LEED Costs, Benefits and ROI

(Energy, Water, CapEx, Health and Productivity)

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2016/2017

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THE COSTS AND BENEFITS OF LEED CERTIFICATION

When it comes to the decision making process for real-property investments, first cost savings are often a priority over green building and sustainable life cycle creation. A perceived lack of information about the actual costs and benefits of green buildings has led, in some cases, to concerns about whether to make a higher investment.[1] There is still some ambiguity about the actual performance of green buildings, (especially regarding energy savings). Despite this ambiguity, however, the general link between high performance buildings and benefits for energy, environment, health and productivity has been proven, and a conceivable return on investment (ROI) on their construction has been noted as well.[2] Practical tools and frameworks have been designed to facilitate decision making and for measuring factors that are not easy to quantify, such as employee well-being and productivity.[3] Obtaining the maximum ROI, however, requires an early integrated, well thought out design[4], which can be achieved through planning and implementation of a project that follows certified green building standards.

Why do you need a certificate?

A green building program provides more than a badge and the standards that come with it. Most of all, it offers guidance, multiple options to pursue your goals, as well as a wealth of experience and expertise. In addition, it gives your endeavour transparency and the credibility it deserves. A certification is the best and easiest way to obtain ethical and economical recognition for your projects.

LEED is the world's leading green building certification program and the referenced standard of the USA. This paper aims to offer insight into the costs and benefits of LEED certified green buildings.

WHAT IS LEED?

LEED (Leadership in Energy and Environmental Design) is the most widely used, internationally recognized third-party verification for green buildings. It was developed by the United States Green Building Council (USGBC) with its parent organization, the World Green Building Council. The independent Green Building Certification Institute (GBCI) examines and evaluates all registered LEED projects and qualifies LEED Accredited Professionals.

Why LEED?

LEED was the first official green building certificate and thus maintains a high level of awareness, credibility and a good reputation among developers and users worldwide. The program offers clear and simple guidelines with various options for implementation, leaving planners a wide scope of development options. The system can be customized to suit your project requirements

By focusing on resource efficiency, reduction in emissions, health aspects and a sustainable, cost-efficient building life-cycle, LEED takes ecological, economical and socio-cultural factors into consideration with regards to the construction of new buildings. LEED is an open system that adapts to the current state of technical development. The latest version (LEED v4) comes with many improvements compared to the former versions, such as better commissioning and performance requirements.

HOW DOES LEED WORK?

In addition to minimum requirements, project-type-specific credits for the following sustainability-related areas of construction can be obtained: 'Sustainable Sites', 'Water Efficiency', 'Energy and Atmosphere', 'Materials and Resources', and 'Indoor Environmental Quality'. For each category, there are a maximum number of points that can be achieved.

Based on the points, the project is classified according to one of four LEED rating levels, as shown in the table.[5]

LEED project types		
BD+C	Building Design and Construction	New construction or major renovation
ID+C	Interior Design and Construction	Complete interior fit-out
O+M	Building Operations and Maintenance	Improvement of existing buildings
ND	Neighbourhood Development	Land development or redevelopment
HOMES	Homes	Up to mid-rise multi-family homes

HOW TO ACHIEVE LEED CREDITS

In the area of Material and Resources, "storage and collection of recyclables" is one of the required prerequisites, while "building life-cycle impact reduction" is one of several pursuable credits for which up to five points can be earned. How many points are given per credit depends on the option used, which here is "to encourage adaptive reuse and optimize the environmental performance of products and materials." The option "renovation of abandoned or blighted building," for example, is worth up to five points, while "building and material reuse" can net between two and four points. The number of points earned is dependent on the percentage of reused completed project surface area.

HOW TO OBTAIN THE LEED CERTIFICATE

LEED projects must be registered online at https://lo.usgbc.org/. Careful documentation, either internally or through the support of an experienced external consultant, is then is then prepared and submitted to GBCI. It will then be reviewed by independent industry experts for compliance and certification eligibility. Detailed guides to LEED certification, as well as LEED Reference Guides with information on each credit and prerequisite are available online.[6]

THE GREEN COST PREMIUM

With the creation of green buildings, examining Capex costs only makes sense when the return on investment (ROI) is also taken into consideration. Investors, however, might still want to know about up-front costs for reasons of planning their initial investment, long-term benefits notwithstanding.

Actual As-Built Construction Premium

According to various sources compiled by the WorldGBC in 2013, estimated green building costs are often higher than the actual reported costs.

Actual - 0.4% - 12.5%

Initially Estimated - 0.9% - 29%

Additional costs for construction according to green building standards cannot be stated as a lump sum nor as a definite percentage, as it depends on the level of certification and the strategy that the project team has decided upon. A significant gap exists in the quantified cost premium range, and the amount of literature addressing the issue does not reflect the significance of the problem, according to Dwaikat and Ali.[7] There are, however, some helpful methods by which to estimate possible additional building costs.

According to the WorldGBC's 2013 green building report, actual reported green premiums range between 0% and 12.5%, with the majority ranging between 0% and 4%. Higher levels of certification (e.g. LEED Silver/Gold) range from 0% to 10% and the highest levels (such as LEED Platinum) from 2% to 12.5%.[8]

Majority of green premiums range between 0% and 4%.

The ranges given usually start at zero (or below), thus in certain situations, green building certification can actually be achieved with no additional Capex costs. There are several examples of this. For instance, Dwaikat and Ali report a range of green cost premiums from –0.4% to 21% for 90% of the 17 empirical studies in their 2016 review, with two projects reported to have cost less than their conventional counterparts.[9] In a 2006 cost and benefit analysis of 30 US LEED-standard green schools, the green premium ranged from 0 – 6.27% (averaging at 1.65%), with four schools built green at no extra cost.[10] An analysis of over 20 LEED projects at Harvard University in 2007 demonstrated that 40 LEED credits could be achieved with no additional cost (assuming efficient management was involved).[11] A 2006 study compared construction cost per square foot of 83 LEED buildings to 138 similar non-LEED buildings

and found that there was no significant difference in the average costs for between the two building types.[12]

GREEN PREMIUM

The term green premium refers to the cost premium typically needed to build a green building versus a conventional building - the up-front cost of which is often greater. These costs are driven by investing in high-performance features such as more sustainable materials, better mechanical systems, design and modelling, as well as the cost for certification.

LEED CERTIFICATION COST

Costs for the certificaton itself depend on the type of project, and discounts are available for USGBC members. Rates can be checked at http://www.usgbc.org/cert-guide/fees

"An increasing number of project teams were shown to have delivered LEED-certified buildings within a budget comparable to that of non-LEED-certified buildings"

(WorldGBC 2013)

EVERYTHING COMES AT A PRICE

According to Loftness et al. (2003) from the Center for Building Performance and Diagnostics at Carnegie Mellon University, the first critical stages in environmental design and engineering, such as orientation, layout, and the use of passive conditioning systems, may not have an impact on the initial cost. They do add, however, that high performance materials, components and systems will increase first cost.[13]

What is the benefit of using these more costly materials? The answer is a measurable life cycle benefit. Even if first cost may increase, quality increase can outperform this investment in a reasonable timescale. The higher the green premiums, the higher the potential for benefits.[14] In other words, non-green building, or even lower certified green building, can come at the price of missing out on long term economic, ecologic and societal benefits.

GREEN BUILDING BENEFITS

Why would you want to make your building green? The most common answer is to reduce environmental impact. This can be done through the use of sustainable and sustainably sourced materials, reduced consumption of energy and water, and lower emissions, which alone should be enough of a reason.

One advantage is that sustainable development comes with life cycle benefits in the form of long-term savings for operations and maintenance, as well as health and productivity benefits for occupants. Energy and other savings in well-planned green buildings do not only typically pay off in a reasonable period, but these cost-saving factors can also considerably increase your project's value, especially when it is certified. Higher lease rates and selling or renting opportunities are almost always the result of green building certification.[15] These add a short-term edge to the long-term perspective.

The next section of this report will outline the benefits of creating green buildings in further detail.

Operation & Maintenance

- Water savings
- Energy savings
- Waste cost savings

- Other maintenance savings

Work, Life & Community

- Health benefits
- Increased productivity
- Lower emissions / overall environmental impact

Assets

- Developer's reputation
- Higher lease rates and occupancy
- Higher sales chances and prices

GREEN 'MAINSTREAM' REDUCES COSTS

A reduction in reported green cost premiums over time has been observed (USGBC 2013), as well as reduced cost for a builder's subsequent green buildings (Quelle).

- Increasing readiness of the building industry to adopt LEED practices
- Improved worldwide supply chains at reduced rates
- Increasing awareness, acceptance, education, expertise
- More experienced professionals/consultants for green design
- Higher sustainability awareness and demand of clients
- Higher non-green building standards, reduced cost/performance gap against „business as usual"

ENERGY SAVINGS

Energy savings in green buildings are achieved by a combination of factors, such as more efficient lighting systems, more efficient heating and cooling systems and sufficiently insulated walls and roofs. Green buildings typically, but not always, use more renewable energy.[16]

EXAMPLES:

In a 2013 study of LEED buildings at UC Berkeley, Diana Zheng compared post-occupancy energy use from three LEED-NC projects to energy use in conventional buildings, LEED energy models, and pre-LEED building energy use. Her results showed LEED buildings to use less energy than conventional buildings, and they performed as expected or better than the energy models in two out of three cases. She concludes that LEED energy models can be fairly accurate, if the assumptions of the building post-occupancy situation in the model are true.[17]

"Energy savings in green buildings typically exceed any cost premiums associated with their design and construction within a reasonable payback period."

(WorldGBC 2013)

In a 2006 Capital E analysis of 30 green US LEED standard schools by Gregory Kats, an average energy reduction of 33% compared with conventional design was found, which translates to an average savings of $0.38/square foot per year in green schools. This report did not quantify additional energy savings that are expected from the installation of reflective roofs or green, planted roofs ("cool roofs") which absorb less sunlight and lower the ambient air temperature. Not only do these roofs reduce ground level ozone creation, cut smog formation and improve comfort and health, they also cut the cost of air

An average energy reduction of 33% compared with conventional design was found, which translates to an average savings of $0.38/square foot per year in green schools

conditioning and thus contribute to further energy savings, especially in warm climates. Additionally, cool roofs and green roofs last considerably longer than conventional roofs because they experience less expansion and contraction than non-reflective roofs.[18]

Indoor environmental quality and energy conservation reduce thermal energy by 20% - 60%.

Loftess et al. (2003) cite several studies that indicate energy savings for high-performance installations. According to the authors, complementary gains in indoor environmental quality and energy conservation should reduce thermal energy loads by 20% - 60%. This can happen, for example, by means of a combination of individual temperature control and responsive central systems (43%) or a reduction in HVAC energy use with smaller HVAC zone sizes, occupancy sensors and broadband set points (14%). Additionally, emerging studies on mixed-mode HVAC demonstrate 39.6%-75% reductions in annual HVAC energy consumption. For improved lighting, the authors identify 13 studies that show energy savings of 25%-90% as a result of daylight responsive dimming, innovative control systems and high quality fixtures.[19]

THE CONTROVERSY ABOUT ENERGY SAVINGS

We do not want to shy away from the fact that some studies and reports on LEED energy performance have been criticized, for example, for comparing LEED certified buildings to average non-certified buildings which are older and therefore less energy-efficient. Other criticisms include pointing out site energy results and not source energy consumption, and for 'cherry-picking' the best results for presentation purposes. The lack of energy consumption data for LEED and other commercial buildings is another critical point.

In 2006, the USGBC commissioned the New Buildings Institute (NBI) to gather and analyze energy performance data from new construction buildings that had been LEED certified. Based on volunteered energy data, the NBI found an average energy savings of 25%-30% energy compared with conventional buildings, with savings increasing with higher levels of certification.[20] Critically re-examining the same data, John H. Scotfield (2009) found that LEED certified buildings used just 10%-15% less site energy than comparable, conventional buildings. Regarding source energy (primary energy) consumption, he did not find a significant difference in his examination.[21]

Several large U.S. cities, for example New York and San Francisco, also require all commercial buildings to submit energy consumption data. These data found that LEED office buildings certified at the Gold and Platinum level outperform other office buildings, but they did not find significant source energy savings for lower certified LEED buildings. This makes sense, as a lower LEED certification (LEED Certified/Silver) might not have gained enough energy credits to achieve the points needed for certification. This allows for the possibility for lower-level certified LEED buildings to focus their certification strategy on energy credits and to then achieve the same benefits as higher-level certified projects.

WATER AND WASTEWATER SAVINGS

There are measurable financial benefits of reduced water and sewer costs associated with green design. Green building water strategies include water reuse and water efficient plumbing fixtures, rainwater catchment and green roofs. Water use reduction directly results in lower water bills, which are of increasing importance nowadays, as water costs are generally rising worldwide. When applied widely or to big projects, it also comes with substantial societal benefits in the form of reduced pollution, waste water treatment, and infrastructure costs to treat and transport waste water.[22]

EXAMPLES:

In Kats' 2006 green school report, an average water use reduction of 32% was apparent for the 30 green schools evaluated[23], and according to a 2010 study by the same author, water consumption savings resulting from green strategies can be as high as 39% compared to conventional buildings.[24]

32% water reduction was apparent for the 30 green schools evaluated

OTHER OPERATIONS AND MAINTENANCE SAVINGS

More sustainable materials that are designed for adaptability and reuse and that are typically used in green buildings have the added benefit of naturally saving money. Materials and installations that are more robust and have a longer durability require less maintenance and will not need to be replaced as often compared to low-price non-sustainable materials. This in turn lowers waste disposal costs.[25]

EXAMPLE:

A study cited by Kats (2006) found operations and maintenance benefits to be worth $8/square foot over a 20 year period for 40 California state agencies.

$8/sqft worth operations and maintenance benefits

LOWER EMISSIONS AND OVERALL ENVIRONMENTAL IMPACT

Air pollution, caused by burning coal and natural gas and oil, leads to health, environmental, and property damage costs. Green buildings lower the emissions of pollutants through reduced electricity and gas use. With the rising health, financial and social costs of global warming, reduced greenhouse gas emissions through energy efficiency and greater use of renewable energy is an increasingly valued benefit of making buildings green. With a green building certificate, builders and investors with large projects can prove their responsibility in this regard.

HEALTH AND PRODUCTIVITY BENEFITS

While a general consensus on energy savings seems to be hard to find, there are several studies to date which show increased work productivity and health benefits for various aspects of an improved building environment associated with green design. For workers and students, this shows in the form of reduced absenteeism and sick days, improved working morale and performance, enhanced recruitment and reduced churn cost. A healthy and productive work environment can be achieved by various means, for example:

- Ventilation and thermal comfort
- Good air quality and reduced indoor air pollution
- Improved acoustics
- Increased natural daylight
- Access to the natural environment

<table>
<tr><th colspan="2">Thermal Comfort</th><th>Air Quality</th><th>Lighting</th></tr>
<tr><td colspan="2">Decoupled ventilation and thermal conditioning</td><td rowspan="8">Dynamic ventilation zones

Maximized ventilation rates and individual control*

Improved site air quality, filtration and delivery*</td><td rowspan="2">Daylighting without glare</td></tr>
<tr><td colspan="2">Mixed-mode conditioning with natural ventilation*</td></tr>
<tr><td>Dynamic thermal zone sizing</td><td rowspan="2">Often achieved through underfloor or desktop air systems</td><td rowspan="2">Separate task and ambient lighting*</td></tr>
<tr><td>individual control of thermal conditions</td></tr>
<tr><td colspan="2">Minimized enclosure heat loss and gain</td><td rowspan="3">Dynamic lighting zone sizing and individual control</td></tr>
<tr><td colspan="2">Thermal load balancing</td></tr>
<tr><td colspan="2">High performance, plug and play HVAC assemblies</td></tr>
<tr><td colspan="4">Innovate with user-responsive automation</td></tr>
</table>

Table 1: Table 1: Possible arrangements in high-performing buildings for thermal comfort, air quality, and lighting. Content taken from Loftness et al. (2003) Options with an asterisk (*) can (but do not have to) lead to increased energy cost, but yield proven productivity benefits. The other options favour both energy savings and productivity.

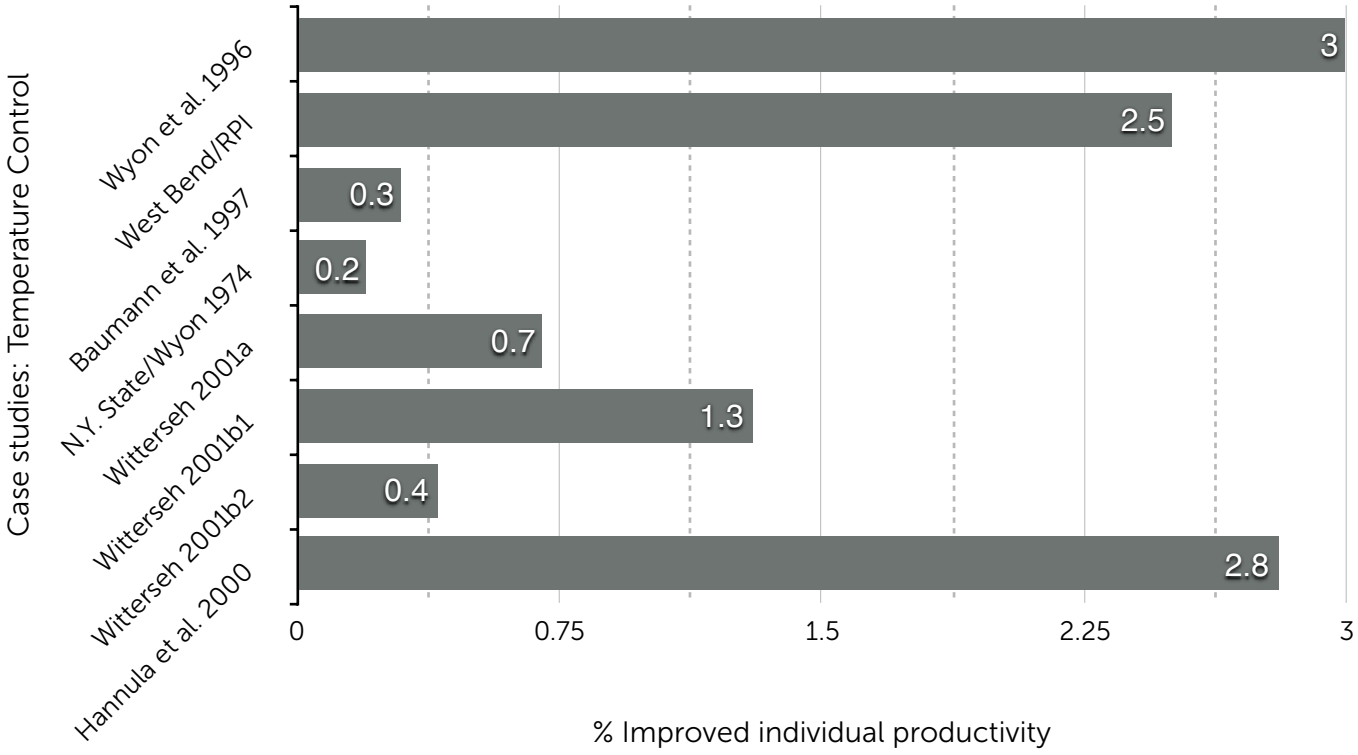
EXAMPLES: THERMAL COMFORT, AIR QUALITY AND LIGHTING

The Center for Building Performance at Carnegie Mellon University has reviewed over 1,500 studies that demonstrate that better building design correlates with increases in tenant and worker wellbeing and productivity. Loftess et al. (2003) from Carnegie Mellon cite several case studies showing improved performance with temperature control, air quality, lighting, and access to the natural environment within the workspace. Regarding temperature control, 14 studies show productivity improvements ranging from 0.2% up to 15%. Under-floor and desktop user-controllable task air systems were shown to result in 11% higher individual productivity and 67% to 90% reduced churn costs. A total of 17 studies found an improvement in health directly related to high air quality, ranging from 13.5% up to 87%. For high performance lighting, such as efficient lighting and use of indirect lighting fixtures, productivity gains ranged between from 0.7% and 26.1% in 11 studies.[26] Kats (2006) also cites a study of 200 utility workers in which better views and workers in offices without glare correlated with better test results.

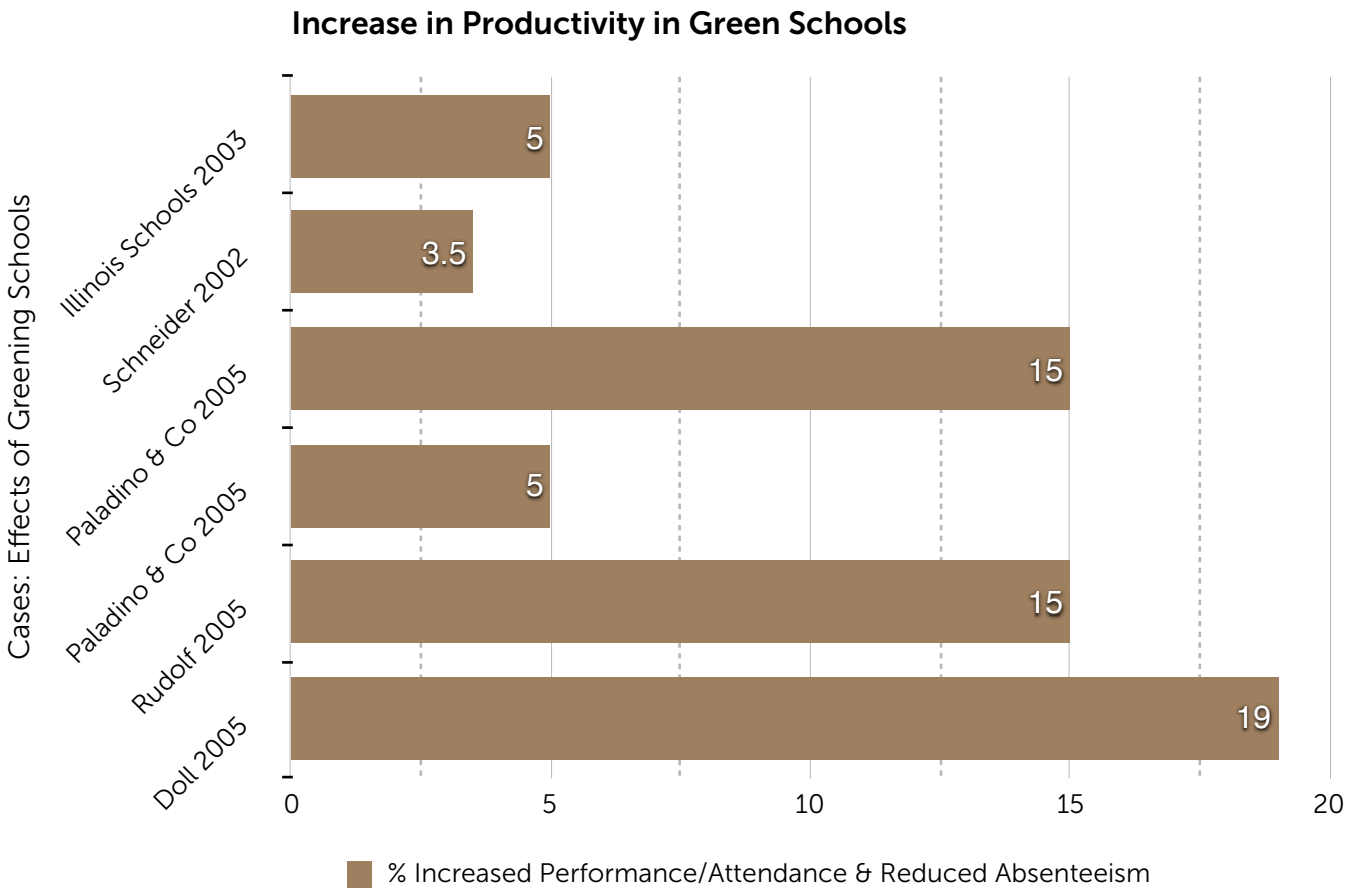
productivity improvements ranging from 0.2% up to 15%

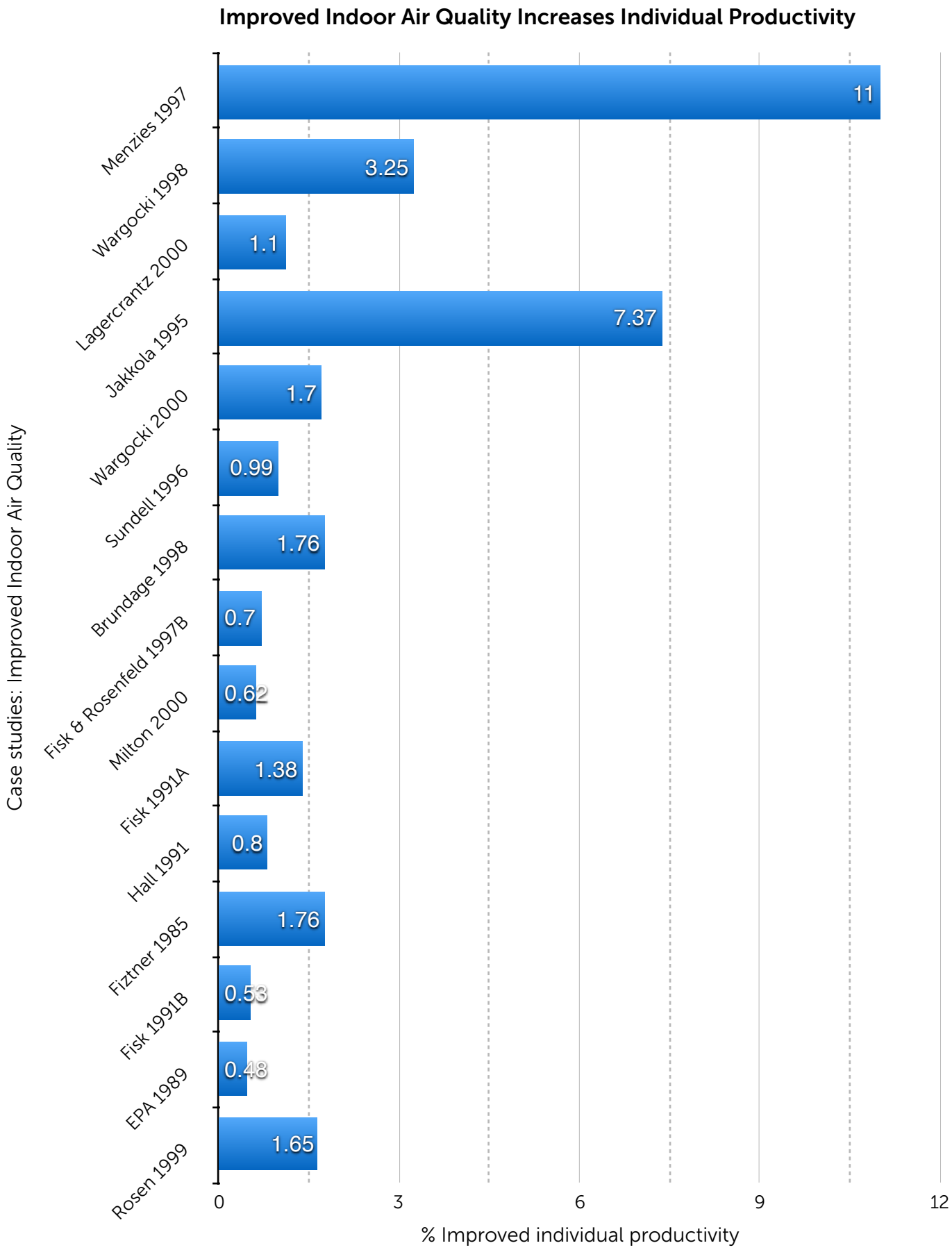
67% to 90% reduced churn costs

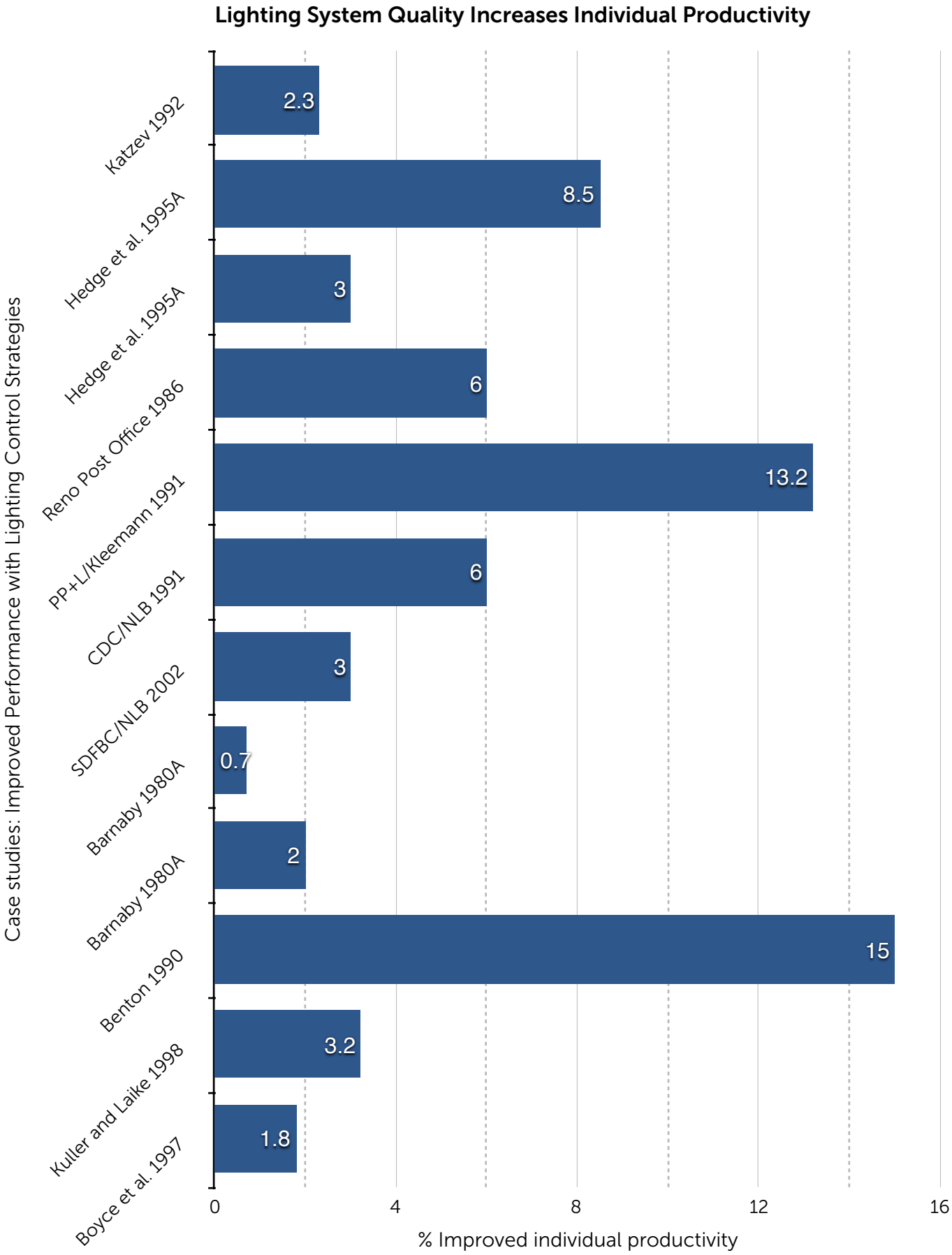
Temperature Control Increases Productivity and Reduces Energy Use



In his school study, Kats points out the problem that US schools typically are not built to provide a healthy and productive learning environment, but rather to achieve a minimum required design level at the lowest possible cost. This leads to a different set of problems that stem from poor indoor environmental and air quality in schools, including higher absenteeism and increased respiratory ailments, lower teacher and staff productivity, lower student motivation, slower learning, lower tests scores, increased medical costs, and lowered lifelong achievement and earnings. This can also be related to office workers, as the tasks they have to perform are similar to those that students are responsible for (such as reading comprehension and calculations). The author mentions two studies of over 11,000 workers in 107 European buildings which link worker-controlled temperature and ventilation and health benefits, and found significantly reduced illness symptoms, reduced absenteeism and increased productivity in buildings that were more effectively designed. A large number of studies show health and productivity benefits of green schools compared to their conventionally built counterparts.[27]




Improved Indoor Air Quality Increases Individual Productivity
Case studies: Improved Indoor Air Quality
Menzies 1997
Wargocki 1998
Lagercrantz 2000
Jakkola 1995
Wargocki 2000
Sundell 1996
Brundage 1998
Fisk & Rosenfeld 1997B
Milton 2000
Fisk 1991A
Hall 1991
Fiztner 1985
Fisk 1991B
EPA 1989
Rosen 1999
11
3.25
1.1
7.37
1.7
0.99
1.76
0.7
0.62
1.38
0.8
1.76
0.53
0.48
1.65
0
3
6
9
12
% Improved individual productivity


Lighting System Quality Increases Individual Productivity
Case studies: Improved Performance with Lighting Control Strategies
Katzev 1992
Hedge et al. 1995A
Hedge et al. 1995A
Reno Post Office 1986
PP+L/Kleemann 1991
CDC/NLB 1991
SDFBC/NLB 2002
Barnaby 1980A
Barnaby 1980A
Benton 1990
Kuller and Laike 1998
Boyce et al. 1997
2.3
8.5
3
6
13.2
6
3
0.7
2
15
3.2
1.8
0
4
8
12
16
% Improved individual productivity

ENERGY AND PRODUCTIVITY: TRADE-OFF OR COMPLEMENTARY GAIN?

Some of the possible measures for a healthier work environment might lead to higher energy costs. For instance, there is a possible trade-off between energy savings and work productivity. A 1:1 comparison between the two variables is of course not feasible, as calculations will have to be done for each individual case, and the energy cost, productivity potential, and other relevant factors must all be known. There are, however, several means by which to achieve a better work environment. With the flexibility that LEED provides in fulfilling credits and earning points, a well-managed project with experienced LEED consultants and facilitators will most likely arrive at an effective solution. This solution will provide a measurable life-cycle benefit even after possible trade-offs between single factors, and can happen by complementing energy-costly measures for a healthier work environment with other, energy-saving measures. Many higher energy costs can be prevented through investing in high performance engineering innovations like improved ventilation effectiveness (for example, displacement ventilation and task air).[28]

HIGHER ASSET VALUES

Green buildings are high-quality, high-performance buildings, which naturally increases their value from an investment perspective. LEED provides a certification with the corresponding reputation and transparency, higher sales prices, marketability and higher lease rates.

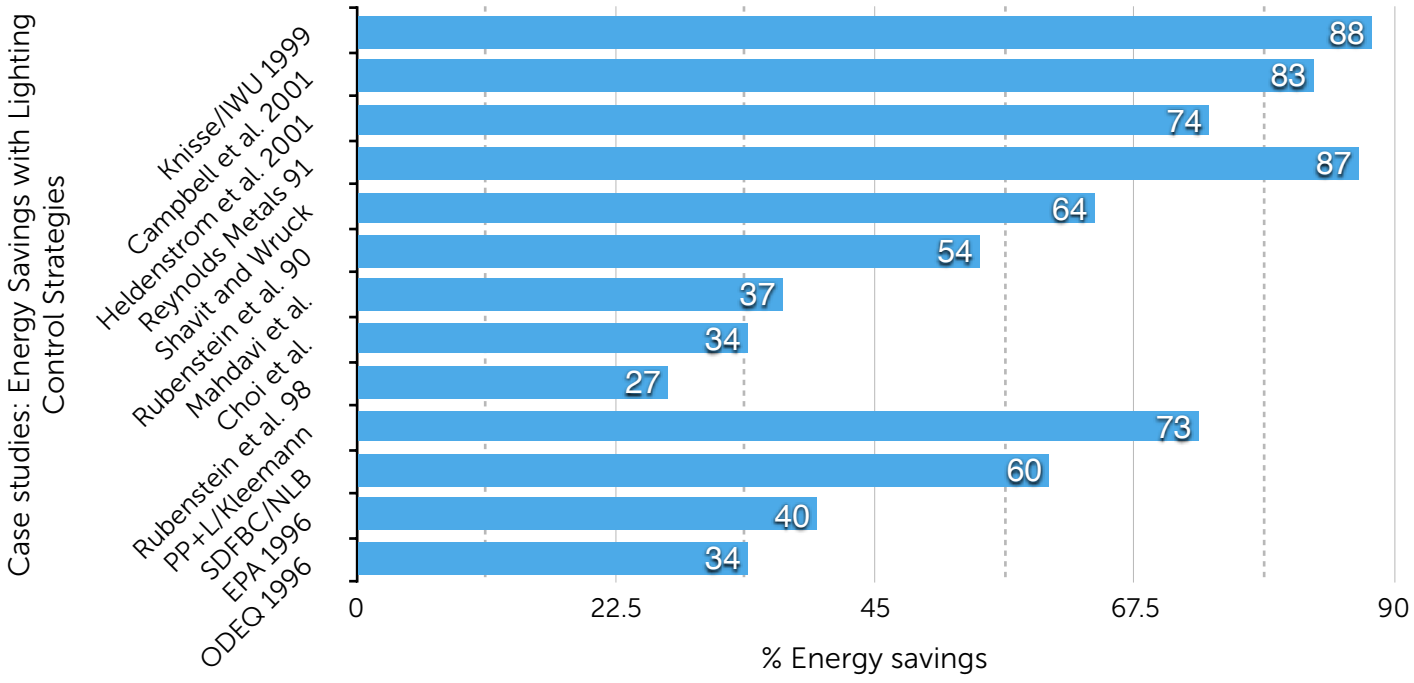
Proof Sets for Decision Support

The Center for Building Performance & Diagnostics (CBPD) at Carnegie Mellon University and the Advanced Building Systems Integration Consortium (ABSIC) collect proof sets from around the world that link improved building environmental quality to life cycle cost-benefits. Based on this database, the BIDS™ (Building Investment Decision Support) tool calculates the economic value added by investing in a high-performance building: cbpd.arc.cmu.edu

SALES PRICES

Studies cited by the WorldGBC compared certified green buildings to non-certified buildings and show price premiums ranging between 0% and 30%. They also found that higher levels of certification for residential as well as office buildings are in most cases leading to higher sale prices and rents, while the price premiums for lower levels of certification corresponded to a proportionally lower asset premium. One study showed that value is added only for higher-certified LEED buildings (Silver and above) and that no value was added for only 'LEED certified' projects.

Lighting System Quality Reduces Energy Use



"Green buildings tend to have higher asset values than their conventional code-compliant counterparts. This differential in asset value is evidenced by higher sale prices."

(WorldGBC 2013)

The premiums in market value typically exceeded the cost premiums. But as the WorldGBC points out, there are other factors than the green credentials in the determination of a project's value, so the impact of building green on asset value cannot be definitively isolated and can vary according to the unique conditions of each market. In addition to higher sales prices, sales opportunities are likely to increase with higher levels of certification, which implies the above mentioned life-cycle benefits.

RENTAL / LEASE RATES AND OCCUPANCY

rental premiums in the range of 0% to 17.3%

Rental rate premiums were found in many cases in recent studies cited by the WorldGBC. For the US and Australia, studies show rental premiums in the range of 0% to 17.3%. Similar to sale prices, one study indicated an increase in rent for each increase in certification level (average 3% per level). Willingness to pay more in rent can be ascribed to higher indoor-quality and lower operating costs (for things like energy and water), which make the building a more attractive place for living and working and promises a discount on the higher rental rate due to reduced utility costs. This might also have a positive effect on occupancy, for which some studies show increases in occupancy for residential and office buildings ranging from 0% to 23.1%.[29]

CRITERIA FOR A SUCCESSFUL IMPLEMENTATION

Nearly all studies and reports on green buildings point out the significance of an "integrated design" approach at an early stage of development and effective management of the LEED process. It is important to be clear about the exact needs of the project in question. As LEED is to some degree quite flexible with regards to the choice and pursuit of the credits, it leaves the implementation team enough freedom to adapt the achievement of the certification to their project's specific needs. The choice of credits to pursue critically influences the potential benefits and thus the ROI. A project that accommodates many knowledge workers, for example, might be willing to compromise on energy savings for the sake of increased worker productivity. Other important aspects are energy modelling, commissioning and life cycle costing assessment (LCCA), possibly throughout the project to ensure that operations and maintenance cost projections are established. Fair assumptions of the building's post-occupancy usage are a pre-requisite for correct modelling.

Criteria for successful implementation

Early integrated design

Awareness

Effective management

Staff expertise

Good collaboration

Modelling, assessment and monitoring

CONCLUSION

This paper gives examples of the costs and benefits of green design. Most costs are found in the upfront investment, which, if managed well, can be paid off in a reasonable time span. A well-designed and well-managed green building can be extraordinarily efficient in lowering energy, water and maintenance costs and can lead to increased well-being and productivity. Several fundamental benefits can in fact be achieved without extra cost.

Higher levels of certification, which have higher ROI potentials, may increase Capex expenditure and require long-term thinking. Short-term financial benefits, if certification is pursued, may still be achieved through the higher asset values of green buildings. The ROI of high-performance green buildings also depends on several other factors, such as good monitoring systems, life-cycle-cost assessments, ongoing commissioning and needs-specific design.

How much saving potential your LEED project will have often depends on which LEED credits your development team decides to pursue. Decisions on the level of certification and how to pursue these goals are therefore important and must be made on a case-by-case basis. The decision for green design in general, however, should not doubted, as societal and ecological benefits are guaranteed and financial payback can be expected on most development projects.

[1] For example shown in a 2005 Survey of Green Buildings by Turner Construction. Available at: http:// www.turnerconstruction.com/greenbuildings

[2] E.g. World Green Building Council (2013) The business case for green building: A review of the costs and benefits for developers, investors, and occupants. World Green Building Council. Available at: http://www.worldgbc.org/files/1513/6608/0674/Business_Case_For_Green_Building_Report_WEB_2013-04-11.pdf

[3] For example: BIDS – building investment decision support: cbpd.arc.cmu.edu/
WorldGBC Report presenting an assessment framework: http://www.worldgbc.org/files/6314/1152/0821/WorldGBC__Health_Wellbeing__productivity_Full_Report.pdf

[4] E.g. Kats, Gregory (2006) Greening America's Schools. COSTS AND BENEFITS. A Capital E Report. Available at: http://www.usgbc.org/Docs/Archive/General/Docs2908.pdf and Loftess et al. (2003) Linking energy to health and productivity in the built environment. Evaluating the cost-benefits of high performance building and community design for sustainability, health and productivity. Greenbuild Conference. Available at: http://www.usgbc.org/Docs/Archive/MediaArchive/207_Loftness_PA876.pdf

[5] http://www.usgbc.org/leed

[6] See http://www.usgbc.org/cert-guide, http://www.usgbc.org/store/products/publications

[7] Luay N. Dwaikat Kherun N. Ali (2016) Green Buildings Cost Premium: A Review of Empirical Evidence. Ener. In: Energy and Buildings, 110. Pages 396–403. Adapted Manuscript available at: https://staff.najah.edu/sites/default/files/Green%20Buildings%20Cost%20-%20A%20Review%20of%20Empirical%20Evidence%20(accepted%20manuscript)_0.pdf

[8] World Green Building Council (2013)

[9] Luay N. Dwaikat Kherun N. Ali (2016)

[10] Kats, Gregory (2006)

[11] HGCI: LEED Credits at Harvard, in: Harvard Presentation to the Deans http://isites.harvard.edu/fs/docs/icb.topic979615.files/Cost%20of%20Green%20Buildings%20at%20Harvard%20ppt%20for%20Financial%20Deans%20%20by%20Leith%20Sharp%2010.3.07.pdf

[12] Davis Langdon (2007) Cost of Green Revisited: Reexamining the Feasibility and Cost Impact of Sustainable Design in the Light of Increased Market Adoption. Available at: http://smartenergy.illinois.edu/pdf/Archive/Cost%20of%20Green%20Revisited.pdf

[13] Loftess et al. (2003)

[14] E.g. World Green Building Council (2013)

[15] World Green Building Council (2013)

[16] Kats, Gregory (2006)

[17] Zheng, Diana Y. (2013) Does LEED save energy? A case study of LEED at UC Berkeley. Available at: http://www.green-rating.com/files/1614/2175/5772/Does_LEED_save_energy_-_A_case_study_of_LEED_at_UC_Berkeley.pdf

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