

Sustainable Real Estate Development: The Dynamics of Market Penetration

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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).¹ 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.² 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.³ 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.⁴ 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

Organization	Time Frame
ASHRAE	1970s and evolving
ENERGY STAR	1992
LEED	1998 (evolving)
Green Globes (Global Environmental Method)	2000 (initially UK & Canada)
NAHB Model Green Home Building Guidelines	2005–2006
Ad Hoc	No-rating; individual projects

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.⁵ 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.⁶ 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 atrophy 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.”⁸ There are currently no means to sensibly correct for such undercounting.

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.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.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.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.¹² 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 2009.¹³ 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.¹⁴ 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.¹⁵ 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

Miller, Spivey, & Florance (2008)			Eichholtz, Kok, & Quigley (2009)	Wiley, Benefield, & Johnson (2009)
Ratings / measure	Descriptive	Regression	Regression	Regression
LEED				
Rent gain	36% (\$11.33 / sq. ft. / yr)		NS	15.2%–17.3%
Sales price gain	64% (\$171)	9.94%	NS	NS
ENERGY STAR				
Rent gain	9% (\$2.40 / sq. ft. / yr)		3.3%	7.3%–8.6%
Sales price gain	27% (\$61)	5.3%	19%	NS

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).¹⁶

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.¹⁷ 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).¹⁸ Without much explanation, they also presented regression results that revealed notably lower returns.¹⁹ 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.²⁰ 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 buildings²¹ 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.²² 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 than those they classified as comparable.²³ 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 2007.²⁴ 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.²⁵ 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).²⁷ 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.²⁸

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. They 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.²⁹ 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.³⁰

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 of 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.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.”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 managers, 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 than 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.³⁶

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).³⁷ 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.³⁸ 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.³⁹ 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.⁴⁰ 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).⁴⁴ 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.⁴⁵

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).⁴⁶ 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 innovations⁴⁷ 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; PricewaterhouseCoopers, 2009).⁴⁸ 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).
- ³ In the 1970s, HUD initiated a major demonstration aimed at improving affordable building technologies in “Operation Breakthrough. A comparable although fully completed level of engineering and technological innovation appear appropriate for sustainable and affordable rental and ownership housing modules. See: <http://www.gao.gov/products/PSAD-76-173>.
- 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.
- ⁷ Residential and commercial building data are available from the Energy Information Administration of the U.S. Department of Energy and from the U.S. Census. See: <http://www.eia.doe.gov/emeu/consumption/index.html>.
- 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.
- ¹⁰ The USGBC issues periodic reports “Green Building Facts.” These data are from their April 2009 report available at: <http://www.usgbc.org/ShowFile.aspx?DocumentID=3340>.
- 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).
- ¹³ See: <http://usgbcny.org/initiatives/green-codes-task-force.html>.
- 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.

- ¹⁵ 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=costar|2987601259.
- ¹⁶ 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.
- ¹⁷ 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.
- ¹⁸ McCormick (2008) also reports a 3.5% higher occupancy, but such a small differential could be the result of sampling and selectivity issues.
- ¹⁹ 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.
- ²⁰ CoStar generated a 61-page report in which more details of their sampling and analysis strategy were presented (CoStar, 2008b).
- ²¹ 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.
- ²² 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).
- ²³ 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.
- ²⁴ 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.
- ²⁵ “...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).
- ²⁶ 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.
- ²⁹ See their website: <http://www.timeequities.com/about-environment.cfm>.
- 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=eddd82c3462061bb99792a1cbd6d6c4f.
- 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>.
- ³² “CHFA Tops in Green QAPs.” 2009. Affordable Housing Finance. (April/May): 6.
- ³³ Jonathan Rose’s company can be found at: <http://www.rose-network.com/> and WHEDCo at: http://www.whedco.org/message_nancy.php.
- 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.
- ³⁵ See: http://www.rose-network.com/projects/index.html?cat_toc.html&top.html&studio_investment.html.
- 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

- residents. See: http://www.metrogreenbusiness.com/news/green.php?title=jersey-city_affordable_housing_to_be_lee&more=1&c=1&tb=1&pb=1.
- ⁴¹ Some progress on this front has been achieved by the Clinton Climate Change Initiative 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.
- ⁴² On SWECO see: <http://www.swecogroup.com/en/enswecose/>. See also: http://unfccc.int/files/methods_and_science/mitigation/application/pdf/berg_von_linde_sweden_the_sustainable_city.pdf. A source on the Dongtan Island Eco-city is found at: <http://www.arup.com/eastasia/project.cfm?pageid=7047>
- 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).

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