GREEN BUILDING MARKET AND IMPACT REPORT 2009

by ROB WATSON
Executive Editor

GreenerBuildings.com

Greener World Media

Contents

Researched and Written by Rob Watson

For Greener World Media:

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Executive Summary

The great American philosopher Yogi Berra once noted: "It's tough to make predictions, especially about the future." Most forecasts for 2009, including ours, called for a flattening or even decline in LEED project registrations, mirroring the general malaise in the market. However, LEED registered and certified floor area in 2009 is estimated to grow by over 40% compared to last year's totals, for a cumulative total of over 7 billion square feet worldwide since the standard was launched in 2000.

New Construction Registrations Exceed National Construction Starts Dramatic declines in 2009 U.S. new non-residential construction might result in construction starts dipping below the one billion square foot mark for the first time in many years, yet registrations of LEED new construction projects in the U.S. are expected to exceed 1 billion square feet! Although the majority of LEED projects registered this year are unlikely to start construction this year, it is not hard to imagine that 25% or more of new non-residential construction starts being registered, which implies that in registrations the LEED Version 2 (V2) standard has pretty much fully penetrated the market.

Construction Industry Clambers Aboard 'Green Lifeboat' but International Disappoints There may be a "lifeboat effect" at work, where the market is jumping to the hot trend in the hopes of dodging the economic bullet. Somewhat reflecting this, membership in the USGBC is stronger than forecast, expecting to grow over 10% and top 20,000 for the first time, compared with a predicted 3% decrease. As a category, International LEED projects showed the greatest decline in floor area, partially reflecting the assumption of certification duties by Canada and India.

LEED 2009 Launches as Version 2 Sunsets The other clear influence on the year-to-date registration figures is the sunsetting of the V2 standard as LEED 2009 rolls out. In the run-up to the LEED Version 3, there was a huge spike in June, with over 4,000 projects registering the month before the deadline.

LEED Certified Floor Area Sets New Record Over 350 million square feet of LEED buildings certified in 2009, tripling the record certification in 2008 and exceeding all certified floor area to date by more than 30%. As impressive as this figure is, in 2010, certified floor area will need to almost triple again in order to keep up with the explosion of registrations that began in 2007.

LEED EB is the Certification Champion and CI Surges LEED for Existing Buildings (EB) certified almost 15% more floor area in 2009—over 10 million square feet—than did LEED for New Construction (NC) and added over 65% new floor area, which to us signals a welcome trend toward the green operation of buildings. Last year, we did not include LEED for Commercial Interiors (CI) in our calculations. CI registered floor area almost tripled to over 200 million square feet this year, and showed similar growth in certifications.

ENVIRONMENTAL TRENDS

Overall, LEED's green impact shows some impressive numbers, but relative to the problem still is not providing sufficient contribution to halting unmanageable climate change.

Non-residential construction, the focus of our report, represents about 40% of the environmental burden of buildings.

Land and Site Impacts Due to the large jump in LEED penetration last year and the inclusion of LEED CI figures, we increased our estimate of vehicle miles traveled (VMT) reduction to 780 million VMT to date vs. 400 million from 2008. By 2030, the annual gasoline savings equal our current imports from the Middle East. There also has been a distinct shift toward more urban infill development, which we predict will accelerate as the heavy emphasis on location efficiency in LEED 2009 influences the market.

Water Impacts Total water savings this year are significantly higher than last year, due to increased floor area from the inclusion of CI, unanticipated growth in all of the standards' floor area, plus an increase in the penetration of projects achieving the 20-30% savings from plumbing fixture efficiency. Total water savings from LEED through 2009 is estimated at 15 billion gallons, comprising .5% of annual non-residential water use. But, by 2030, LEED results in nearly 1.3 trillion gallons of saved water, which represent a noteworthy 30% reduction of annual non-residential water use.

Energy Impacts Buildings use more energy than any other human activity and the building sector's share of global energy use continues to grow. It will not be possible to effectively address carbon pollution and climate change without an aggressive, concerted effort to reduce energy consumption in buildings. LEED is starting to make a difference in the United States; we estimate that the annual CO_2 savings from LEED buildings is approximately 2.9 million tons from energy efficiency and renewables. This figure grows to 130 million tons per year by 2020 and almost 320 million tons annually by 2030. In both the Low Savings case and the High Savings case, forecast penetration of LEED results in a net decrease in national energy consumption in non-residential buildings, by 2030 in the Low Savings case and by 2020 in the High Savings case.

Materials Impacts Based on average materials costs, green building materials represented approximately $7 billion in cumulative spending through 2009, reaching $230 billion by 2030. Moreover, the embodied energy in buildings that are renovated instead of demolished is expected to save as much energy in 2030 as we import this year from Saudi Arabia. In addition, an average of over 60% of C&D Waste is diverted from LEED projects, totaling 25 million tons to date and reaching almost 800 million cumulative tons by 2030.

IEQ Impacts While operational savings are real and important, the financial benefits in LEED are largely achieved through the enhancement of employee productivity. Salaries represent approximately 90% of the money flow through a building. To this end, we calculate that an average of at least 580,000 employees are currently enjoying improved indoor environments in LEED buildings at present. Looking ahead, the "green building workforce" is expected to approach 29 million by 2020, and almost 64 million strong by 2030. The productivity benefits from LEED buildings to date are estimated at $230 million to $450 million; we expect this number to reach between $11 billion and $22 billion by 2020, and $25 billion and $49 billion by 2030.

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LEED Market Trends

The current economic situation coupled with increased stringency in the LEED requirements will contribute to an expected slowdown.

This year we are expanding our coverage of market trends in LEED, hence the renaming of the report as "Green Building Market & Impact Report."

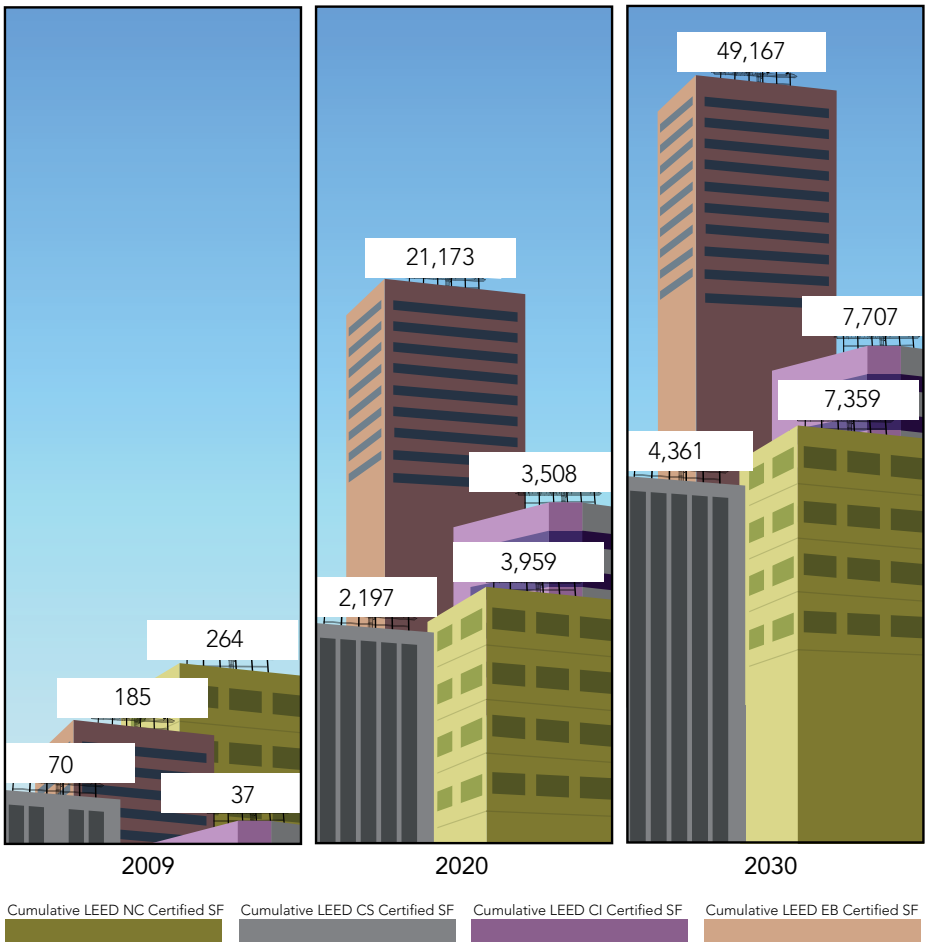
Overall, LEED market performance greatly exceeded our expectation of a flattening and maybe even a decline. Total registered and certified floor area in 2009 is estimated to grow by over 40% compared to last year's totals for a cumulative total of over 7 billion square feet worldwide since LEED was launched in 2000.

This growth is perplexing for a couple of reasons. First, dramatic declines in 2009 U.S. new non-residential construction starts—by some estimates almost 40% below the peak of 2007—means that new non-residential construction might dip below the one billion square foot mark, yet registrations of LEED new construction projects in the U.S. are expected to exceed 1 billion square feet! [This includes LEED New Construction (NC), Core & Shell (CS), Commercial Interiors (CI), LEED Schools and LEED Retail, but not LEED for Existing Buildings(EB).]

What is going on?

We think a couple things might be operating here. The unexpected growth

Floor Area Forecast
(millions of square feet)



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phenomenon is likely something of a "lifeboat effect" where the market is jumping to the hot trend in the hopes of dodging the economic bullet. Membership in the USGBC is stronger than forecast, growing over 10% and topping 20,000 for the first time, compared with a predicted 3% decrease below 2008 totals. Although growing below historical rates, the fact that membership is growing at all reflects the relative strength of the green sector compared with other segments of the building industry.

It is not hard to imagine 25% or more of new non-residential construction starts being registered, which implies that in registrations the V2 standard has pretty much fully penetrated the market.

The other clear influence on the year-to-date registration figures is the sunsetting of the Version 2 (V2) standard as LEED 2009 rolls out. Following the pattern seen when the old LEED AP exam was retired—the number of people who registered for the exam in the last four months almost equaled all previous applicants—there was a huge spike in project applications in June, with over 4,000 projects registering the month before the deadline.

As for the registered floor area expected to exceed new construction starts, the most likely explanation is that projects register at very different times during their development. It's quite likely that projects started in 2007 or 2008 have deferred registering until now either because of uncertainty whether certification was possible or to get their project in under the V2 deadline. Similarly, it's quite likely that projects expected to be started in 2010—or even 2011—registered early to avoid the cutoff. It's not hard to imagine 60-70% of total registrations falling outside of the 2009 start year.

Even if this were the case, it implies that over 40% of new construction starts registered in the system, which does not seem realistic either. While there is no way of knowing the magnitude, our guess is that there is some cohort of "wishful thinking" projects that register each year. These projects fail to materialize for any number of reasons, lack of financing being the most obvious. With prevailing economic conditions, it's not hard to imagine a higher-than-normal amount of "vapor estate," as opposed to real estate, projects this year.

Yet, it is quite possible that 25% or more of new non-residential construction starts being registered, which implies that in registrations the V2 standard has pretty much fully penetrated the market. Now all we need is for certifications to catch up.

Certifications One of the main stories this year is the huge ramp-up of certifications compared to historical rates. We expect 2009 certified floor area to grow by more than 200% compared with 2008 and by 30% compared with all certified floor area to date.

In spite of more than doubling each year since the launch of LEED, certifications so far represent only approximately 10% of registered floor area. That certifications lag registrations is to be expected and in a rapid-growth situation low numbers are not surprising—but the 10% certification rate is lower than we'd like to see. We believe that a 70% "graduation rate" is acceptable, and as a whole, LEED exceeded, a 70% graduation compared to 2006 (assuming a 3 year "graduation cycle"), as shown in following table. However, compared with 2007 registrations, LEED falls far short of a 70% graduation rate, with the exception of LEED for Existing Buildings: Operations & Maintenance (EBOM).

LEED Standard	CI	CS	EBOM	Schools	NC	Grand Total
2009 Certification Rates vs. 2006 Registrations	68%*	115%	390%	299%	57%	112%
2009 Certification Rates vs. 2007 Registrations	29%**	14%	72%	3%	23%	29%

*For CI we compare vs. 2007—reflecting the shorter turnaround cycle.

**For CI we compare vs. 2008—reflecting the shorter turnaround cycle.

In what could be a harbinger of the future, certifications of LEED EB/EBOM of over 135 million square feet of projects are likely to significantly exceed NC project certifications of about 120 million square feet.

What's interesting about the table above is that LEED NC is the main laggard in the certification realm on the three-year cycle. LEED EBOM is the standout, exceeding the 70% graduation rate compared with both 2006 and 2007 registration levels.

However, in order to keep up with the pace of registrations, certifications in 2010 will need to triple compared to 2009. There is sufficient capacity in the certification pipeline, but it remains to be seen what impact the economy has and whether acceptable "graduation rates" can continue.

It was the Best of Forecasts, it was the Worst of Forecasts… In the 2008 Green Building Impact Report, our crystal ball gazing resulted in this mixed-bag forecast:

> "The current economic situation coupled with increased stringency in the LEED requirements will contribute to an expected slowdown. In the U.S.—the focus of this report—we expect a flattening of the growth rate or even a decrease in the new construction markets, both of which will reflect a slight decrease in general LEED NC and LEED CS projects and rapid growth in the Schools and Retail markets. We do expect, and indeed hope, that the growth in LEED EBOM continues, given the relative magnitude of the existing building stock compared with the size of new additions to floor space.
>
> Going forward, we anticipate that LEED's growth will flatten relative to the market as it reaches the expected saturation point for the level of stringency the market is able to handle. Even though the growth rate flattens, in absolute terms we believe the amount of floor area being added to the system will continue to grow."

LEED CI and EB Soar The registration growth rate sweepstakes winner of 2009 is LEED CI, which increased a whopping 165% compared with 2008, while LEED CS is the biggest loser, actually declining by 3% compared to last year. New CI certified floor area could almost triple this year to approximately 23 million square feet.

In what could be a harbinger, exepcted certifications of LEED EB/EBOM of over 135 million square feet of projects are likely to significantly exceed NC project certifications that this year will top about 120 million square feet. This is the first time the Existing Building standard will certify more floor area than the

New Construction standard. LEED EB/EBOM certified floor area will grow by approximately 250% compared with last year, though registered floor area (over 600 million square feet) still lags that of New Construction.

New Construction Remains Strong LEED NC Registration continues strong growth of almost 40% in 2009, adding 1.2 billion square feet worldwide. The NC certification growth rate of 20% is the slowest in years, while Core and Shell actually registered less floor area this year than in 2008, a first.

Application Guides Gain Traction On the Application Guide front, LEED for Schools is doing quite well, Growth in LEED for Schools is anticipated to exceed 65%, consistent with our "skyrocket" forecast. LEED Retail has not grown as much as expected, in part due to delays in finalizing the update of the Retail Application Guide and project classification issues between the CI and LEED Portfolio programs.

Almost hitting 800 million square feet of registered projects this year, aggressive growth of LEED internationally continues, representing over one quarter of all project square footage.

Cumulative Certifications 2000-2009

NC	CS	CI	EBOM	Application Guides (Schools & Retail)
283,000,000	91,000,000	40,000,000	191,000,000	8,500,000
46%	15%	6%	31%	2%
2009 Certification totals are estimated from year-to-date figures through September				

So What About Homes? The residential sector in the U.S. represents the largest share of the environmental burden of buildings and in response, the USGBC launched LEED Homes at the end of 2007. LEED for homes covers several different types of dwelling units: single-family, duplex/triplex and low-rise multi-family types. Because of the structure of the homebuilding industry, a very different delivery system for LEED needed to be established. This took a little over a year to perfect and LEED has now certified nearly 3,000 units, with several thousand more awaiting certification. Similar to the non-residential market, LEED for Homes project activity did not reflect the market as a whole and still remains strong. Particularly gratifying is the very strong participation of the affordable housing industry, which indicates in this razor-thin margin market being green allows you to do well while doing good.

International Market Almost hitting 800 million square feet of registered projects this year, aggressive growth of LEED internationally continues, representing over one quarter of all project square footage. This brings the total registered floor area internationally to almost two billion square feet, about 25% of the LEED total.

Foreign LEED projects could show a 30% increase in registration this year, despite the tanking of the Dubai market. China and India seem to have somewhat taken up the slack of the Middle East. Another interesting development is the growing penetration in Europe, notably Germany and Italy, which is already populated with excellent green building standards.

Most Active Countries for LEED

USGBC has successfully developed a project certification structure that can adapt to current projects, but needs further improvements before LEED can penetrate the international market at the same level as the U.S. market.

Country	Number of Projects	Total Floor Area (square feet)
India[1]	491	478,000,000
UAE	669	455,000,000
Greater China[2]	310	250,000,000
South Korea	94	123,000,000
Saudi Arabia	59	89,000,000
Canada[3]	326	72,000,000
Mexico	109	43,000,000
Brazil	145	38,000,000
Germany	92	22,000,000

Data through September 2009

[1] Includes projects registered directly with IGBC

[2] Includes Hong Kong, Macau and Taiwan

[3] Only includes figures prior to program administration by the Canada GBC.

The structure of real estate development, particularly in Asia and the Middle East, tends to be more speculative than in the U.S., which accounts for the much higher proportion of LEED Registered projects in CS compared with NC. Since we did not see significant LEED activity prior to 2005—approximately 97% of international projects have registered in the last 3 years—it is still too early to draw conclusions about certification, particularly given the average size of these projects. International projects tend to be much larger than the U.S. average as indicated by the nearly 1 million square foot average of projects in India, China and South Korea.

2009 International Registration Share

NC	CS	CI	EBOM	Application Guides
463,000,000	155,000,000	6,000,000	89,000,000	2,800,000
65%	22%	1%	12%	0%

2009 Registration totals estimated from year-to-date through September figures

USGBC has successfully developed a certification structure that can adapt to the current portfolio of projects, but further improvements are needed before LEED can begin penetrating the international market at the same level as in the U.S. Challenges to increased penetration in large international markets include:

- benchmarking environmental performance standards, particularly energy
- development of qualified industry professionals from designers to builders
- translation of support materials to local language
- the infrastructure needed to support, protect and certify to the LEED brand.

Site and Land Use Impacts

Far Fewer Car Trips, and an Implosion of Erosion

It's an axiom in real estate that "it all starts with the land" and that is true with LEED as well. LEED addresses impacts to the land in a three principal ways: location efficiency, site protection and restoration, and site performance.

Unlike most other impact categories, where benefits of LEED are directly related to project floor area, site impacts relate to the number of projects. Thus, our assessment of progress to date is based on actual project figures from USGBC; although our project number projections derive from the growth in floor space and the average size of LEED projects.

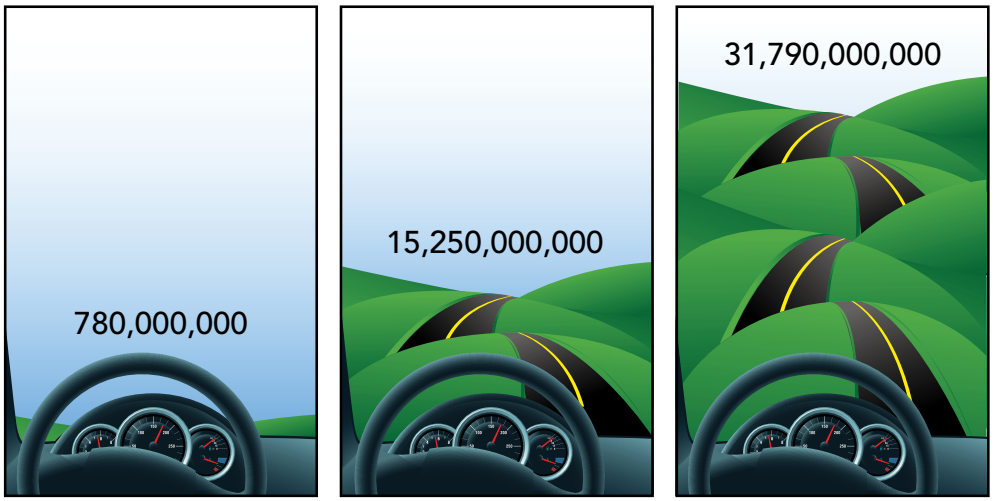
Location Efficiency We kept the same indicator of location efficiency—vehicle miles traveled (VMT)—to illustrate LEED's benefits of location efficiency and alternative transportation methods. Due to the large jump in LEED penetration last year and the inclusion of LEED CI figures, we increased our estimate of VMT reductions to 780 million VMT to date vs. 400 million from 2008. Our projections indicate that roughly 15 billion VMT are avoided by 2020, up from 4 billion estimated last year. By 2030 that figure grows to about 32 billion. These figures seem large, but compared to total national VMT they represent a reduction of less than 1%. Of commuting VMT, it represents a drop of over 2%.

Due to the large jump in LEED penetration last year and the inclusion of LEED CI figures, we increased our estimate of VMT reduction to 780 million to date vs. 400 million in 2008.

These reductions result in the equivalent of taking nearly 60,000 vehicles off the road, saving almost 30 million gallons of fuel, and eliminates over 7 million tons of CO_2. These figures grow to 2.5 million vehicle-equivalents and over 1.2 billion gallons of fuel saved annually by 2030, preventing over 300 million tons each year of CO_2, as well as over 120,000 tons of other air pollutants.

Site Protection There was little change in the adoption rates of land protection measures, so the 100% growth in site protection measure impacts vs. 2008 is principally due to increased penetration of LEED certified projects. As of 2009, we estimate that LEED certified buildings prevented nearly 800,000 tons of soil erosion to date and 11 million tons of prevented soil loss by 2020, which grows to almost 22 million tons by 2030.

Site Impacts: Vehicle Miles Traveled
(VMT reductions)



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LEED stormwater prevention and treatment requirements have avoided or treated approximately 350 million gallons of toxic flush, significantly more than we calculated in 2008.

Land-Use Impacts Summary

	2009	2020	2030
VMT Reductions	780,000,000	15,250,000,000	31,790,000,000
Vehicles Reduced	59,000	1,271,000	2,540,000
Gasoline Reduced	29,000,000	622,000,000	1,244,000,000

Emissions Reductions
(in tons)

	2009	2015	2020
Hydrocarbons	59	1,260	2,518
CO	2,659	57,104	114,132
NOx	86	1,847	3,693
Particulates	8	168	336
CO_2	7,100,000	152,500,000	304,800,000

We revised our calculation method of sensitive land and open space impacts, which resulted in significant increase in land impacts, due to the growth in the number of projects and the strong shift to urban development. To date we estimate that development on roughly 24,000 acres of sensitive lands have been avoided, compared with 5,000 acres calculated in the 2008 report and 147,000 acres in 2020 vs. 70,000. By 2030, the total grows to almost 280,000 acres.

There was a significant shift in the amount of brownfield development between 2008 & 2009, with almost triple the number of projects achieving this credit in 2009. This jump shows that LEED has resulted in an estimated 4,800 acres of brownfield reclamation vs. 250 calculated acres last year. We expect reclaimed brownfield acres to grow to over 30,000 by 2020 and 57,000 by 2030.

Stormwater The first ¾ inch of a storm produces what is known as "toxic flush," where all of the debris and air pollution that precipitates out of the sky is washed into the watershed.

When stormwater runoff overwhelms sewage treatment plants, "combined sewer overflow" (CSO) results in untreated sewage going straight into our waterways, lakes and beachfronts. When debris and bacteria counts get too high as a result of CSO, beaches are closed to protect public health. According to the Natural Resources Defense Council (NRDC) report "Testing the Waters 2009," over 20,000 beach closures occurred nationwide in 2008—the fourth consecutive year, at this level. This indicates that polluted stormwater runoff from CSO is still a major problem around the country.

LEED gives credit for measures to reduce and treat stormwater runoff and we base our stormwater treatment estimates on a reference storm, since it's impossible to aggregate impacts of all of the different types of storm events in different climate zones. Between 2008 and 2009, we saw greater adoption of stormwater measures in certified projects growing from about 40% in 2008 to 50% in 2009. This reflects the growing importance of stormwater mitigation.

We estimate that LEED stormwater prevention and treatment requirements have avoided or treated at least 350 million gallons of toxic flush during each storm event, significantly more than we calculated in 2008 due to the growth in numbers of projects and land associated with these projects. However, due to growth in LEED floor area, by 2020, volume treated grows to approximately 3.5 billion gallons per storm event compared with 1 billion gallons estimated in the 2008 report. By 2030, LEED projects reduce or treat over 7 billion gallons of stormwater per ¾ inch storm event.

Urban Heat Islands About 21,000 acres of land and rooftops have implemented measures to reduce urban heat islands and we expect over 180,000 acres of measures by 2015 and nearly 375,000 by 2020. Urban heat islands can increase ambient temperatures by up to ten degrees Fahrenheit and result in millions of dollars of air conditioning costs and millions of tons of carbon dioxide pollution.

Looking Ahead LEED 2009 criteria significantly boost the amount of credit given to projects that are "location efficient," meaning infill lots adjacent to mass transit. Given this shift in emphasis, we expect that transportation- and land-related impacts going forward will be greater relative to earlier projections. And credits such as the much-maligned "bike-rack" receive significantly less weight compared to location efficiency (1 point vs. 11 points) within the Sustainable Sites category. However, given the time it takes for projects to migrate through the LEED system, it will be a while before these changes are reflected in the data.

Water Efficiency Impacts

Savings Grow from a Trickle to a Flood

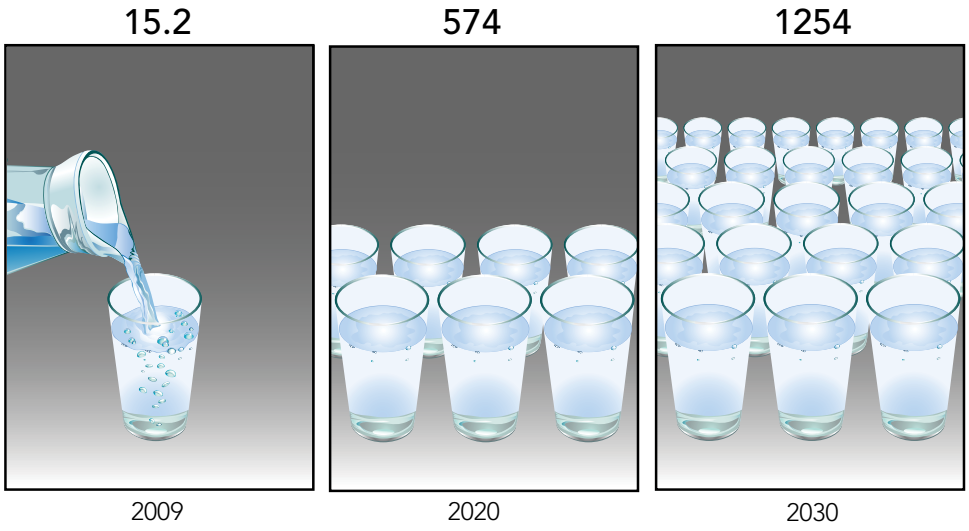
We calculated that 18.1 billion gallons of wastewater have been avoided to date, a .6% reduction in the annual wastewater generated.

Potable water is our most precious and scarce resource, at less than one-tenth of one percent of all the water on the planet, or less than 10% of accessible freshwater from underground and surface (river, streams, lakes and reservoirs) sources. Water use in buildings makes up, on average, 80% of the world's potable water. So, what do we do with this most precious of resources in buildings? We flush our toilets with drinking water in the desert.

Indeed, we believe that water shortages will put the brakes on real estate development long before energy shortages do. Because it is treated largely as a public or, at best, a "quasi-market" good, water is not likely to be priced at its true value. This means price signals, a good indicator of energy availability that helps encourage conservation, don't apply to water. To be sure, water and sewer prices are going up, but compared to the cost of delivering the service and what the public is willing to bear, these prices are far below water's true worth.

What we've seen in jurisdictions when water runs short are lurching public policy responses, with last-minute building moratoriums or hastily created offset policies requiring builders to "find" an amount of water equivalent to what their development would use, before permits are approved.

Total Water Savings
(in Billions of Gallons)



LEED addresses the need for efficient and reduced water use in buildings foremost through conservation. Plumbing fixtures, cooling towers, and landscaping are the main areas where green design can effectively minimize a building's demand for potable water, so we're not just flushing it all away.

Total water savings estimated for this year's report are significantly higher than the estimates from last year, largely because of increased floor area from the inclusion of CI and unanticipated growth in all of the standards' floor area. There

Water Efficiency and Treatment Impacts

	Units	Impact to Date	Projected Impact 2015	Projected Impact 2020
Total Water Savings	Million Gallons	15,200	574,000	1,254000
Plumbing Water Savings	Million Gallons	2,350	106,800	237,200
Landscape Water Savings	Million Gallons	8,420	255,700	561,100
Cooling Tower Water Savings	Million Gallons	4,410	211,200	470,500
Annual Non-Residential Water Use	Percent	0.5	15.5	29.8
Wastewater Reduction				
Total	Million Gallons	18,100	852,000	1,890,000
Annual Wastewater Reduction	Percent	0.6	30.4	67.5

also was an increase in the penetration of projects achieving the 20-30% water use reduction in plumbing fixtures. These high levels of credit achievement were the impetus for LEED 2009 to increase the prerequisite savings requirement to 20% above minimum standards and to reward 30-40% savings. As with Sustainable Sites, Water Efficiency is more heavily emphasized in the LEED 2009 standards.

We've seen a slight drop in the number of projects using graywater treatment systems, largely because water chemistry is complicated and these systems require a great deal of maintenance and capital to install. However, as on-site wastewater treatment experience grows and technology improves—not to mention the expected $1 trillion water and sewer infrastructure bill our local jurisdictions face in the next decade—we expect there to be increased emphasis on buildings serving as "reservoirs" through the use of cisterns and other rainwater capture methods, as well as "sewage treatment plants" by treating their own wastes mostly on-site.

Aggregate Water Savings Total savings from plumbing, landscaping, and cooling towers combined as of 2009 is 15 billion gallons, comprising 0.5% of annual non-residential water use. By 2020, with LEED certified and "built-to" LEED floor area approaching 45 billion square feet, this figure is expected to approximate 575 billion gallons, or 15.5% of annual non-residential water. This number will more than double by 2030, to nearly 1.3 trillion gallons of saved water, which represents a noteworthy 30% savings of annual non-residential water use.

Wastewater Reductions Based on the fraction of LEED projects pursuing water efficiency, combined with innovative wastewater treatment, we calculated that 18.1 billion gallons of wastewater have been avoided to date, a 0.6% reduction in the annual wastewater generated. This year we included reductions in water use from plumbing and cooling tower savings, as well as estimates of savings in excess of minimum LEED requirements.

We expect savings of over 850 billion gallons of wastewater generation avoided by 2020, growing to nearly 1.9 trillion gallons by 2030. These figures represent, respectively, 30% and almost 68% reductions in annual wastewater generation.

Energy Impacts

Efficiency Savings Are Losing Power

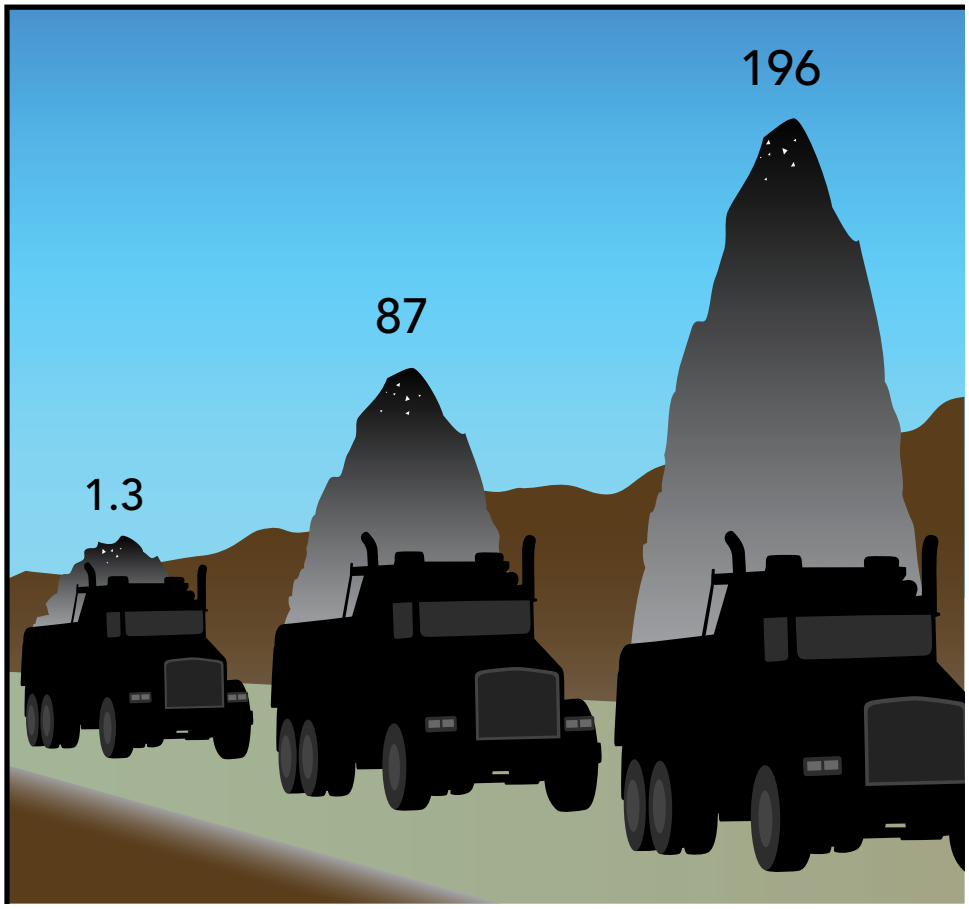
Energy savings are expected to reach 1.75 Quads by 2020 and approximately 3.9 Quads by 2030, or 8.3% and 17.3%, respectively, of national commercial building energy use.

Buildings use more energy than any other human activity and the building sector's share of global energy use continues to grow. It will not be possible to effectively address carbon pollution and global warming without an aggressive, concerted effort to reduce energy consumption in buildings.

The principal influences on how buildings use energy are (1) Occupant behavior, (2) Building design and (3) Technology. LEED attempts to influence building energy use principally through design and technology choices. Because of the large impact of occupant behavior, some LEED buildings are not performing as expected given their design and technology elements. This is an area of controversy and a source of great attention by the US Green Building Council.

Energy Savings Trends in LEED As shown in the table below, based on trends observed in LEED-certified projects, this year we are basing our projections on a smaller percentage of savings against a lower-energy baseline. After the release of Version 2.2 in October of 2005, the USGBC found that projects certifying under this standard were pursuing fewer energy credits than under Versions 2.0/2.1, with fully half the projects not pursuing any LEED credits at all! In response to this trend, USGBC began requiring that projects registered after June 2007 must achieve a minimum of two credits, or 14% energy savings beyond the ASHRAE 90.1-2004 minimum standard.

Energy Savings
(in Millions of Short Tons of Coal)



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	% Savings in LEED Projects		% Savings 2008 GBIR
	Low	High	Low-High
LEED NC 2.0, 2.1	22%	31%	25-31%
LEED NC 2.2	16%	24%	25-31%
CS 2.0	15%	20%	25-31%
EB/EBOM	28%	37%	37%
CI	14.1 (kBut/SF)		

In spite of this temporary sag in energy savings per project, total energy savings estimated in this year's report rapidly outstrips the totals of last year's report, principally due to greater projections of LEED floor area in the future.

For the 2009 base case (low-savings) energy savings scenario, our findings indicated 0.03 quad (quadrillion Btu) energy savings to date, which represents 0.15% of US commercial building energy consumption. This represents 1.3 million tons of coal, enough to fill Yankee Stadium.

Given the acceleration of the adoption of LEED, energy savings are expected to reach 1.75 Quads by 2020 and approximately 3.9 Quads by 2030, or 8.3% and 17.3%, respectively, of national annual commercial building energy use. The High Case savings scenario indicates that energy savings in non-residential buildings could hit 22.3% by the year 2030. The coal represented by these energy savings would fill every football and baseball stadium in the U.S.

National Impact of LEED Energy Savings

	2009	2020	2030
Baseline U.S. Commercial Building Consumption – Quads	19.07	21.09	22.72
TOTAL LEED SAVINGS (Low Case-Quads)	0.03	1.75	3.92
Net Commercial Building Consumption	19.04	19.34	18.80
Percent of 2009 Commercial Building Energy Use Baseline	100%	101%	99%
TOTAL LEED SAVINGS (High Case-Quads)	0.04	2.25	5.07
Net Commercial Building Consumption	19.03	18.84	17.65
Percent of 2009 Baseline	100%	99%	93%
The level of savings calculated for both the Low (Base) Case and the High Case result in a decrease in absolute non-residential energy use by 2030 compared with 2009. In the High Case, net growth in commercial building energy consumption shows an absolute decrease by 2020.			

If the recent growth continues in LEED for Existing Buildings Operations and Maintenance, which is based on measured energy use, we believe that zero net growth in non-residential energy use is achievable by 2020. It would require an aggressive combination of targeted policy and economic measures outside of the scope of USGBC's voluntary program to zero-out net growth in non-residential building energy consumption by 2015.

LEED buildings have purchased or generated 2.45 BkWh total renewable electricity to date, representing 0.2% of annual nationwide non-residential electricity.

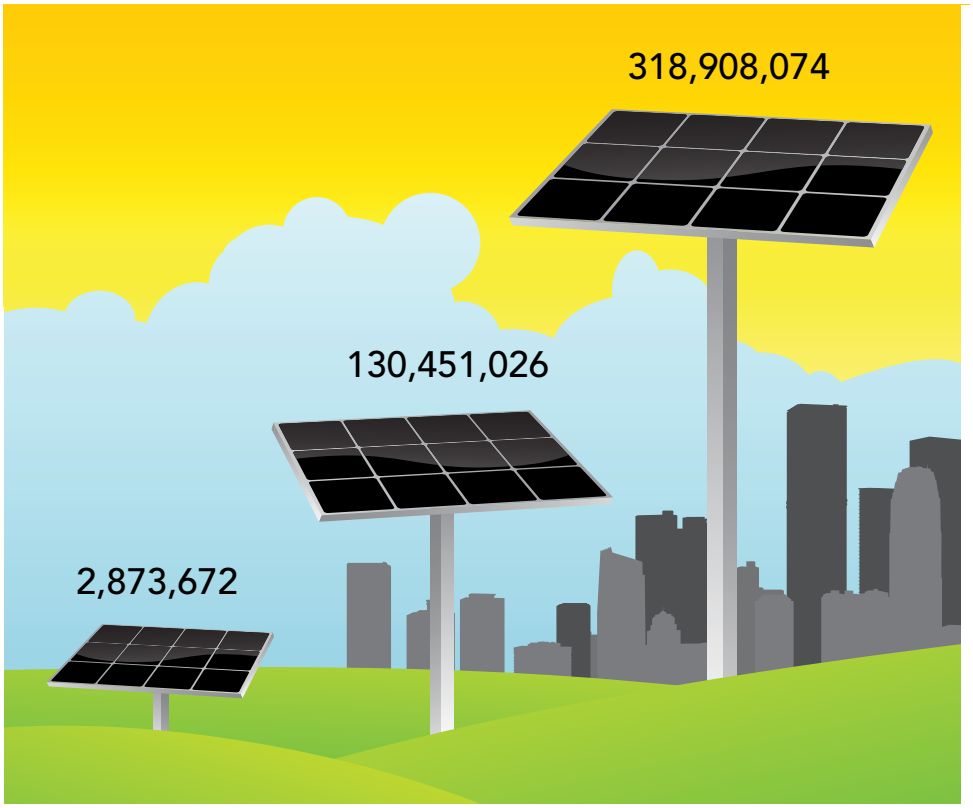
Renewable Energy Impact The use of renewable energy in buildings delivers significant environmental benefits. Though relatively low to date, renewably derived energy in green buildings has considerable growth potential. This comes both in the form of on-site renewable energy technologies as well as (in the case of LEED EB, in particular) using clean sources of energy to power buildings through renewable energy certificates (RECs) and direct purchases of renewable energy.

From our findings, we conclude that LEED buildings have purchased or generated 2.45 BkWh total renewable electricity to date, representing 0.2% of annual nationwide non-residential electricity. Doesn't sound terribly impressive, until you realize that it's almost enough to power the city of Lincoln, Nebraska.

Commensurate with expected continued green building growth, we forecast that green building electricity from renewable sources will exceed 56 billion

Renewable Energy Summary

CO2 reductions (in tons)



Do LEED buildings save energy compared to standard buildings or not? Overall, the answer is an unequivocal "Yes."

LEED Building Renewable Energy

	2009	2020	2030
On-Site Generation (Billion kWh)	0.11	1.45	2.72
Grid Renewable Electricity Purchased (Billion kWh)	2.45	56.84	123.38
% Non-residential Electricity that's renewable	0.2%	3.3%	6.2%
Household Equivalents	240,000	5,471,000	11,836,000

kilowatt-hours by 2020, approaching 125 billion kWh by 2030. These numbers represent 3.3% and 6.2%, respectively, of forecasted annual nationwide non-residential electricity, equivalent to the energy use of 12 million homes.

Emissions Reductions We estimate that the annual CO_2 savings from LEED buildings is approximately 2.9 million tons from energy efficiency and renewable energy. This figure grows to 130 million tons per year by 2020 and almost 320 million tons annually by 2030.

Financial Savings from Commissioning and Monitoring & Verification (M&V): Earlier this year, the Lawrence Berkeley National Laboratory (LBNL) updated its 2004 study on the "Cost Effectiveness of Commercial-Building Commissioning." In the 2009 update, no direct calculation of the economic value of non-energy benefits for commissioning was included, reflecting the difficulty of evaluating the multi-faceted aspects of the commissioning process and the lack of a baseline for comparison. The LBNL report did indicate that non-energy benefits were likely to offset all or most of the upfront costs of commissioning. LBNL found, on average, that projects for new and existing buildings resulted in median energy savings of 13% and 16%, respectively, and had good paybacks: 4.2 years for new construction and 1.1 years for existing buildings.

Do LEED Buildings Save Energy?

Last year, in the first *Green Building Impact Report*, we punted on addressing the critiques that LEED buildings do not save energy, but we feel as though we now need to address this question head on because our work indicates that energy savings are the largest source of environmental benefit in LEED.

So, do LEED buildings save energy compared to standard buildings or not? Overall, the answer is an unequivocal "Yes." Equally unequivocal is our belief that they can save still more.

LEED's holistic approach to building sustainability has expanded the definition of building energy consumption beyond the building envelope to include the building's location, the upstream and downstream energy consumption of water

supply and treatment and the embodied energy of materials. LEED buildings are more location-efficient than average U.S. buildings, more water efficient and use a higher percentage of lower-energy materials.

Okay, so it's about more than just operational energy, but what about operational energy? Are LEED buildings more operationally efficient than regular buildings?

In spite of the ongoing controversy, the answer remains: most are, some aren't and LEED continues to improve rapidly in this area to figure out how and why some buildings slip through the cracks, particularly the buildings that were certified earlier in the system's life.

Early versions of LEED had flaws in the way energy efficiency was evaluated. LEED now requires evaluation based on whole building energy consumption and minimum energy performance.

LEED is not perfect in the efficiency realm, but before going into more detail we think it is important to note that energy efficiency is the area where LEED has changed the most since it was launched. These improvements have been driven both by the importance of the issue and because of some of the problems uncovered by the NBI study and other market and project research conducted by the USGBC.

NBI Study But what of the New Buildings Institute (NBI) study where fully 20% of the LEED certified buildings studied received poor to abysmal Energy Star scores and that only slightly more than 20% of the LEED buildings certified by 2007 actually tracked their energy use to begin with?

Clearly, neither of these findings can be dismissed as irrelevant as they indicate serious problems with how energy efficiency is captured and evaluated in certain kinds of LEED buildings. However, these problems are not representative of LEED certified projects as a whole, particularly more recent projects: Approximately four times more floor area certified in 2007-2009 compared with what certified between 2000 and 2006. Increasingly, projects will have certified under later versions of LEED that corrected many of the problems described below.

About 550 projects were certified by LEED by the end of 2006 and all of these projects were surveyed asked to supply their energy consumption information. About 120 projects responded with all of the necessary information. Another 128 projects responded, but with insufficient data for comparison, for a total response rate of approximately 45%, which is a pretty phenomenal response given the sensitive nature of the information being sought. However, the NBI study discovered some problems in the cohort of certified projects, the most prevalent of which was that the majority of projects were not adequately metered to respond to the survey. As a result of this finding, all LEED buildings certified to Version 3.0 are required to report their energy consumption.

First, it's important to understand the composition of the sample of LEED buildings evaluated by NBI & to recognize that it is not terribly representative of LEED as a whole, particularly today. All of the projects in the survey were certified under LEED Version 2.0 or 2.1, which means most of them were completed before the end of 2005, and in many cases designed before 2000.

Early versions of LEED—versions 2.0 & 2.1—had flaws in the way energy

efficiency was evaluated. These problems stemmed mostly from the early underlying ASHRAE 90.1-1999 standard, which was never intended to be applied in the way LEED applied it. In addition, the part of the "non-regulated loads" that included computer equipment and office electronics was just beginning to explode in the market and this end use was not at all addressed by the ASHRAE standard.

These and other problems continue to be fixed by LEED, which now requires evaluation based on whole building energy consumption and requires minimum energy performance at least 10% beyond code. In addition, ASHRAE has made important improvements by increasing the stringency of the 90.1 standard by about 20% between 1999 and 2007 and by introducing the Appendix G modeling guidance prescribes the modeling rules that allow comparisons between the baseline building and the design case building.

The mechanics of producing an energy savings calculation are ephemeral, particularly with regards to new buildings.

LEED Version	LEED Energy Standard	Requirement
NC Version 2.0 (3/2000)	ASHRAE 90.1-1999	Comply for regulated loads only (envelope, HVAC, lighting); Plug loads not included
NC/CS Version 2.1 (11/2002)	ASHRAE 90.1-1999	Comply for regulated loads; Plug loads not included
Version 2.2 (10/2005)	ASHRAE 90.1-2004	Comply for whole building/Exceed by 14% (after 6/2007) Appendix G Modeling protocol introduced
Version 3.0 (3/2009)	ASHRAE 90.1-2007	Exceed by 10% as a Prerequisite

Savings Compared to What? Everyone loves the concept of "savings" because it connotes a concrete achievement. However, the mechanics of producing a savings calculation are ephemeral, particularly with regards to new buildings.

Savings calculations are just that, calculations. They involve simplifying and standardizing assumptions and the quality of the calculation depends on the degree of accuracy of these assumptions. Another way of putting it: The derivation of savings is always a guess, even with an existing building.

For this reason, most existing buildings in LEED are evaluated according to Energy Star, which relies on actual performance as benchmarked against comparable buildings across the country. And, as noted above, trends in LEED certification and registration are tending much more heavily toward LEED EB/EBOM than ever.

Energy Standard	% Change in Efficiency	U.S. Penetration of ASHRAE Standard at time of LEED adoption
ASHRAE 90.1-1999	N.A.	66% (90.1-1999)
ASHRAE 90.1-2001	0-3%	10% (90.1-2001)
ASHRAE 90.1-2004	15%	45% (90.1-2004)
ASHRAE 90.1-2007	3-5%	8% (90.1-2007)

Some critiques have unfavorably compared the buildings in the NBI study with the performance averages in the Commercial Building Energy Consumption Survey of the Energy Information Administration.

For new buildings, the value of certification comes early in the development process, so waiting for a year or more of energy performance is a non-starter in the market. Thus, we are stuck with "savings." So, again, the question arises: *Savings compared to what?*

Each building is a unique engineered object, so any comparison to averages is problematic. Thus, the most accurate answer depends on how that building would have performed in the absence of efficiency measures. This is the intent of LEED in comparing the code-compliant building with the designed building. In addition, the definition of "code-compliant" is highly variable across the country. Currently, less than 10% of the U.S. building market is required to build to the ASHRAE 90.1-2007 standard two years later. Past upgrades have been similarly slow to be adopted. Thus, in most jurisdictions, merely complying with the ASHRAE standard results in some savings compared to what that building would have done in the absence of the LEED requirement.

On the other hand, benchmarking to comparable buildings is an important indicator of how well the facility is being run and also must be part of tracking building performance over time.

The reality is that empty and occupied buildings are completely different creatures. LEED attempts to true up the differences through the commissioning process, but the necessary reconciliation effort must extend far beyond simple commissioning, particularly in multi-tenant buildings. Our hope is that USGBC and the Green Building Certification Institute (GBCI) will continue to improve the transition from green design to green operations so that buildings certified as green designed can legitimately carry that designation forward into operations.

LEED Building Consumption Compared to "Average" Some critiques have unfavorably compared the buildings in the NBI study with the performance averages in the Commercial Building Energy Consumption Survey (CBECS) of the Department of Energy's (DOE) Energy Information Administration (EIA). The most recent CBECS survey available is 2003, but the 2007 version should be out in late 2009 or early 2010.

There are several problems with comparing these datasets, some of which involve arcane statistics, and some of which involve whether the datasets are indeed comparable and of sufficient quality to draw conclusions.

The arcane statistics part involves the comparison of the median value of the NBI dataset with the mean value of the CBECS dataset. Everyone agrees that this is not a great match statistically, the NBI study authors included. However, for a small, highly variable dataset, the median is a better metric to use because

it fluctuates much less as the data expands. Of course, the larger the dataset, the more robust the mean value becomes.

There is no doubt that CBECS uses the mean value for all of its datasets, but the question is never asked whether it *should* use this measurement for certain sets of data. It's obvious for the coherence of the CBECS report that a common statistical measurement be used, which is why the mean is used consistently throughout and most of the datasets support the use of that measure.

One peer-reviewed paper noted that when the energy values from CBECS and the original NBI study are compared between like categories, such as offices, the energy-saving benefits of LEED are apparent.

Mean Energy Consumption in CBECS for Different Building Groups

90s Buildings - Cohorts	EUI-Site Energy	EUI-Primary Energy	Source
1992 CBECS (Buildings built 1990-92)	69	157	Table 3.2-Total Energy Consumption by Major Fuel, 1992
1995 CBECS (Buildings built 1990-92)	115	242	1995 CBECS-Table 1. Total Consumption Tables
(Buildings built 1990-95)	105	225	1995 CBECS-Table 1. Total Consumption Tables
1999 CBECS (Buildings built in the 1990s	98	220	Table C1: Total Energy Consumption by Major Fuel
2003 CBECS (Buildings built in the 1990s	89	201	2003 CBECS Table C1 (Non-Mall Buildings) p. 249
2003 CBECS (Buildings built 2000-03)	80	187	2003 CBECS Table C1 (Non-Mall Buildings) p. 249

However, as shown in the table above, for small datasets the CBECS-derived mean is wildly variable—the 1990-1992 energy use intensity (EUI) mean fluctuates by over 65% between the 1992 and 1995 CBECS surveys—which simply confirms the statistical preference for the use of the median until the data is sufficiently fleshed out to provide a useful mean value. Indeed, we can see how the value of the EUI for 1990s buildings becomes less variable over time, but still significantly different from the initial survey values.

The other issue involves the mix of buildings in the underlying dataset, particularly the impact of high- and low-energy energy buildings on the overall EUI. The LEED dataset has approximately 17% of its buildings in the high-energy category, compared with 11% in the CBECS survey. In addition, CBECS includes such low-energy building types as vacant buildings and warehouses, comprising 8% of the floor area, whereas none of these buildings were included in NBI's LEED analysis.

Comparison of High Energy-Using Buildings in CBECS and NBI LEED Study

High Energy Buildings in LEED		High Energy Buildings in CBECS	
Occupancy	**% of Sample**	**Occupancy**	**% of Sample**
Data Center	5.0%	Other	2.4%
Health care	1.0%	Health Care	4.4%
Supermarket	1.7%	Food Sales	1.8%
Recreation	1.7%	Food Service	2.3%
Lab ("Other" in CBECS)	8.3%		
Total	**17%**	**Total**	**11%**

NBI's Cathy Turner, in her peer-reviewed paper presented at the 2008 ACEEE Summer Study on Energy Efficiency in Buildings, noted that when the energy values from CBECS and the original NBI study are compared between like categories, such as offices, the energy-saving benefits of LEED are apparent.

The table below shows the impact of using the median versus the mean value, though the only conclusion that can be drawn is that the early LEED buildings evaluated by NBI have saved less than anticipated—certainly not that LEED buildings use more energy than an average building.

LEED and CBECS Office EUIs by Size

(Source: Green Building Performance Evaluation: Measured Results from LEED-New Construction Buildings, Cathy Turner, Mark Frankel, New Buildings Institute, 2008 ACEEE Summer Study on Energy Efficiency in Buildings)

Size Range	CBECS	LEED Median values		LEED Mean values	
(Square Feet)	Site EUI (kBtu/SF)	Site EUI (kBtu/SF)	LEED/ CBECS	Site EUI (kBtu/SF)	LEED/ CBECS
Under 25,000	80	46	58%	46	58%
25,001-100,000	91	66	73%	72	79%
100,001-200,000	101	77	76%	78	77%
Over 200,000	105	80	76%	79	75%
Size-Weighted Average	94 (all bldgs.)	62	66%	68	72%
LEED Savings			34%		28%

Materials Impacts

Reusing More, Wasting Less

Although buildings use approximately 40% of all materials produced, the Materials & Resources category in LEED was downgraded in importance in the LEED 2009 update.

Although buildings use approximately 40% of all materials produced, the Materials & Resources category in LEED was downgraded in importance in the LEED 2009 update. However, data on the environmental impacts of buildings is improving somewhat, particularly in the quantification of embodied energy. The window manufacturer Serious Materials commissioned Lawrence Berkeley National Laboratory to quantify embodied energy in building materials and this analysis shows that approximately 8% of all energy use in the United States goes to residential and non-residential building materials.

As LEED moves toward a more normalized lifecycle assessment basis for evaluating the onsite, upstream and downstream impacts, we believe that we will better be able to evaluate these impacts comprehensively.

Building & Materials Reuse Reusing buildings is becoming more common for LEED certified projects, with 12-15% of LEED NC and LEED CS projects reporting significant reuse of buildings and interior components, up from 12% reported in our 2008 study. In square footage terms this exceeds 68 million square feet to date. Our calculations show that this figure will exceed one billion square feet by 2020 and two billion square feet by 2030.

Embodied Energy Impacts Last year we inadvertently omitted the embodied energy impacts of building reuse, so this year's figures are significantly larger than last year's. We estimate that building and materials reuse in LEED buildings have saved cumulatively almost 17 million barrels of oil equivalent in embodied energy, which will grow thirtyfold to over 510 million barrels equivalent by 2030, which is approximately equivalent to the amount of oil currently imported from Saudi Arabia.

Construction & Demolition Waste Aggregate data show that over 60% of the C&D waste generated by LEED NC projects is diverted. CS and CI projects are estimated to have a weighted waste diversion rate of approximately 54%. Between cumulative certified and "built to" projects, we estimate that LEED buildings have recycled or reused elsewhere a total of nearly 25 million tons of construction waste so far. These diversion figures are expected to mushroom to over 400 million tons in 2020 and 780 million tons in 2030.

Green Materials Impacts The varied use of materials and the lack of good data make an evaluation of materials' other environmental impacts difficult. For this reason LEED chose to evaluate several materials categories on a dollar basis, as did we.

	2009	2020	2030
Green Building Materials Spending in LEED	$7,100,000,000	$120,700,000,000	$233,900,000,000

Approximately 38% of LEED NC projects specify Forest Stewardship Council (FSC) certified wood.

Based on average materials costs, local and recycled-content building materials represented approximately $7 billion in cumulative spending through 2009. By 2030, cumulative spending in this area is expected to exceed $230 billion. In spite of greatly increased LEED floor area forecasts, our materials value figures are only slightly higher than the values calculated last year. This year we factored in the potential for materials having overlapping sustainability characteristics. For example, a local material might also have recycled content. We also should note that these figures are conservative because they do not include the value of materials that are evaluated based on their indoor environmental quality characteristics, such as paints and adhesives.

Certified Wood Approximately 38% of LEED projects specify Forest Stewardship Council (FSC) certified wood for half the value of the forest products in the project. Based on average non-residential wood use estimates and the penetration of the certified wood credit in LEED our evaluation shows that to date over 220 million board-feet equivalent of certified wood has been installed in LEED projects. If current penetration rates continue, this utilization will exceed 8 billion board feet by 2030.

LEED Building Materials Facts

	2009	2020	2030
Building Reuse (Million square feet)*	68	1,062	2,030
Annual Energy savings (Million barrels of oil equivalent)	16.7	267.3	512.9
Materials Expenditures ($US billions)	$7.1	$120.7	$233.9
C&D Waste Diverted (Million tons)	24.6	405.0	782.0
Certified Wood Use (Million board feet)			
NC Projects	188.1	2,566.3	4.8
CS Projects	25.8	595.5	1,194.1
CI Projects	9.1	996.2	2,174.1
Total	223.0	4,158.0	8,169.0
* Based on LEED NC and LEED CS only			

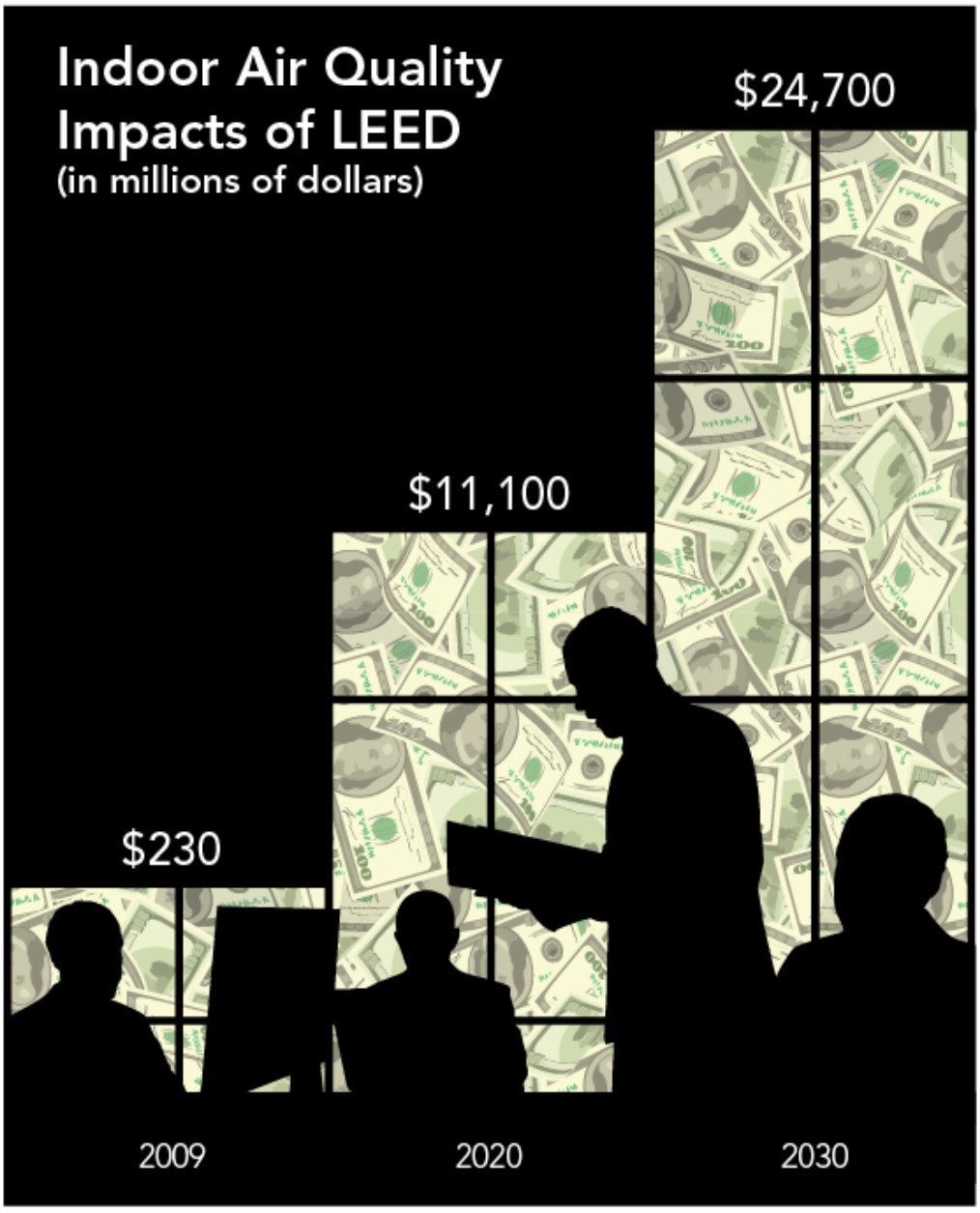
Indoor Environmental Quality

Cleaner Air Leads to Healthy Profits

We calculated that at least 580,000 employees are currently enjoying improved indoor environments in LEED buildings.

Early conventional wisdom had it that green principally was a soft public relations gimmick that maybe could be justified by savings in operations costs. Now, this thinking is increasingly being shown to be the product of the "90/10 Syndrome" where people spend 90% of their time quantifying 10% of the benefits. While operational savings are real and important, we believe that the financial benefits in LEED are largely achieved through the enhancement of employee productivity. Salaries represent approximately 90% of the money flow through a building, the rest being amortized construction costs and operations and maintenance, including utilities.

For our estimates of green building benefits from LEED, we assume a conservative range of 1%-2% productivity increase in "built-to" and LEED-certified projects, respectively, from the aggregate of the indoor environmental quality measures rewarded by LEED.



We believe that our productivity estimates understate the true benefits of green, particularly in light of recent research by the University of San Diego on LEED and Energy Star certified buildings, as well as that done by CB Richard Ellis (CBRE) on LEED and BREEAM certified projects internationally. The San Diego study of 5,000 tenants in 124 buildings found that for tenants self-reporting higher productivity and fewer sick days taken, these increases were approximately 6%.

While not all buildings reported these benefits, the studies reviewed by the University of San Diego researchers covering a range of work situations showed productivity increases from green building measures ranging from 1% in manufacturing to over 25% in an Australian law office.

And green buildings also are putting building owners on the Yellow Brick Road. CBRE found that certified green buildings showed an income increase of 6% through a combination of higher occupancy and higher rents. When capitalized at prevailing rates, this increase was found to increase building value an average of $5 million.

Taking an average of the number of employees affected by various features of green buildings, we calculated that at least 580,000 employees are currently enjoying improved indoor environments in LEED buildings. Presuming that LEED floor space—particularly LEED EB—continues to grow through the next 10 to 15 years, the "green building workforce" is expected to approach 29 million by 2020, becoming almost 64 million strong by 2030.

Our results reinforce the notion that the bottom line of green is black: an estimated $230 million to $450 million has already been saved through added productivity of the "green building workforce." Given continued growth in green buildings, we expect this number to grow significantly in the future: reaching between $11 billion and $22 billion by 2020, and totaling between $25 billion and $49 billion by 2030.

The Big Picture

Can LEED Make a Dent in Climate Change?

As demonstrated by our research, LEED buildings conserve the land, save water and energy, reduce materials impacts and result in better, more productive indoor environments.

The LEED Green Building Rating System has been a key, transformative element in moving the building industry in America and abroad toward sustainability.

As demonstrated by our research, LEED buildings conserve the land, save water and energy, reduce materials impacts and result in better, more productive indoor environments. The market has embraced LEED because it allows people to do well, while doing good.

The general scientific consensus is that in order to maintain global carbon dioxide levels at less than twice pre-industrial levels, carbon dioxide emissions would need to be reduced by 80% below the levels of the year 2000 by 2050. CO_2 concentrations in excess of 500 ppm are feared to give rise to unmanageable global warming. "Unmanageable" means global warming cannot be mitigated or adapted to and, as John Holdren, Director of the White House Office of Science and Technology Policy, has said, the only alternative is to suffer. To put the magnitude of this challenge in perspective, in spite of projected floor space increases of 150%, total building sector emissions in 2050 will need to be only 20% of their current levels.

Robert Socolow and Stephen Pacala of Princeton University have suggested that these reductions can be split into "wedges" of global actions, each of which results in annual CO_2 reductions of 4 billion tons by 2050. Applying eight of these wedges before 2050 would allow emissions and CO_2 levels to stabilize. One of these wedges is energy efficiency in buildings. The Princeton analysis indicates that a 25% reduction in global building electricity use would be equal to one 4 billion ton CO_2 reduction wedge. Some large buildings are claiming to approach carbon neutrality, so in theory buildings could squeeze out two wedges instead of just one.

Under our fairly aggressive uptake forecast for LEED, by 2030 approximately 10% of a wedge is accomplished in the US alone. However, this means that LEED-equivalent and beyond standards will still need to increase tenfold by 2050.

The Little Picture If we assume that this 80% reduction were to be spread evenly, then buildings' CO_2 footprint on a per square foot basis would need to decline steadily each year, by roughly 1.6% or a total of 16% improvement by 2009.

The good news is that LEED buildings are still somewhat ahead in terms of their own performance relative to this goal. The bad news is that the entire building sector must hit this reduction target.

Indeed, LEED buildings' better performance still barely makes a dent in reducing of building sector CO_2 emissions, even as far out as 2030. We need more savings, and faster, in order to reduce total emissions at the necessary scale, scope and speed.

How much more and how much more quickly? Last year our back-of-the-envelope guesstimate was that by 2010, average LEED buildings needed to be at least 35% more efficient than average buildings and that the LEED EB standard will need to penetrate 50% more rapidly than our projections in order to stay on track. While LEED EB penetration did increase significantly beyond

last year's estimates, the energy-saving performance of the average LEED building decreased somewhat.

We are cautiously optimistic that USGBC improvements to the LEED system will halt this performance slide in the mid-term, but the current market downturn makes short-term predictions nearly impossible.

Building codes will need to improve by greater amounts and more frequently.

The efficiency performance of certified LEED EB projects and their growing penetration is encouraging, but even our High Case savings forecast would need to double and be coupled with significant improvements in minimum efficiency standards in order to have even a remote chance of hitting the building wedge even in the United States.

Market Transformation Realistically, LEED cannot do it all by itself. LEED is a vital part of the market transformation process that combines market pull with regulatory push. On the market-pull side, LEED was designed to lead by improving the performance of the top quartile of buildings and in fewer than 10 years it appears to nearly have succeeded in achieving this market share objective. However, LEED will need to be supported by accelerating the uptake of energy efficiency measures in the mass market.

Additional market mechanisms in the form of technology incentives and energy prices that reflect true environmental and social costs will also be needed to accomplish these goals. Regulators must enable utilities to significantly ramp up their energy efficiency incentive programs. Grid connection fees could be established that reward efficient "grid-smart" buildings with low to no fees, while code-minimum buildings should get socked with hefty hook-up fees. Banks and insurance companies must increase their current offerings for green buildings to reflect the lower risks of green buildings, as well as help minimize total extra initial costs of green. Non-economic incentives, such as accelerated permit approval and project density bonuses for advanced levels of efficiency will also help improve green uptake.

In addition, policymakers must price carbon.

We know with 100% certainty that zero is the only price that is precisely wrong.

No matter what price is put on carbon, approximately right will be better than what we have now.

This *is* a policy decision, since our current 18th century market structure is not capable of pricing social goods (like the survival of the human species) without intervention.

What's Next?

Feedback wanted

This is our second comprehensive evaluation of the environmental impacts of green buildings as represented by the LEED Green Building Rating System. The Green Building Market & Impact Report continues to be a work in progress. Although we were pleased with how many new sources of real data on building performance were available this year compared with last year, many aspects of our assessment still stem from educated guesses.

In true American tradition, we hope to continue improving and expanding the GBMIR, but we don't want to do so without your feedback. We expanded our LEED market section and tried to get a bit more under the skin of the 'does LEED save energy' question, and we looked at international trends a bit more, but so what? Is this important to you, our readers?

Please give us your thoughts on how to make the report better next year. What are the green building performance and analytical issues you are dying to know about…or know even better than we do? Send your ideas and comments to greenbuildings@greenerworldmedia.com.

GREEN BUILDING MARKET AND IMPACT REPORT 2009

Appendix: Methodology

Floor Area Calculations The calculation of environmental impacts in this report has its foundation in a spreadsheet model that quantifies and projects the total floor space of certified and registered LEED NC, LEED CS, LEED CI, LEED EBOM and LEED for Schools and LEED for Retail Application Guide projects. Based on data available from the USGBC and the methodology described below, we calculated floor area streams of LEED Certified and "built-to" LEED projects into the future.

2000-2009: We used actual historical figures from the US Green Building Council though 2008. For 2009, we used actual project figures through the end of September 2009 and assumed that 4th quarter results would mirror 3rd quarter registrations and certifications. Due to some reporting issues, we have project counts for LEED Version 3, but not floor area. We used historical average floor area by rating system to estimate floor area additions from the 2009 (V3) rating systems.

2020 and 2030 Projections: Based on reported construction starts and LEED project registration data, we can estimate a "penetration" of LEED projects in the market. This penetration data served as the starting point for making a best guess on the future trajectory of LEED. We modeled our post-2009 projections of LEED registrations based on a Pearl-Reed growth curve, which is an 'S'-shaped function that trends toward an upward limit. Pearl-Reed curves often are used to simulate and predict technology penetration trends.

We assume that the maximum penetration of LEED registered projects is 25% in any given construction year for any given standard. This forms the upward limit of the Pearl-Reed S-curve. Each standard, based on historical performance and market size has a different curve. Using historical data, we then made a best fit to a Pearl-Reed curve and used this curve to project registrations forward.

We then "graduate" the registered projects to certified projects. On average, based on historical certification rates to date, about 70% of CS, CI and EBOM projects that register ultimately certify, though NC projects seem to only certify about 60% of registered projects. Projects register at different points in their design/construction process and that produces a wide range of time spent registered in the system prior to certification—from 4 months to over 4 years, with an average of just under 3 years. Projects that register, but do not certify are classified as "built-to" LEED (see below).

International Projects The number of overseas LEED projects has grown to represent over 25% of all the floor area in the system. However, because of the infeasibility of developing environmental performance baselines for the over 100 countries where LEED projects are registered, the commercial model evaluates only the environmental impacts of green buildings in the U.S. As an order of magnitude, however it would be safe to say that the global environmental impact of LEED is at least 25% larger than is reported here.

"Built to LEED" In evaluating the impacts of LEED we also created a category we call "built to LEED." Generally, these are projects that register, but don't certify—approximately 30% of registered projects to date according to our research. While we do not expect these buildings to achieve the same level of

green performance of LEED certified buildings, the performance is not zero and, in aggregate, their environmental impact is not trivial. Though we do not have measured figures to corroborate the impact of LEED on these buildings, we assume that their achievement is half that of a certified project.

Site/Land-Use Impacts Methodology According to research by the Natural Resources Defense Council (NRDC), location-efficient development—a combination of density and transit accessibility—results in a 30% reduction in vehicle miles traveled. We use this figure as a proxy for the range of measures used in LEED for reduce travel demand.

For the various site-related impacts, we calculated an average plot size based on average project floor area and an estimated average floor-area ratio (FAR) for each project.

Water Savings We derived baseline water consumption figures from the US Geological Survey (USGS) figure for daily water use in order to obtain an annual per square foot figure for water consumption in commercial buildings. This served as a baseline case against which LEED water savings were measured.

Plumbing and Cooling Tower Savings To derive water savings estimates in this area, we took a weighted average of the percentage of water saved in LEED buildings based on the percentage of projects that have achieved specific credit ratings and quantifiable (20% or 30%) water savings requirements. In order to ascertain total savings, we first multiplied the percentage savings by the baseline gallons of water consumed per square foot of commercial space. Taking climate disparities into consideration—i.e. warmer climates demand more air conditioning, and thus buildings in warm climates use more water in cooling tower applications—as well as the water consumption levels that differ according to the age of buildings, we conservatively took 13 gallons of water per square foot per day as the baseline number against which we compared NC and CS buildings, and 22 gallons against which we compared existing buildings. We finally used the derived gallons of water per square foot per day saved in green buildings and multiplied it by total LEED floor area to yield an aggregate figure.

Landscaping Water Reductions To derive landscaping-related water savings, we similarly took a weighted average of the percentage of water saved in LEED buildings based on the percentage of projects that have achieved quantified landscaping water reductions. In order to ascertain total savings, we first multiplied the percentage savings times the baseline gallons of water consumed on landscaping per square foot of commercial space to get the per square foot savings. As with plumbing and cooling tower use, we took geographic water consumption disparities into consideration, and conservatively used 19 gallons of water per square foot per day as the baseline number of water used for landscaping. We finally took the derived gallons of water per square foot saved in landscaping of green buildings and multiplied it by total LEED floor area to yield an aggregate figure.

Wastewater Reductions: Wastewater figures were derived in a similar fashion, using an average of 40.9 gallons of water generated per square foot daily in commercial buildings. Considering that implied reduction in usage from efficient cooling towers is not included, the final estimated savings are believed to be a conservative estimate.

Energy Methodological Issues This year we used the 2003 CBECS (Commercial Building Energy Consumption Survey) report as the primary data source for Base Case primary energy, as opposed to DOE's Buildings Energy Data Book (BEDB). We felt that CBECS provided a more consistent and survey-based data source across the range of calculations than the BEDB, which combines survey data with calculations.

2009 Savings & Baseline Estimates vs. 2008 Report The two tables below compare the underlying information behind the calculated energy savings.

2009 Report	Base Case-Primary Energy (kBtu/SF)	% Savings in LEED Projects		LEED Primary Energy Savings (kBtu/SF)	
		Low	High	Low	High
LEED NC 2.0, 2.1	209[1]	22%	31%	44.5	63.6
LEED NC 2.2	194[2]	16%	24%	32.7	49.0
CS 2.0	77[3]	15%	20%	11.6	15.4
EB/EBOM	191[4]	28%	37%	53.6	70.8
CI				14.1	

1 Consistent with primary energy use in buildings built in the1990s per 2003 CBECS.

2 Consistent with primary energy use in buildings built in the 2000s per 2003 CBECS. Though we believe this dataset is too small to be reliable and that actual energy use in this cohort may be higher than the initial reporting, we use this figure as a conservatism.

3 Assumed to be 40% of New Construction baseline to reflect smaller portion of load addressed by the standard.

4 Consistent with primary energy use in "all buildings" surveyed in the 2003 CBECS, including mall buildings.

2008 Report	Base Case-Primary Energy (kBtu/SF)	% Savings in LEED Projects		LEED Primary Energy Savings (kBtu/SF)	
		Low	High	Low	High
NC/CS	241	25%	31%	60.1	75.1
EB	241	37%		88.3	N.A.

The data from nearly 1,000 LEED Certified project scorecards provided the percentage savings for the report. For the New Construction standards, we felt that a range of values better reflected the uncertainty around using predicted savings as a long-term indicator of building performance. The Low Case value in the existing building category is based on the average score of certified LEED EB projects and the High Case value is the average achieved by certified EBOM projects to date.

Renewable Energy Savings We used the breakdown of LEED projects that have attained various percentages of on-site renewable energy generation to obtain a weighted average of total renewable source electricity green buildings have contributed. We introduced a 20% measurement adjustment for LEED CS floor area to reflect the smaller baseline of consumption and to account for potential double-counting of LEED CI projects. Finally, we assumed that all renewable energy associated with LEED EB came in the form of RECs and not on-site generated electricity.

Commissioning This year, as an additional conservatism, we have assumed that the value of commissioning and M&V is represented in the energy savings only. Although less than 25% of the 640+ buildings in the updated 2009 LBNL report on the value of commissioning were commissioned in the context of LEED, we assume that the value of energy and non-energy benefits resulting from commissioning are embedded in the LEED energy savings results. Consistent with this approach we also assumed that the achievement of M&V credits contributed exclusively to the persistence of energy savings and do not represent an independent benefit of LEED.

Conservatisms Given the range of inconsistent data sources, we continue to be conservative in our calculation methods. When ranges of impacts of LEED measures were calculated, we used the low figures derived. In addition, we only based our savings on the LEED requirement, as opposed to thresholds actually achieved. For example, if a project purchased renewable electricity to cover 75% of its needs, that project only would be quantified at the 50% LEED threshold. Similarly, projects achieving energy efficiency credit in between the point thresholds are assumed to save at the lower level. In addition, we assume no "free driver" effects—for example improvements in the ASHRAE 90.1 standard or the development of ASHRAE Standard 189.

IEQ Methodology To determine the number of employees currently enjoying better IEQ through green building design, we began by using the DOE Commercial Building Energy Consumption Survey's (CBECS) figure for commercial floor space per employee. Determining the average number of employees was a simple expression of the total floor space divided by the per employee floor space.

The "green building workforce" figure was then multiplied by the implementation rate—or the percentage of floor space affected by various IEQ-related improvements. For example, improved ventilation effectiveness was implemented by roughly 25% of LEED projects, so the number of employees affected by this feature would be roughly one-fourth the total "green building workforce." Then these workforce figures were averaged to get the final figure.

Using Department of Commerce figures to determine average annual earnings of the employed workforce, we used both a conservative 1% productivity gain (low) and 2% productivity gain (high) to produce an aggregate figure. This approach is consistent with that taken by Capital E in its study of the economic benefits of green buildings in California. Additionally, this calculation excludes some green building-related health benefits not easily quantifiable, increasing its conservatism.

About the Author

Rob Watson is the Executive Editor of GreenerBuildings.com, the one-stop website for the green design, construction and operation of commercial and institutional buildings. GreenerBuildings.com is produced by Greener World Media, the leading media company focused exclusively on the greening of mainstream business.

Described by Thomas Friedman as "one of America's best environmental minds," Watson also serves as the Chairman, CEO & Chief Scientist of the EcoTech International Group, which helps clients around the world achieve cost-effective high performance green buildings through design, technology and operations.

Under Rob's direction as the "Founding Father of LEED" and as its national Steering Committee Chairman between 1994 and 2005, the U.S. Green Building Council's LEED rating system became the most widespread and fastest-growing standard by which green buildings are measured worldwide. A pioneer of the modern green building movement for over 20 years, in 2007 Rob founded the EcoTech International Group to meet the fast-growing demand for green building technologies and services in China, India and the U.S.

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