand side
(investors) and the supply side (fund developers and initiators). As a consequence,
the current challenge lies in aligning the goals and motivations of socially
Step-by-Step to Sustainable Property Investment Products

Responsible investing with efforts to increase the share of property assets within investment portfolios. This will create a demand for sustainable property investment products and thus strengthen the demand for sustainable buildings in general. Meeting with this challenge requires (1) increasing the awareness level of such investment products through systematic marketing; (2) delivering more scientifically robust evidence regarding the economic advantageousness of sustainable property investments; and (3) purposefully serving investors’ existing sustainability reporting requirements.

Research carried out on the situation in Germany revealed that institutional investors that are already engaged in the SRI market represent a most promising target group for sustainable property investment products. But even though there is market demand and the untapped market potential can be estimated, most existing property fund providers/initiators are reluctant to develop appropriate investment products. As a result, there are opportunities for both fund initiators aiming to enter the property sector, as well as for established property fund initiators to successfully extend their product range. These opportunities are major and they have to be taken advantage of.

References


BKI. Baukosten. Published by Baukosteninformationszentrum Dt. Architektenkammern, 2007.


The authors thank the German Federal Ministry of Transport, Building & Urban Affairs as well as the Federal Office for Building & Regional Planning for funding the research project. The authors thank also Prof. Schäfer (Universität Stuttgart, Germany), Mr. Gromer (Universität Stuttgart, Germany), Dr. Neligan (IW Consult, Germany), Mr. Friesenbichler (Friesenbichler Consulting, Austria), Dr. Lorenz (AAAcon Assetmanagement GmbH), and Dr. Scholand (WestLB AG) for their cooperation within the scope of the research project and in the preparation of this paper.

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Industry Insight

The Green Building Impact Report 2008

Rob Watson
Executive Editor, GreenerBuildings.com

This is the executive summary of the first annual Green Building Impact Report, an in-depth look at how LEED-certified and built-to-LEED buildings are affecting land, water, energy, materials, and employee productivity. The full report is available for free download from http://www.GreenerBuildings.com/BuildingsImpact08.

Green buildings, as represented by the U.S. Green Building Council’s Leadership in Energy and Environmental Design (LEED) Green Building Rating System, are an undisputed market success. In the eight years since the launch of LEED, green has firmly established itself among mainstream leaders in the building sector, representing tens of billions of dollars in value put in place and material sales.

LEED was created to reduce the environmental impacts of the built environment, but so far no comprehensive evaluation of the overall impact of LEED has been conducted until now.

This Green Building Impact Report is the first-ever integrated assessment of the land, water, energy, material, and indoor environmental impacts of the LEED for New Construction (LEED NC), Core & Shell (LEED CS), and Existing Building Operations and Maintenance (LEED EBOM) standards. (We did not include Commercial Interiors due to concerns about double counting, which we hope to have resolved before the release of the 2009 report.)

In this report, we attempt to answer whether commercial green buildings live up to their name—that is, that they are engendering demonstrable environmental improvement.

Our findings are both encouraging and cautionary. Overall, we believe that LEED buildings are making a major impact in reducing the overall environmental footprint of individual structures. However, significant additional progress is possible and indeed necessary on both the individual building level and in terms of market penetration if LEED is to contribute in a meaningful way to reducing the environmental footprint of buildings in the U.S. and worldwide.
**Market Summary**

To date, our calculations indicate that LEED Certified projects represent more than 6% of new commercial construction, but there has been an astronomical ramp-up in the past year of new project registrations, with new construction sector penetrations approaching 40%. On average, it takes approximately two years from Registration to Certification, with an attrition rate of 25% to 30%.

LEED NC continues to lead the way, with Certified projects representing almost 6% of new construction starts and new registrations representing approximately 30% of the market.

Registrations of Core & Shell projects have ramped up considerably in the past two years, now approaching 12% of new commercial starts, though they lag significantly behind LEED NC in submarket share and absolute terms. Certified LEED CS projects represent only about 0.5% of new construction starts.

Although introduced three years later, the floor area of new registrations in LEED EBOM has nearly caught up to that of LEED NC, though as a percentage of the annual addressable market, certifications remain insignificant.

**Environmental Impacts**

Non-residential construction, the focus of our report, represents about 40% of the environmental burden of buildings. The environmental benefits of LEED are multifaceted and hard to generalize, so we present the topline findings here and in more detail in the body of the report.

- **Land Use.** We estimate that between efficient location and the myriad alternative transportation options supported by LEED, nearly 400 million vehicle miles traveled have been avoided by the occupants of LEED buildings. This will grow to more than 4 billion vehicle miles by 2020.

- **Water.** We expect water savings from LEED commercial buildings to grow to more than 7% of all non-residential water use by 2020. The equivalent of 2008 LEED water savings would fill enough 32-ounce bottles to circle the Earth 300 times.

- **Energy.** LEED saves energy on many different levels, including energy related to operations, commuting, water treatment, and the lower energy embodied within materials. In operational energy terms, LEED buildings consume approximately 25% less on average than comparable commercial buildings. By 2020, these energy savings amount to more than 1.3 million tons of coal equivalent each year, representing approximately 78 million tons of carbon dioxide (CO₂) avoided emissions.

- **Materials and Resources.** LEED has helped spur an entire industry in green building materials. Certified projects to date have specified a total
of more than $10 billion of green materials, which could grow to a cumulative amount exceeding $100 billion by 2020.

- **Indoor Environmental Quality.** We believe that indoor environmental quality is the most important contributor to the productivity attributes of LEED. We conservatively calculated that companies with employees working in LEED buildings realized annual productivity gains exceeding $170 million resulting from improved indoor environmental quality, a number that will grow to nearly $2 billion of annual productivity improvements by 2020.

Details on the methodological approach behind this study can be found in the Appendix of the full report, starting on page 18.

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**What’s Next?**

Our 2009 Green Building Impact Report will include the impact of LEED buildings overseas as the growth of LEED’s new construction standards shifts beyond the U.S. market, with fast-growing development in emerging economies.

Several new non-residential LEED standards have recently been released, such as those for schools and retail establishments, and the 2009 report will evaluate these impacts as well. It will also include the eco-footprint of residential construction, the built environment’s largest source of environmental impacts.
Personal Perspectives on LEED
Management and Investment

Jason Tuomey
CoStar Group

Jason Tuomey, JT below, is a field researcher for the CoStar Group. In May of 2009, he conducted interviews that provide some in-the-trench perspectives on the sustainability trends in real estate. While too small a sample to become a scientific study, they provide insights into the thinking of those trying to implement the topics of discussion within this journal. As such, we provide some excerpts from three of these conversations.

Amanda Timmons, a LEED Accredited Professional, Founder of Ampajen Solutions, a LEED certification consulting and education company, and associate at Master Klean, a Denver based nightly janitorial service pioneering green cleaning for that market.

JT: In the current economic downturn, has the green wave changed its momentum away from the construction of new buildings and toward retrofitting existing buildings?

AT: The focus has been moving more toward existing buildings. New commercial building construction has almost ground to a halt. In my opinion, existing buildings should have been the focus for LEED (Leadership in Energy and Environmental Design) from the start. There are so many existing buildings, that newly constructed buildings could never be enough to turn the tide of climate change and energy usage.

Editors Note: On average, over the long run we build about 2% new office stock each year, so unless we observe retrofitting of existing buildings, now rapidly increasing, it would take several decades to truly have much of an impact on energy conservation and provide healthier buildings.

AT: With regard to the current state of the economy, some property managers have decided to take steps they can afford and establish practices that position them to obtain LEED certification when the economy picks up again in 2010 or 2011. The managers and owners that can afford to certify their buildings now are quietly pursuing it. This would give them an advantage over other property managers who delay making these changes, as they compete for tenants who prefer (or must) have a LEED-certified building to occupy.

JT: I noticed in some green projects that many of the materials used were obtained from international sources such as China or Italy. Do you think more value should be placed on using local or regional materials in an effort to reduce the carbon emissions created by transporting these materials?
AT: I think it would be nice if that were possible, but for example, here in Colorado we have natural resources, but almost no manufacturing. So it is a kind of “chicken or the egg” scenario. If there were more demand, perhaps supply would come online. But what is interesting with regard to LEED Version 3, the materials section has lost points. So it is becoming less important as far as the existing building rating system goes.

JT: Why is that the case, in your opinion?

AT: I think they are trying to tackle the issue in a different way. In the former point system known as EBOM (Existing Buildings Operations & Maintenance), 4 points were available for sustainable sites and alternative transportation, if 10, 25, 50, or 75% of the building occupants used some form of alternative transportation to commute to work. In LEED Version 3, alternative transportation can earn a building 3 to 15 points, making this the second largest area of focus for certification, with the first being a building’s ENERGY STAR score. So, rather than considering the materials selected for the renovation of an existing building, the USGBC (United States Green Building Council) is now more focused on the method by which people commute to the building. When the USGBC created Version 3, the focus (at least for existing buildings) was on carbon emissions. Evidently, their research found that material transportation to existing buildings created less carbon emissions than daily commuting.

JT: Should there be more tax incentives for retrofitting existing buildings for energy efficiency? Do you think this is likely as a result of initiatives championed by the Obama administration?

AT: Everyone is asking about that. Every single property manager seeking LEED certification has asked if there are any tax advantages in performing the renovation. Property taxes and energy use are the two largest operating expenses for any building. Property tax incentives would have a great impact on “green” renovations, and I believe would help to curb the effects of this economic slowdown.

JT: Do you see any use of carbon credits in larger developments or portfolios?

AT: I have not seen a lot of that right now. What LEED is still focusing on is renewable energy—either buying renewable energy offsite or putting something onsite. They do have a credit for something called “emissions reduction reporting.” That is getting property managers of buildings to share how much carbon they have reduced by having a good energy performance score (through ENERGY STAR). This may help to build the market for carbon credits by having people report their reductions. Less efficient properties could then buy credits saved by those buildings that are more energy efficient.

Editors Note: Third parties that pool credits may be a way for small players to participate in the global market.

JT: What is not measured by the current LEED standards that you think should be, and that is important to tenants?
AT: When LEED for existing buildings first came out, indoor environmental quality had the most points. That is basically anything you can do to enhance tenant productivity. Originally there were 23 points in that credit category. That was reduced for Existing Buildings Operation and Maintenance, and reduced again for LEED 3.0 2009.

What tenants want to see, according to property managers, are LEED buildings that have a healthy indoor environment and buildings that have reduced operating expenses. What is good for them is the reduced liability and health costs. It is interesting that indoor environmental quality is becoming less and less important in the current rating system. Green cleaning was cut by approximately a third. Things like tenant control of the systems has been reduced. It seems the focus on what is good for tenant productivity is becoming less important. They (USGBC) are looking at the building’s impact on the environment, instead of what will make people more productive.

JT: Do you see any conflicts between state and local building codes and the green movement in buildings?

AT: I think things are moving in the other direction. State and local codes seem to be aligning with LEED standards. LEED was never written to become code. I had a class in the city of Sacramento, and they already were mandating that any new construction be certified LEED Silver or better. The movement seems to be that local government is taking off with the green movement and delegating a great deal of power with the USGBC. That pendulum in certain cases seems to swing too far, with the adoption of some rules that are difficult or cost prohibitive for businesses.

JT: You mentioned that companies have been reluctant to perform a waste stream audit. What is the incentive in auditing the waste stream? Is there not enough reward in the grading system to make it worth doing?

AT: The waste stream audit is only worth one point. All that we are trying to do is quantify how well the tenants are using the building’s recycling program. The reason for doing this is to be able to go back to the tenant population and inform them of the amount of Styrofoam they use, for example, and discuss possible substitutes, such as glasses and ceramic plates. Or perhaps there is a lot of paper that is not making it into the recycle container for some reason. We then look at how to position things differently and consider options to increase the amount recycled.

JT: When comparing the current LEED Accredited Professional and the new Green Associate accreditation, which is more intensive or more valuable?

AT: They used to allow anyone to become an Accredited Professional. Now there are over 100,000 Accredited Professionals in the United States. I am not sure exactly where the idea came from, but they wanted to distinguish between somebody like myself who works for a janitorial company, and wanted to focus on just that aspect, versus someone who could be a consultant, who could actually take someone or a company through this process. The USGBC has decided to
have a three-tiered education base now. So if you have not worked on a LEED project, in which you actually work toward getting a building certified, the only thing you can become now is a LEED Green Associate. That is based upon an overall test covering sustainability, construction, operations and maintenance, and health. Although it is only the first level of education, it covers a huge scope of information.

The second level is the LEED Accredited Professional. That level, you can only now achieve if you have worked on a project team, and is focused on one rating system in particular (operations and maintenance, building construction, or interior construction).

The third tier, called a LEED AP Fellow, has not yet been developed.

**JT:** What are some new technologies and strategies affecting water consumption, and are they cost effective?

**AT:** Water consumption has increased in importance with regard to the LEED rating system. It used to only be worth a maximum of 5 points. Now it has increased to 14, at least on the existing building side. What we have seen here locally is a huge amount of increases in rebates from Denver Water. The rebates are for new toilets and urinals, which are 1.6 and 1 gallon per flush (respectively) installed. There was a big drive toward waterless urinals, but word of mouth seems to have dissuaded some people from putting those in. There have been complaints of odors. Some people love them, some hate them. But skepticism prevails in the market for that product. We have heard rave reviews about new urinals that only use a cup or a pint of water per flush, because it still dilutes urine enough to dispel odors.

A lot of people have been looking at simply retrofitting toilets, especially with the slow economy. There are retrofit kits that, for example, bring the old 3.5-gallon toilet down to 2.4 gallons per flush. The building engineering teams must then work to optimize pressure to make sure everything gets flushed down in one flush instead of multiple attempts. Incentives and rebates have been critical in Denver to generate the high number of retrofits of toilets and urinals.

Interview with Kelly Cook of Equity Office, an affiliate of the Blackstone Group, LEED Accredited Professional, property manager of approximately 812,000 square feet of office space in seven buildings in Centennial, Colorado.

**JT:** My assumption is, with the economic downturn, most commercial construction has ceased unless it is too far along to stop, it is a government building, or the rare case of a business expanding. Does this turn the focus of the LEED/“Green”/sustainable movement away from new structures, and toward sustainable building operations, and/or retrofitting existing buildings with energy-efficient features?

**KC:** I think that the focus has shifted a bit, but there will still be an interest in green construction when development picks back up. The movement toward
sustainability is here for the duration. But certainly with development slowing down, and construction coming to a halt, my focus is certainly on operations, and looking for ways to incorporate green incentives and programs into day-to-day operations. The big thing for us though is that with things being so tight, and with tenants not as readily available to fill vacant space, we are being pressured to cut costs. We find ourselves in between a rock and a hard place, so to speak. What we are doing is, rather than considering full-blown retrofits, is looking at ways as we are spending our budgeted dollars, to incorporate green practices that are not too much of a hit to our budget. We are finding a lot of things that we can do that are either low cost or no cost and incorporating these into our day-to-day operations. This way, at some point down the road, we are already half way there, should we decide to pursue a LEED certification.

JT: It sounds like a lot of property owners and managers are positioning themselves for when the market does improve, to be able to obtain LEED certification.

KC: Exactly. We have a written sustainability program in place. Green cleaning is an example where you can use cleaning products and equipment that do not cost any more money over time. We select vendors that have those programs in place, so that they can easily put them into practice in your building. This puts pressure on the vendors that we are selecting. I am getting a lot of calls from vendors asking what they can do to be on a preferred bid list. I then ask them to show what they know about LEED and green practices, and how they can help me incorporate those practices.

JT: Do you find that the chemicals used in green cleaning work as efficiently and cost effectively as the products used previously?

KC: For the most part they do. There are certain circumstances when you would have to use harsher chemicals, though typically we are able to find a green solution to clean the buildings just as well.

JT: Have you learned any lessons from trying products or practices that did or did not work as intended?

KC: Recently, I was talking with a carpet supplier over the course of 6 to 9 months in which we had discussions about what to do with all the carpet we pull out when changing tenants. When we began the discussion, it was difficult to find anyone to recycle the carpet. Now the vendor has found a source for recycling virtually all the carpet that previously would have gone straight to a landfill. I think as one continues to press the vendors and suppliers to find green alternatives, they get more creative and come up with options that had not been available or that they were simply not aware of.

JT: Do you put recycling goals into lease provisions in any way?

KC: We do track recycling. We get quarterly reports from our trash company that shows percentages that we are either trashing or recycling. This does not tell us exactly what is going in the recycling stream or the trash stream. That would be
the next step to take. We are tracking and sharing the information with our tenants
to show how much of what they discard is actually getting recycled, versus getting
thrown in the trash. We have set a goal of recycling 70% of what gets thrown
out. We are able to compare actual results with that goal over time.

We do not put green provisions in leases, at least not yet. We have found that
initially a lot of our tenants are very resistant. We found that with just a little bit
of (tenant) education, they have really jumped on the bandwagon with us. Now
that we are getting more buy in, and there will probably be more focus on the
lease language, and from an ownership perspective, more of a requirement rather
than a choice. We are looking at general janitorial things, like day cleaning, which
saves a lot of electricity. You have to get the tenant buy in for now, because the
leases do not yet require these measures. We are definitely looking at lease
language changes as we are finding things working or not working.

JT: How would you mandate green practices? Would you give them a minimum
benchmark as soon as you can easily quantify recycling with information from
your waste and recycling company, for example?

KC: We would have to put something in place that we have already demonstrated
was readily achievable.

JT: Do you notice any difference in morale or productivity among tenants when
they know they are in a green building?

KC: I have noticed that there is usually a group of individuals, especially in larger
companies, who are really excited about this. When they know you are
implementing green practices, they ask if they can do this or that also. They run
with it and really charge up the rest of the employee base. There is also a block
of people who just do not want to be bothered.

JT: Do you find that most companies have a designated individual charged with
finding green things they can do?

KC: Yes. They typically have small task forces looking for ways participate in
the whole green movement.

JT: Does your company have a green mission statement?

KC: We have a sustainability program. It takes elements from the USGBC LEED
program, which we can easily implement in day-to-day operations. Some
examples are the green cleaning program, our procurement practices for tenant
improvements, and indoor air quality. This gives a guideline to work toward in
our daily operations of a property.

JT: You mentioned procurement. Do you mean a vetting of your vendors?

KC: Yes. For example, when we are looking for office supplies or furniture, we
buy recycled paper and furniture made from recycled content or renewable energy
sources. We have a whole list of things we look for first, which do not impact
our budget significantly.
JT: Do you see any of these practices translating into increased rent?

KC: More and more we see lease proposals from prospective tenants containing a question as to whether the building is LEED certified or if there is a LEED Accredited Professional on staff, or what kind of green programs are in place, such as a recycling program. We are able to explain what we are doing as we respond to those questions. Even if a building is not LEED certified, there are tenants out there looking for companies that are interested in green building operations. They put some weight into that aspect in their overall decision about where they are going to locate.

JT: What are some of the techniques and strategies you employ with regard to water consumption?

KC: Our buildings are fairly new, so were fitted with low-flow toilets in all of the buildings. We did switch out some of the urinals to a lower water consumption model. We are not monitoring any of the inside plumbing fixtures at this point. We have installed sensors so that when it rains, the landscaping sprinklers do not come on.

JT: What about electrical and lighting fixtures?

KC: We have a campus here with a variety of old and new buildings. We converted one of our older buildings to lower wattage fluorescent bulbs. The newer ones have energy-efficient systems already. We have automation systems in all the buildings. We have economizers for the rooftop heating and cooling units, which utilizes outdoor air as much as possible during the year, to take advantage of free cooling. A lot of our buildings have occupancy sensors, so the lights are off unless someone is using the space. Our computerized automation systems allow us to run reports so that you can determine trends in usage. This way you can decide to have rooftop units to come on at optimum times of the day or the week. This allows you also to address vacant space with a wider range of heating and cooling, so that it hardly is used at all, since comfort is not an issue. You can have lighting set up automatically on these systems as well so that you determine on and off times.

JT: When you have retrofitted older buildings with more energy-efficient lighting ballasts and bulbs, has it been cost effective, and if so, how long did it take to recoup the costs?

KC: It has definitely been cost effective. There are also rebates from Excel Energy, our local provider. I would say that a two-to-three year payback has been the calculation for us. We are looking for less than a two-year payback when considering a retrofit. Typically we are not too far off of that.

JT: So solar would be out of the question for now?

KC: We always keep an eye on things like that, but for our particular application, it would be difficult.

JT: I know some of your tenants encourage carpooling, but what can you as a property manager do to encourage alternative transportation?
KC: It really is up to the employer or tenant to encourage employees to use alternative transportation. We have no control over that. The nice thing for us is that we are located right on a light rail stop, and have multiple bus stops on our property. This really makes it easy for employers to encourage their people to utilize those transportation methods. Purely by our location, we qualify for LEED points. We find our location at the top of the list for employers who value alternative transportation.

JT: Do you have any general lessons or strategies with regard to going green in building operations?

KC: I would say that this whole movement to “go green” is not just a fad. It is something people are really interested in. It may have been pushed to the back burner for now due the economic slowdown. But when things hopefully get stronger, we will see this charge right back to the forefront with a push for more and more companies to do what they can. There is a lot of legislation getting kicked around, so we will probably see more things become law in the future.

Interview with Shawn Murphy, LEED Accredited Professional, Vice President & General Manager, Gubb & Ellis Management Services (GEMS), Denver, Colorado.

JT: Shawn, could you tell me about yourself, how much property you manage, and who your clients are?

SM: I am the vice president and general manager for Grubb & Ellis management services here in Denver. I oversee a portfolio of roughly 2.4 million square feet, which encompasses seven buildings in Colorado and Nebraska.

JT: When does common sense conflict with the green movement?

SM: Let’s say you have a large campus environment with 80,000 square feet of roof space. It is sitting there, open, covering an atrium. That might be a perfect place to do some type of green roof project. I really do think it comes down to each individual building. Implementing some of these projects is costly. The capital markets crashed two years ago, when LEED was the hot topic and your peers were discussing getting their building LEED certified within the next couple of years, whether or not they fully understood what that meant. Now many ownership structures are left strapped for cash, and to do these large improvements for the purpose of LEED certification is not in the cards at this point.

Grubb & Ellis has just launched our sustainability program or plan, making a large push nationally to look for low cost or no cost green strategies to implement, versus the LEED certification projects requiring large capital outlays. These are basic building operation considerations, such as energy management, start and stop times on all equipment, lighting schedules, automation of lighting, and for tenants occupying larger equipment spaces in buildings, the sub metering of all utilities. When looking at the low cost or no cost measures, consider a recycling program and waste stream audit, with eventual LEED certification in mind. In a
building in downtown Denver, we implemented a recycling program for almost 6,000 building occupants. We removed all garbage cans and replaced them with recycling cans, gave them extensive education on what can be recycled on a daily basis. With items they cannot recycle, they must walk to a common area such as a kitchen or break room to discard other items. There has been a large and painful learning curve with that program. But now the tenants are starting to see the results we publish on a quarterly basis.

JT: How exactly did you disseminate this information to the tenants in a way that you knew it was absorbed and understood?

SM: This was an extensive project. Over a six-month period, we began meeting with our major tenant representatives or contacts. We met with them on a floor-by-floor basis to tell them what we were going to do and the timeline of the phased approach that we were to roll out. Then we followed up so that when we did the roll out, every employee got a new trash can, a letter on their desk with a graphic that described everything they could recycle through the program. In our lobby area, we set up a 40-foot table of everything they could recycle, and a 3-foot table with the items they could not recycle. It is a single-stream recycling program.

You are not only educating the tenants, but also the janitors on how to dispose of materials and recycle them. Through this program, we went from recycling zero as a building, to 55% of our waste stream right now.

JT: Do you foresee or have you used any lease provisions that encourage or mandate these or other green practices?

SM: No we have not. We have not included anything with regard to green practices in our leases. But I expect that a number of companies will probably be including that in their lease structure soon.

JT: Have you used green cleaning services?

SM: Absolutely yes. I think that cleaning today, other than using day cleaning or using battery gel pack vacuums, can cause you to run into either cost constraints, or interruption of tenant operations. Everything else, such as green seal cleaning products, are now available at no increased cost over non-green products used previously.

JT: Do you find that these products work just as well?

SM: Yes.

JT: Do you find a lot of companies have a designated person on staff who is charged with finding ways to implement green strategies?

SM: Yes, the majority of tenants here in downtown Denver have a green, or sustainability team.

JT: What do you think the government should be doing with regard to green buildings, and where might they be over reaching?
SM: First, you cannot mandate this. With regard to the bailout program released this past fall, there are a lot of dollars appropriated for energy retrofits. Also, there are rebates the utility companies are offering. But is this enough to surmount the financial hurdle and be able to make the right decision? I am still not seeing anyone taking advantage of these programs. There are a lot of ownership groups who want a twelve-month payback on an energy retrofit. The thing we need to insure as building owners and commercial real estate brokers is that these regulations do not get mandated.
Journal of Real Estate Research

Winner of the Homer Hoyt Advanced Studied Institute Manuscript Prize ($1,000) for the “best” research paper published in JRER in 2008.

A Cross-Sectional Analysis of Cap Rates by MSA
(30:3, 249–292)
Doina Chichernea, Norm Miller, Jeff Fisher, Bob White, and Michael Sklarz

Journal of Real Estate Portfolio Management

Winner of the Institutional Real Estate, Inc. Manuscript Prize ($1,000) for the “best” research paper published in JREPM in 2008.

Does Green Pay Off?
(14:4, 385–399)
Norm Miller, Jay Spivey, and Andrew Florance

Congratulations to all the authors.
2009 American Real Estate Society Manuscript Prizes

The American Real Estate Society proudly announces the following manuscript prize winners for research papers presented at the American Real Estate Society's 25th Annual Meeting.

Best Research Paper Presented by a Practicing Professional, sponsored by the James R. Webb ARES Foundation Qualification for this award requires that not more than 50% of the authors are full-time academics: Andy Krause and Max Kummerow, both of Greenfield Advisors, for “Mimicking Sales Comparison Pricing Models: An Approach to Mass Appraisal Modeling with Validation by Prediction Error Summary Statistics.”

Real Estate Cycles (in honor of the late Waldo Born) sponsored by the James R. Webb ARES Foundation: Patric Hendershott and Robert Hendershott, of the University of Aberdeen, and James D. Shilling, of DePaul University, for “The U.S. Mortgage Finance Bubble.”

Innovative Thinking “Thinking Out of the Box,” sponsored by the Maury Seldin Advanced Studies Institute (MSASI): Geoffrey K. Turnbull, Georgia State University, and Velma Zahirovic-Herbert, University of Georgia, for “The Transitory and Legacy Effects of the Rental Externality on House Price and Liquidity.”

International Real Estate Investment/Portfolio Management, sponsored by LaSalle Investment Management: Colin Lizieri, University of Reading, for “Real Estate Investment in Global Financial Centers: Risk, Return, and Contagion.”

Office Buildings/Office Parks, sponsored by the NAIOP Research Foundation: Franz Fuerst, Patrick McAllister, and Claudia Murray, all of the University of Reading, for “Designer Buildings: An Evaluation of the Price Impacts of Signature Architects.”

Real Estate Brokerage/Agency, sponsored by the Center for the Study of Real Estate Brokerage/Agency at Cleveland State University: Bennie D. Waller and Raymond T. Brastow, both of Longwood University, for “The Probability of Dual Agency.”

Apartments, sponsored by the National Multi-Housing Council (NMHC): Kwame Addae-Dapaah and Kim Hiang Liow, both of the National University of Singapore, and Adam Stults, JLL, Shanghai, for “What Drives Value Property Premium?”


Housing, sponsored by the Lucas Institute for Real Estate Development and Finance at Florida Gulf Coast University: Muhammad Faishal Ibrahim, National University of Singapore, and Fu Weiming Leonard, Inland Revenue Authority of Singapore, for “Naming Strategies of Residential Developments: Is there a Winning Formula?”

Real Estate Finance, sponsored by Real Capital Analytics: Joseph Ooi, Seow-Eng Ong, and Woei-Chyuan Wong, all of the National University of Singapore, for “Can Bank Lines of Credit Protect REITs Against a Credit Crisis?”

Real Estate Investment/Portfolio Management, sponsored by RREEF: Bartley R. Danielsen and Richard S. Warr, both of North Carolina State University, David M. Harrison, Texas Tech University, and Robert A. Van Ness, University of Mississippi, for “REIT Auditor Fees and Financial Market Transparency.”

Real Estate Investment Trusts, sponsored by the National Association of Real Estate Investment Trusts (NAREIT): Michael J. Highfield and Kenneth D. Roskelley, both of Mississippi State University, and Dennis F. Steele, Jr., Southern Adventist University, for “Can Secondary Market Investors Profit from REIT IPOs?”

Real Estate Market Analysis, sponsored by CBRE Econometric Advisors (formerly Torto Wheaton Research): Patric H. Hendershott and Bryan D. MacGregor, both of the University of Aberdeen, and Colin M. Lizieri, University of Reading, for “Asymmetric Adjustment in the City of London Office Market.”

Real Estate Valuation, sponsored by the Appraisal Institute (AI): Kimberly Winson-Geideman, University of North Texas, Dawn Jourdan, University of Florida, and Shan Gao, Texas A&M University, for “The Impact of Age on the Value of Historic Homes in a Nationally Recognized Historic District.”

Retail Real Estate, sponsored by the International Council for Shopping Centers (ICSC): Kim Hiang Liow, National University of Singapore, for “Are Corporate Properties Undervalued? Evidence from International Retail Companies.”

Seniors Housing, sponsored by the National Investment Center for the Seniors Housing and Care Industry (Nic): David W. Chapman and John R. Lombard, both of Old Dominion University, for “Can’t Get No Satisfaction or Can They? Examining Housing and Neighborhood Satisfaction Factors in the 55+ Generation.”

CoStar Data, sponsored by the CoStar Group, for a paper on any topic using CoStar data: Sofia V. Dermisi and John F. McDonald, both of Roosevelt University, for “Is There a Link between Transaction Frequency and Property Characteristics? The Case of the Chicago Office Market.”

Sustainable Real Estate, sponsored by the NAIOP Research Foundation: Franz Fuerst and Patrick McAllister, both of the University of Reading, for “New Evidence on the Green Building Rent and Price Premium.”

No award was given for the Mixed-Use Properties or Industrial Real Estate categories.
S P E C I A L  I S S U E S
JOURNAL OF REAL ESTATE RESEARCH

Real Estate Brokerage (Summer, 1988): Sponsored by the National Association of REALTORS (NAR).

Corporate Real Estate (Fall, 1989): Sponsored by AICAM and HHASI.

Appraisal (Spring, 1990): Sponsored by the Appraisal Institute (AI).

Determinants of Demand (Fall, 1991): Sponsored by NAR.

Environmental Influences on Value (Summer, 1992): Sponsored by AI.

Real Estate Investment (Fall, 1992): Sponsored by the Pension Real Estate Association.

Corporate Real Estate (Fall, 1993): Sponsored by the International Association of Corporate Real Estate Executives (NACORE).


Real Estate Brokerage (Winter, 1995).

REITs (1995: Vol. 10(3/4)): Sponsored by the National Association of Real Estate Investment Trusts (NAREIT) and Equitable Real Estate Investment Management.


International Real Estate Investment (1996: Vol. 11(2)): Sponsored by Jones Lang Wootton USA.


International Real Estate Investment (1997: Vol. 13(3)): Sponsored by Jones Lang Wootton USA.


REITs (1998: Vol. 16(3)): Sponsored by the National Association of Real Estate Investment Trusts.

Corporate Real Estate (1999: Vol. 17(3)): Sponsored by NACORE International.

Cycles in Real Estate (1999: Vol. 18(1)): Sponsored by PricewaterhouseCoopers and SynerMark Investments.


Corporate Real Estate (2001: Vol. 22(1/2)): Sponsored by NACORE International.

Multifamily Housing (2003: Vol. 25(2)): Sponsored by Freddie Mac.

Issues For Inner-City Real Estate Markets: (2003: Vol. 25(4)): Sponsored by the Real Estate Research Center of Morehouse College.

ARES MONOGRAPHS
PAST, PRESENT AND FUTURE

PAST
1996: Megatrends in Retail Real Estate (co-sponsored by ICSC: 378 pages).
1997: Seniors Housing (sponsored by the National Investment Center for the Seniors Housing and Care Industries: 248 pages).
2006/7: Indigenous Peoples and Real Estate Valuation Issues (co-sponsored by the Appraisal Institute Education Trust and the Appraisers Research Foundation).

FORTHCOMING
2010/11: ARES 25 Year Anniversary.

IN PROCESS
2011/12: Property Values and Environmental Factors (needs a sponsor).
2013: Financial Engineering and Innovation in Real Estate (needs a sponsor).
2014: Real Estate Market Microstructure (needs a sponsor).
2015: Behavioral Real Estate (needs a sponsor).
2016: Dangerous Visions: The Future of Real Estate Research (needs a sponsor)
CoStar Group will provide a $1,000 manuscript prize for the best research paper presented at the ARES Annual Meeting that uses CoStar data. CoStar has comprehensive, detailed property level information and up to 15 years of historical data in most major markets throughout the U.S. and U.K. They currently track approximately 1.6 million commercial properties totaling 30 billion square feet and have verified comparable sales data on approximately 1.3 million sales transactions—all property types, including retail, multifamily, hospitality and land. Anyone interested in obtaining CoStar data for research purposes should contact:

Jay Spivey  
Director of Analytics  
CoStar Group, Inc.  
2 Bethesda Metro Center, 10th Floor  
Bethesda, MD 20814  
Phone: 888-576-9223  
Fax: 888-537-9358  
Email: jspivey@costar.com
The Journal of Real Estate Research (JRER) has a new set of best paper awards. As you know, currently there are two best paper awards ($5,000 and $10,000) for papers published in JRER. In April 2007, the awards ($5,000 and $10,000) were given for two papers that were published in 2006. In April 2009, the two awards will be given again for two papers published in the JRER during 2007 and 2008.

For April 2011, the top award will be increased to US $25,000. This means that there will be three awards ($5,000, $10,000, and $25,000) for papers published in JRER during 2009 and 2010. However, the Editor (Ko Wang) reserves the right to extend the evaluation period for the three awards from 2009–2010 to 2009–2011. Again, the winners of the awards will be based on the votes of the JRER editorial board.

Please solicit (or send your) very best papers to JRER. Any paper accepted now will be eligible for the three awards, since it will be published in 2009 or later (2008 is full). Your efforts to make JRER a better journal are greatly appreciated.

The top two papers published in JRER for years 2007–2008 as determined by the editorial board of JRER are as follows:

$10,000 Prize
The 1998–2005 Housing Bubble and the Current Correction: What's Different this Time?
by William Wheaton and Gleb Nechayev

$5,000 Prize
The Pricing of Home Mortgage Loans to Minority Borrowers: How Much of the APR Differential Can We Explain?
by Marsha Courchane
The American Real Estate Society (ARES) has established three best paper awards for papers published in the Journal of Real Estate Research (JRER) in selected years. The first award is $25,000 (US), the second is $10,000 (US), and the third is $5,000 (US). The three awards will be determined by the votes of the JRER Editorial Board after the papers are published in the Journal. The three awards, ($25,000, $10,000, and $5,000) will be given for the first time either in 2011 (for papers published in 2009 and 2010) or in 2012 (for the papers published in 2009, 2010, and 2011). The exact year (2011 or 2012) will be determined later by the editor of the journal. For details on the selection process of the three awards, please visit, http://cbeweb-1.fullerton.edufinance/jurnal/awards/default.htm.

In addition to these three awards, ARES also gives one $1,000 (US) best paper award for papers published in each calendar year. This $1,000 best paper award is selected based on the votes by all ARES members.
CALL FOR PAPERS

Journal of Real Estate Research
Special Issue on Chinese Real Estate Markets

The American Real Estate Society announces a call for papers for a special issue of the Journal of Real Estate Research. Authors are encouraged to submit original research on topics related to the Chinese Real Estate Markets. Areas of interest include, but are not limited to, the following:

- **Property Rights**: Their relationships with development strategies, property valuation, and market structure.
- **Pre-sale System**: The rationale for the system and its impact on property markets.
- **Foreclosure Laws**: Their protection to tenants and their impacts on mortgage lending practices and the capital market.
- **Tenant Eviction Protection**: Its effect on lease contract type, leasing strategies, and property value.
- **Planned Unit Development**: The value of design, planning, and amenities.
- **Units Provided by Employers and the Government**: The impact of their limited marketability on property prices and the market structure.
- **Land Auction System**: Developers’ strategies under supply constraints.
- **Land Lease**: How to price land leases and development options.
- **Brokerage System**: The system and its agency issues
- **Development Process**: What can we learn from the development of real estate market in China?
- **International Diversification**: The potential benefits of including real estate of developing areas (or countries) to a diversified portfolio.
- **Real Estate Returns**: The risk and return characteristics of real estate investment in Chinese real estate markets.
- **Performance Characteristics**: Their relationships with macroeconomic variables and policy changes.
- **Speculation versus Fundamentals**: The behavioral aspects of Chinese real estate markets.

All papers will be subject to double-blind anonymous review. Empirical and theoretical oriented manuscripts are welcome. Style and submission guidelines can be found at the back of the JRER and on the ARES website. Electronic submissions are encouraged in MS Word or PDF formats.

Authors should submit their manuscripts **no later than January 31, 2010** to Ko Wang via email at: Ko_wang@baruch.cuny.edu.

The co-editors for this special issue of the JRER are:

Hongwei Wang
Shanghai University of Finance & Economics

Ko Wang
Baruch College
City University of New York
CALL FOR PAPERS
RESEARCH IN REAL ESTATE MONOGRAPH SERIES

“THE AMERICAN REAL ESTATE SOCIETY:
25 YEARS OF THOUGHT LEADERSHIP”

The American Real Estate Society (ARES), in commemorating its 25 Year Anniversary (2009), shall publish a monograph that collects the perspectives and insights concerning the organization’s contribution to thought leadership. Authors are encouraged to submit original research that can explore the significance of thought leadership to the real estate discipline generally. Additionally, papers are solicited that will evaluate different aspects of thought leadership in the context of the contributions of the American Real Estate Society.

Topics of interest include, but are not limited to, the following:

■ The Founding of the American Real Estate Society
■ Making History: The First Twenty-five Years of the American Real Estate Society
■ The Impact of ARES on Academic Real Estate
■ Twenty-five Years of Thought Leadership
■ The Continuing Evolution of the American Real Estate Society
■ Development of the American Real Estate Society and It’s Mission
■ The Impact of ARES Upon Careers in the Academy
■ The International Impact of ARES
■ The Impact of ARES on the Real Estate Industry
■ The Publications of the American Real Estate Society
■ The ARES Annual Meetings: 1985–2009
■ The Members Speak: A Summary and Comparison of ARES Membership Surveys
■ ARES in the Twenty-first Century and Beyond
■ The Awards of ARES: Past, Present, and Future
■ The ARES Foundation: Its Formation, Operation, and Mission

Authors should submit manuscripts by December 15, 2009 via email to Larry Wofford (larrywoff@yahoo.com).

All papers will be subject to double-blind anonymous review by professionals, as well as academicians. Articles must be written to be understandable by practicing professionals; lengthy formulas and mathematics should appear in an appendix. Style and submission guidelines can be found on the ARES website: www.aresnet.org. Electronic submissions are encouraged in MS Word.
CALL FOR PAPERS

ESSAYS IN HONOR OF JAMES R. WEBB
Research in Real Estate Monograph Series

James R. Webb has made an outstanding contribution to the development of the real estate body of knowledge, as well as actively leading and contributing to the stature of the American Real Estate Society. His contribution has also been highly significant through his leadership at a personal level for colleagues, both locally and internationally.

The American Real Estate Society, with support by and in cooperation with John Benjamin, announces a Call for Papers for a special volume of the Research in Real Estate Monograph Series entitled Essays in Honor of James R. Webb. John Benjamin, in thanks for Jim's encouragement and counsel during his academic career, has pledged $15,000 and will match any and all funds up to this amount to pay for this monograph. All contributions will be acknowledged in the introduction to the monograph. They should be made to “ARES—JRW Monograph” and sent to:

Karl L. Guntermann
Arizona State University
W.P. Carey School of Business
Department of Finance
P.O.Box 873906
Tempe, AZ 85287-3906

Authors are encouraged to submit the results of original research, both theoretical and empirical, on all aspects of real estate research that link into real estate research where James Webb has made a significant contribution. Areas of research include, but are not limited to, the following: real estate finance, real estate strategy, real estate brokerage, international real estate, real estate investment, portfolio diversification, and real estate education.

In addition, this monograph also seeks contributions that highlight James Webb's leadership role in the following areas:

• Substantive papers that highlight the contribution of James Webb in developing ARES, regional real estate societies, academic real estate, practicing professionals, and students.
• Thoughtful papers on the real estate discipline “moving forward” over the next ten years in the areas that James Webb has contributed to, including real estate research, education, and real estate societies.
• Shorter reflective papers highlighting the personal contributions made by James Webb in people's careers, organizations, and lives.

It is planned to have this ARES monograph complete by the 2010 ARES Conference in Naples. All manuscripts submitted will be reviewed anonymously by the Editorial Board of the monograph, as well as practicing professionals. Authors should email their manuscript no later than, April 15, 2010 in MS Word or a PDF to one of the following:

Stephen E. Roulac
Roulac Global Places
sroulac@roulacglobal.com

Graeme Newell
U. of Western Sydney-Hawkesbury
g.newell@uws.edu.au

Michael J. Seiler
Old Dominion University
mseiler@odu.edu
CALL FOR PAPERS

Journal of Sustainable Real Estate, Vol. 2

The American Real Estate Society, in cooperation with and funding by the CoStar Group, announces a call for papers for the second volume of the Journal of Sustainable Real Estate (JOSRE). All reviewed papers accepted for publication, as well as the best research paper published will receive honorariums. Authors are encouraged to submit original research that can help investors, developers, appraisers, lenders, asset managers, elected government officials, and land use regulators improve their strategies, decision-making, and understanding of the impact of sustainable real estate practices. Topics and questions of interest include, but are not limited to, the following:

Philosophical and Definitional
- What is a “green building” and/or a “sustainable development”?
- Who should set the standards and what types of measurement systems should be used?
- What does green or sustainable real estate mean around the world and how is it measured? What can we learn from others outside the U.S.? What can we learn from some of the global thought leaders about sustainable real estate?

Regulatory Issues
- Nearly every major city and several states now require LEED certification for certain types or sizes of buildings. How do these requirements compare and can we learn anything from some of the incentive systems versus requirement systems in terms of effectiveness and efficiency?
- Some states like California have emission limits and energy efficiency standards or water limitations that are being phased in over time. What is their impact on building cost? How much impact will they have on energy consumption?
- Some governments use rebate systems and tax credits for utilities or green features. How have such programs impacted the return on investment for energy savings and or co-generation via solar or other means?
- Are there “carrots” or “sticks” that work well? What are the effects of these subsidies, taxes or other incentives on the return on investment for green development?

Financing and Valuation Issues
- Are there or should there be financing incentives for green buildings and sustainable development? How do you value a building with green features? Are benefits imbedded in rents and occupancy or expenses, or is there an impact on risk that should affect required returns? How do lenders view the costs and benefits of green?
- What are the implications of the green and sustainable movements for appraisers and the appraisal process?
- How and what are the observable value effects of green and sustainable development?

USGBC’s LEED Program, CABA, ENERGY STAR, and Hi-Performance Building Systems
- How are standards evolving for measuring important dimensions of building performance? Should we have a required disclosure system for building performance like ENERGY STAR for appliances, but on broader issues of concern?
- Are there conflicts with state and local building codes and municipal subdivision and site conditions that make implementation difficult? Is land use and building code official education an issue?
- What is the impact of green buildings on worker productivity and morale, retail sales, and benefits that go beyond energy savings? Can these be valued? Do they or will they eventually translate into rent?
- What is the state of the art for water efficiency in terms of operation, rain water capture, gray water use and what regulations impede or assist in this effort?

Green and Sustainable Strategies and Policies
- How many public and private companies have green policy statements? How has this affected real estate decisions?
- Portfolio approaches to energy consumption: Are carbon credits possible for larger scale developments and portfolios?
- What are the new technologies and strategies affecting water consumption? Are they cost effective?
- Who is defending the status quo? Why?
- Who is or should be developing new products?

Case Studies of Innovative Properties, Products, Design or Management Strategies
- What are the lessons learned? Good examples of bad practices? Good examples of good/best practices? Great resources?

Authors should submit their manuscript no later than, March 15, 2010 to Norm Miller via email at nmiller@sandiego.edu. All papers are subject to anonymous double-blind review by practicing professionals and academicians. Papers must be written to be understandable by institutional real estate investors; lengthy formulas and mathematics should appear in an appendix. Applied empirical studies will be given preference. Contact Norm Miller if you have industry commentary for the Industry Insight section. Submissions are preferred in MS Word or PDF format.
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Manuscripts should be original, unpublished works not under publication consideration anywhere else. Interested authors should contact or submit manuscripts to:

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The American Real Estate Society announces a Call for Papers for the Journal of Real Estate Practice and Education (JREPE). The purpose of the JREPE is to motivate research in real estate practice and education and encourage excellence in teaching. It provides a basis for the exchange of innovative opinions and research results among real estate practicing professionals, educators and researchers internationally.

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Four hard copies of the manuscript should be submitted along with an electronic file in Microsoft Word or WordPerfect 6.0. Editorial guidelines printed in a current issue of the Journal of Real Estate Research should be followed. The JREPE is published biannually.

Interested authors should contact or submit manuscripts to:

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