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More Than Just a Glass Face: What Makes a "Green" or "Sustainable" Building, Exactly?

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MORE THAN JUST A GLASS FACE:

WHAT MAKES A "GREEN" OR "SUSTAINABLE" BUILDING, EXACTLY?

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Introduction

Let me begin in a slightly unusual way by admitting that the question posed in the title—what makes a green or sustainable building, exactly?—will not be directly answered by the end of this thesis. This is in large part due to the last word of that question: “exactly.”

“Exactly” leaves no room for multiple interpretations or ambiguities; but so far in the early twenty-first century, even familiar words like “green” or “sustainable”¹ in respect to buildings have muddled, imprecise meanings. From the outside, modern green buildings seem to be distinguishable by their glassy facades and at times elaborate designs. But while it is true that ample glazing tends to be a common trait, what makes the building green often goes beneath that surface. The features that come together to form a green building are rather diverse and difficult to define, especially given the several different approaches to characterizing what a green building is.

One way to study these characterizations is to look at various green building standards. The standard that has become the most well-known in the United States since its beginning in 1998 and its release in the year 2000 is the Leadership in Environmental and Energy Design (LEED) certification. Although it was initially launched in the United States by the US Green Building Council (USGBC), LEED has been growing in popularity throughout other countries as well. According to the USGBC, LEED has so far made its way to 160 countries and territories across the globe, with over 79,000 projects completed or underway.²

¹ For convenience, in the introduction, I will use the general term “green building” to describe all buildings striving towards a lesser environmental impact.

² “This is LEED: Better Buildings Are Our Legacy,” USGBC, <http://leed.usgbc.org/leed.html>, 2016.

With its inception in 1990, the United Kingdom’s Building Research Establishment Environmental Assessment Method (BREEAM) became the first ever green building standard, preceding the LEED standard by a decade. Though perhaps not as widely adopted as LEED, reaching about 70 countries, BREEAM has a great depth of projects—with the amount of certified buildings reaching over 550,000 and total registered projects reaching over 2,251,000. BREEAM projects are most concentrated in the country of its birth, but it is also extending its influence to other countries and continents.³

However, not all green building certifications are meant to be used worldwide. Taiwan’s Ecology, Energy Saving, Waste Reduction, and Health (EEWH) certification system was developed specifically with the Taiwanese climate in mind, and therefore was not meant to be applied to other projects across the globe. The first version of EEWH was created by the Architecture Building Research Institute (ABRI) around the same time as LEED’s creation in 1999. As of the end of the year 2013, EEWH had certified 4,300 green buildings—a number that is understandably smaller than that of LEED or BREEAM but is growing as the concept of green buildings gains traction in Taiwan.⁴

One of the newer certification systems is already building a reputation as the most stringent standard yet: The International Living Future Institute’s Living Building Challenge, established in the year 2006. The name itself is called a “challenge,” which points to the true difficulty of achieving this certification. However, the fact that The Living Building Challenge’s standards are so intensely high also in turn mean that the certification is held in extremely high regard. To help put The Living Building Challenge’s rigor in perspective—

³ “What is BREEAM,” BRE, <http://www.breeam.com/>, 2016.

⁴ “Green Building Label,” ABRI, <http://smartgreen.abri.gov.tw/art-en.php?no=61&SubJt=Green+Building+Label>, 2013.

since its founding, only a grand total of 44 projects have been able to meet its demands, with only 11 of these projects gaining the *full* certification.⁵

But returning to the issue with the word “exactly” in the title question, there are essentially two types of ambiguities currently surrounding green buildings. The first involves a general confusion around the distinction between buzzwords such as “green” and “sustainable.” The second is due to differences in interpretation, as shown by the several aforesaid types of green building certifications. In this thesis, I hope to help clarify the first, but celebrate the second. There can sometimes be a natural desire to create a single, standardized system so that things can be easily defined and recognized. However, I hope to use the LEED, BREEAM, EEWH, and Living Building Challenge standards as lenses of interpretation to explore this question of what makes a green or sustainable building, while also arguing that having multiple interpretations is a very good thing—for there is no single way of defining *exactly* what a green or sustainable structure is.

⁵ “Certified Project Case Studies,” International Living Future Institute, <http://living-future.org/casestudies>, 2015.

The theory foundation:

What's the difference between "greenness" and "sustainability?"

The words "green" and "sustainable" echo across our television and computer screens, newspapers, magazines, and face-to-face conversations; but they are often used synonymously or interchangeably without in-depth consideration. There appears to be a simultaneous attraction to and frustration associated with the vagueness of sustainability and greenness: on one hand, these terms' vagueness allows them to perhaps garner more widespread support than if they had a strict list of the practices they would entail, instilling a general public interest in the topic. In a political setting, this vagueness allows parties to reach a supposed "consensus" on the importance of sustainability related issues—a strategy that Henry Kissinger called constructive ambiguity.⁶ On the other hand, people naturally seek a certain level of standardization to be able to simply judge and communicate qualities to one another. The concept of a green initiative or a sustainability revolution sounds quite appealing in theory, but because there is no consensus on a simple step-by-step process to follow, implementation of these at first appealing ideas is often met with some frustration or jadedness.

Yanarella et al. attempt to simplify the distinction between greenness and sustainability. The authors first define what is called the *sustainability tripod*, which consists of "environmental health, economic vitality, [and] social justice."⁷ They contend that being green

⁶ Frances C. Moore, "Toppling the Tripod: Sustainable Development, Constructive Ambiguity, and the Environmental Challenge," *Consilience: The Journal of Sustainable Development* 5, no. 1 (2011): 141-150.

⁷ Ernest J. Yanarella, Richard S. Levine, Robert W. Lancaster, "Green versus Sustainability: From Semantics to Enlightenment," *Sustainability: The Journal of Record* 2, no. 5 (2009): 296-302, doi: 10.1089/SUS.2009.9838.

is only contingent on the environmental improvement leg and sometimes the economic vitality leg, while sustainability is contingent on all three of the tripod legs. Greenness is often thought to be more pragmatic and achievable because it can operate within our current societal and economic systems. Conversely, the goals of sustainability are thought of to be far more ideal, but attaining these goals would require changes to our current societal and economic systems that would be much more difficult to bring about. Furthermore, greenness is focused more on single products and practices, while sustainability is more concerned with the “larger picture” processes.⁸

To help illustrate this concept, the authors employed the ideas described in William McDonough’s and Michael Braungart’s *Cradle to Cradle: Remaking the Way We Make Things* as an example. In the case of manufactured goods, greenness would most likely manifest in how the product is made, what it is made of, or how it is used—things that are all undeniably important. An example of this could be manufacturing a cosmetic product without the use of palm oil, a substance whose production contributes to mass deforestation and air pollution. But sustainability would take this consciousness a step even further. It would not only focus on the greenness of the products themselves, but it would also take a look at the larger processes at hand. The cradle-to-cradle approach suggests that we “remake the way we make things,” which essentially suggests a change in a manufacturing system that has been engrained in society since the Industrial Revolution that creates goods largely so that they can be used and then disposed of. McDonough and Braungart propose that instead, goods should be produced with the idea that they would “provide nourishment for something new” after their lives are finished.⁹ In the example of the cosmetic product, this would also mean that the

⁸ *Ibid.*

⁹ William McDonough, Michael Braungart, *Cradle to Cradle* (New York: North Point Press, 2002).

vessel of the product—be it bottle or otherwise—must also be able to be reused completely or composted easily. Greenness focuses on lessening a product’s negative impact on the environment, while sustainability focuses on a more holistic approach to lessening or eliminating negative impacts altogether.

How do these distinctions between “green” and “sustainable” apply to the built environment?

This way of thinking about greenness and sustainability can be applied to the built environment as well. Jason McLennan, the founder of the International Living Future Institute, describes how these two terms can also apply to building design. He too expresses a frustration with the vagueness of terms like “green architecture” and “sustainable design,” saying that: “These terms have come to mean a lot of different things to different people,” which in turn causes people to use them to describe buildings that are perhaps not actually very sustainable at all.¹⁰ In an attempt to straighten out these misconceptions, McLennan proposes a definition of sustainable design: “a design philosophy that seeks to maximize the quality of the built environment, while minimizing or eliminating impact on the natural environment.”¹¹ He emphasizes that sustainable design is a *philosophy* rather than just a style. Although a style could gain or lose popularity over the years based on its aesthetic appeal, a philosophy would long outlast trendiness and would spill into projects and endeavors even outside of building design.

¹⁰ Jason McLennan, *The Philosophy of Sustainable Design: The Future of Architecture* (Ecotone Publishing Company LLC, 2004), 2.

¹¹ McLennan, *The Philosophy of Sustainable Design*, 4.

McLennan then elaborates on what it means to maximize quality by dispelling the myth that sustainable design would compromise people’s comfort or wellbeing, and he instead asserts that it in fact seeks to “create physical artifacts that benefit people.”¹² By this definition, even if a building had a million solar panels and the most advanced rainwater capture system, if its design adversely affects the health of its inhabitants, it would not qualify as a sustainable design. But the benefit of sustainably designed buildings is not just meant for its inhabitants, either. Sustainable design is stretched even further, challenging designers to not only provide “a product or commodity,” but also “a service that goes beyond the immediate client to other people, to other species and even to future generations.”¹³ Buildings that strive to lessen their harm on the environment could qualify as green buildings, but the specific term “sustainable” building is reserved only for those structures that have “no negative operational impacts on the environment and few embodied¹⁴ ones”¹⁵—essentially, “net-zero” buildings that also take into account social and economic factors.

How can we expand on the sustainability tripod in the built environment?

Understanding green or sustainable buildings requires far more nuance than simply knowing the three legs of the sustainability tripod or a single definition. There are several different approaches to pursuing sustainability in the built environment. Simon Guy and

¹² McLennan, *The Philosophy of Sustainable Design*, 7.

¹³ *Ibid.*

¹⁴ Impacts associated with the production or maintenance of a building, usually referred to in energy form (Geoff Milne, “Embodied energy,” *Australian Government*, 2013, <http://www.yourhome.gov.au/materials/embodied-energy>).

¹⁵ McLennan, *The Philosophy of Sustainable Design*, 6.

Graham Farmer outline six of them, calling them the “six competing logics of sustainable architecture”:

Table 1 The six competing logics of sustainable architecture

Logic	Image of Space	Source of Environmental Knowledge	Building Image	Technologies	Idealized Concept of Place
Eco-technic	global context macrophysical	technorational scientific	commercial modern future oriented	integrated energy efficient high-tech intelligent	Integration of global environmental concerns into conventional building design strategies. Urban vision of the compact and dense city.
Eco-centric	fragile microbiotic	systemic ecology metaphysical holism	polluter parasitic consumer	autonomous renewable recycled intermediate	Harmony with nature through decentralized, autonomous buildings with limited ecological footprints. Ensuring the stability, integrity, and “flourishing” of local and global biodiversity.
Eco-aesthetic	alienating anthropocentric	sensual postmodern science	iconic architectural New Age	pragmatic new nonlinear organic	Universally reconstructed in the light of new ecological knowledge and transforming our consciousness of nature.
Eco-cultural	cultural context regional	phenomenology cultural ecology	authentic harmonious typological	local low-tech commonplace vernacular	Learning to “dwell” through buildings adapted to local and bioregional physical and cultural characteristics.
Eco-medical	polluted hazardous	medical clinical ecology	healthy living caring	passive nontoxic natural tactile	A natural and tactile environment which ensures the health, well-being, and quality of life for individuals.
Eco-social	social context hierarchical	sociology social ecology	democratic home individual	flexible participatory appropriate locally managed	Reconciliation of individual and community in socially cohesive manner through decentralized “organic,” nonhierarchical, and participatory communities.

Figure 1: A table of Guy and Farmer's Six Competing Logics of Sustainable Architecture¹⁶

The six logics are the following: eco-technic, eco-centric, eco-aesthetic, eco-cultural, eco-medical, and eco-social. In order to come up with these six logics, the authors performed extensive research into both existing buildings themselves and literature concerning sustainable, green, or environmental buildings. From there, they determined trends in the types logics that influenced ways of thinking about sustainable architecture.

The eco-technic approach to sustainable architecture is characterized by its emphasis on technology and policy implementations as the solutions to environmental problems, and therefore aims for progress that can be quantified scientifically. This means that the environmental issues that the eco-technic logic focuses on are those that can be tracked

¹⁶ Simon Guy and Graham Farmer, “Reinterpreting Sustainability: The Place of Technology,” *Journal of Architectural Education* 54, no.3 (2001): 141, doi: 10.1162/10464880152632451

through measurements such as energy efficiency, water efficiency, and waste reduction. The buildings that result from this type of logic are often equipped with high-tech energy-saving design features such as “new types of glass and solar shading, intelligent facades, double-skin walls and roofs, and photovoltaics.”¹⁷ Buildings that embody the eco-technic way of thought are often the more modern, glass-faced buildings alluded to in the title of this thesis.

Although technology is undoubtedly responsible for reducing the environmental impacts of some buildings, this type of eco-technic, techno-optimistic logic is often met with much opposition. Michael Huesemann, who has a doctorate in chemical engineering, and Joyce Huesemann, who holds a doctorate in applied mathematics, are experts in fields very familiar with technology. However, they are skeptical of the idea that technological developments will be the world’s panacea for environmental issues. As they point out in *Techno-Fix: Why Technology Won’t Save Us Or the Environment*, techno-optimism is a predominantly Western way of thinking because modern developments in technology have been able to “ameliorate some forms of environmental damage in industrialized countries by developing pollution controls, advanced sewage treatment, hybrid vehicles and the like—but all in response to problems technology itself has helped to generate.”¹⁸ Moreover, technology cannot be created in a vacuum. The creation of technologies necessitates the use of a certain amount of raw materials and energy, but also necessitates a certain amount of waste and polluting by-products. Therefore, the authors argue that relying solely on technology to achieve real sustainability is a flawed concept.

¹⁷ Guy and Farmer, “Reinterpreting Sustainability: The Place of Technology,” 142.

¹⁸ Michael Huesemann and Joyce Huesemann, *Techno-fix: Why Technology Won’t Save Us or the Environment*, (Gabriola Island: New Society Publishers, 2011), xviii.

While the eco-technic logic suggests that all environmental issues can be overcome “without leaving the path of modernization,”¹⁹ the eco-centric logic instead suggests that humans must switch paths completely if we are to truly achieve sustainability. This logic stems from an attempt to combat the anthropocentric ideology and from a moral responsibility to consider the lives of non-humans as well. Instead of viewing nature as something to be managed or something that has value only because it is useful to people, the eco-centric logic promotes the idea that the earth has value in and of itself. In fact, nature is viewed as something delicate—something that needs to be protected. In terms of the built environment, this means that “each building is an act against nature; it directly makes some proportion of the earth’s surface organically sterile by covering it over, rendering that area incapable of producing those natural resources that require the interaction between soil, sun, and water. As a result in ecological terms, a building is a parasite.”²⁰ The belief that buildings are inherently unhealthy for the environment results in buildings designed with recycled materials that strive for more self-sufficient, “off-the-grid” designs.

The issue with this type of building approach is that it requires a revolution in the way that several human-made systems are set up in developed countries. In many areas around the United States, living literally “off-the-grid” is highly opposed by the government. An article published by The Alternative Daily listed several instances in Florida, Colorado, California, and Alabama in which occupants of off-the-grid homes or communities faced eviction or relocation unless they agreed to connect their homes to the grid. The reason for these evictions is mostly due to zoning or utility codes that make living off-the-grid

¹⁹ Gert Spaargarten and Arthur P.J. Mol, “Sociology, Environment, and Modernity: Ecological Modernisation as a Theory of Social Change,” *Society and Natural Resources* 5 (1992): 323-344.

²⁰ Steve Curwell and Ian Cooper, “The implications of urban sustainability,” *Building Research and Information* 26 (1998): 17-27.

impossible.²¹ Especially with such restrictions in place, it is difficult for a large-scale, revolutionizing change to occur. However, a possibly even bigger obstacle to overcome is the lifestyle changes that would have to come with living in a completely eco-centric building. Currently, the “off-the-grid” lifestyle is seen as reserved for “hippies” or “mountain men.” For example, Discovery Channel’s television program *Alaskan Bush People* portrays the life of the Browns—a family of seven who lives off of the land out in the wilderness of Alaska.²² In many people’s minds, living “off-the-grid” is associated with the rugged lifestyle portrayed in these types of shows. Therefore, making the transition to eco-centrism seems to mean giving up a certain standard of living that they are already accustomed to.

The eco-aesthetic logic is concerned with more than just creating net-zero buildings. Primarily stemming from a more Eastern type of philosophy, the eco-aesthetic logic puts an emphasis on the building’s role as a symbol—a spiritual space where humans’ connections to nature thrive. This view is quite contrary to the eco-technic view because rather than putting faith in modern Western technology and machinery to solve environmental issues, it instead suggests that the solution lies within people’s spirituality. It rejects the sharp edges of modernism and instead encourages a return to “organicism, expressionism, the chaotic, and the nonlinear,”²³ which results in “a language of building and design close to nature, of twists and folds and undulations; or crystalline forms and fractured planes.”²⁴ The hope is for these

²¹ “Is it Illegal to Live Off the Grid?”, The Alternative Daily, <http://www.thealternativedaily.com/illegal-to-live-off-grid/>, 2016.

²² “Alaskan Bush People: A Family Like No Other In Alaska,” Discovery, <http://www.discovery.com/tv-shows/alaskan-bush-people/videos/a-family-like-no-other-in-alaska/>, 2014.

²³ Guy and Farmer, “Reinterpreting Sustainability: The Place of Technology,” 144.

²⁴ Charles Jencks, *The Architecture of the Jumping Universe: How Complexity Science is Changing Architecture and Culture* (London: Academy Editions, 1995): 9.

biomimetic buildings to inspire and foster connections to the natural world in their human inhabitants.

Although the eco-aesthetic logic is wonderfully poetic, and although spirituality is undeniably deeply influential for some people, spirituality is often something extremely subjective and difficult to measure—set within this context specifically. Even if eco-aesthetic buildings became required all around the world, it is difficult to define a rubric of characteristics that would reach the profound goal eco-aestheticism seeks to achieve. The very same building design that fosters a spiritual connection in some people could repel others, and it is also difficult to really gauge how people would react to a space until the space actually exists. Moreover, the organic and non-linear designs proposed by eco-aestheticism could be appealing appearance-wise, but at times these rounded or curved areas create inefficient interior spaces that may potentially become frustrating to work with.

While the eco-aesthetic is concerned with the individual's connection to buildings, eco-cultural logic argues instead for the inherent connection between buildings and the culture of a group of people. When traveling to another place, part of observing that place's culture comes simply from seeing the local architecture—think of the distinctive white-and-blue domed landscape of the Cyclades, the smooth, sun-dried mud structures in the Egyptian desert, or the brightly-colored rectangular houses lining canals in Denmark. Each of these places relies on architecture to create a unique sense of place. Therefore, part of the backlash against the green building movement results from the worry that architecture will be homogenized—that it would wipe out existing cultural buildings in favor of more generic, modern buildings. In response to this, the eco-cultural logic pushes for the recognition of culture in the rubric for sustainable design. In the words of Arne Naess, founder of Deep Ecology: “Any model of ecologically sustainable development must contain answers, however

tentative, as to how to avoid contributing to thoughtless destruction of cultures, and to the dissemination of the belief in a glorious, meaningless life.”²⁵

The eco-cultural logic also deals with non-quantifiable, intangible concepts. The extent to which a building fits in with or mimics the existing vernacular architecture of an area can be subjective. This becomes an issue, for instance, when a certain method of building in a region’s vernacular style may not necessarily be as environmentally friendly as it could be. If perpetuating a cultural style or avoiding the “thoughtless destruction of cultures”²⁶ is indeed an essential part of what defines a sustainable building, to what extent can that style be altered to become more *environmentally* sustainable? Because there is no way to standardize culture, there is no clear way to determine just how much of a cultural building style can be compromised for the sake of the environment.

The eco-medical logic embodies the “social justice” leg of the sustainability tripod. This logic is primarily concerned with improving the quality of human health through building design, but it takes a scientific, medical approach rather than a spiritual approach like the eco-aesthetic logic. Researchers such as Laura E. Jackson have discovered “a growing body of evidence” that “identifies design of living space and associated activity patterns as a public-health issue.”²⁷ Buildings can affect human health in very physical ways—for example, certain building materials can emit chemicals that, when inhaled by its inhabitants, are potentially very harmful. But they can also affect human health through the psychological aspect—for example, having to work or live in a poorly lit building with little or no windows

²⁵ Arne Naess, “Sustainable Development and the Deep Ecology Movement,” Proceedings of the European Consortium for Political Research Conference, *The Politics of Sustainable Development in the European Union*, University of Crete (1994): 1.

²⁶ *Ibid.*

²⁷ Laura E. Jackson, “The Relationship of Urban Design to Human Health and Condition,” *Landscape and Urban Planning* 64 (2003): 191.

can most definitely take a toll on a person’s mental health. In fact, “sick building syndrome” is a legitimate condition even recognized by the US National Library of Medicine, loosely defined in the *Indian Journal of Occupational & Environmental Medicine* as “a situation in which the occupants of a building experience acute health—or comfort—related effects that seem to be linked directly to time spent in the building.”²⁸ In response to problems with sick-building syndrome, the International WELL Building Institute (IWBI) launched WELL Building Standard in 2014. The WELL Building Standard is the first standard to focus on using eco-medical logic to certify buildings that are biologically and psychologically beneficial to human health.²⁹

Probably the biggest obstacle surrounding the construction of eco-medical buildings is the extra effort or cost that may come with finding alternatives to conventional building materials that pose threats to human health. The International Living Future Institute developed a “red list” of these materials—essentially detailing all of the conventional building materials that are known to negatively impact health. An example of a common material banned by the red list is polyvinyl chloride, also known as PVC. PVC is most known for being found in piping, but it is also a part of electrical wire sheaths and window frames. According to the Green Building Alliance, not many effective alternatives to PVC exist for wire sheaths. Some try to use metal instead, but metal is more difficult to maneuver and is more expensive. In piping, metal can again be substituted for PVC, but it still faces the same shortcomings of being difficult to work with, expensive, and prone to corrosion. Moreover, the mining of metals is known to be environmentally disruptive—it releases several pollutants into the

²⁸ Sumedha M. Joshi, “The Sick Building Syndrome,” *Indian Journal of Occupational & Environmental Medicine*, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2796751/>, 2008.

²⁹ “About,” The International WELL Building Institute, <https://www.wellcertified.com/about>, 2016.

earth and air, and it can seriously damage soils and vegetation.³⁰ In window frames, PVC can be replaced with wood, aluminum, or fiberglass. Each of these alternatives tend to require more maintenance, and furthermore, their manufacturing process is not necessarily always environmentally friendly.³¹ PVC is only one of the several materials to avoid on the red list. Therefore, eco-medical buildings could potentially become extremely expensive or require much more maintenance than conventional buildings.

The last logic that Guy and Farmer outlined in their article is the eco-social logic. The eco-social logic ventures into a more political realm, connecting issues with sustainability to larger-scaled societal issues. Guy and Farmer bring up the social-ecologist view that “human domination and degradation of nature arises out of social patterns of domination and hierarchy, patterns of social life in which some humans exercise control or domination over others.”³² “Others,” in this case, can refer to both other people or the environment. This need to dominate, not collaborate with, others leads to a strongly individualistic attitude that can at times disregard the consequences of damaging actions. The eco-social logic tries to combat this potentially damaging individualism by proposing smaller community-based living situations. The aim with these smaller communities is to create “healthy, self-reliant societies that exercise local control, take responsibility for their environment, operate a local economy based on minimal levels of material goods and the maximum use of human resources.”³³ In terms of the built environment, this logic encourages that buildings be designed to be receptacles for community collaboration. In other words, environmental journalist Dick

³⁰ Sharon Beder, “Environmental Impacts,” University of Wollongong, <http://www.uow.edu.au/~sharonb/STS300/sustain/mining/impacts.html>, 2001.

³¹ “Product and Building Materials Red List,” Green Building Alliance, <https://www.gba.org/resources/green-building-methods/materials-red-list/>, 2016.

³² Joseph R. Des Jardins, *Environmental Ethics: An Introduction to Environmental Philosophy* (Belmont: Wadsworth, 1993): 240.

³³ Guy and Farmer, “Reinterpreting Sustainability: The Place of Technology,” 148.

Russell's observes: "we need a building metaphor that somehow encapsulates the idea of co-operative community, of a responsibility toward the earth and each other that we have abandoned."³⁴ This more decentralized, self-sufficient way of life is similar to the eco-centric logic proposed, except that it further emphasizes the importance of working and living as a community.

The issue with the eco-social logic is that it proposes radical lifestyle changes for the several people already accustomed to living more individually. Even if people enjoy being a part of communities, the idea of constantly living in a small community that requires active participation may be a bit too involved for some. Moreover, in countries like the United States, if this type of living were to be implemented on a large scale, it would require that the current infrastructure be almost completely redone. Infrastructural projects can be extremely expensive, and it is unlikely that a proposal to transition to this type of living would garner enough support to actually become the dominant type of lifestyle. Besides, not all communities may be able to be completely self-sufficient. For example, communities in areas stricken with drought will need to get water from other areas, or perhaps areas with not much on-site energy potential will need to get energy from elsewhere. Therefore, although these self-sufficient communities can be achieved in some areas, they may not be logistically feasible on larger-scale or global projects.

Simon and Guy call these logics the "six competing logics of sustainable architecture," but in actuality the logics are fluid and at times collaborating. Although some of the logics' beliefs are indeed at odds with others, it is entirely possible for a building to embody more than one of the logics. An eco-medical building could also exhibit eco-technic features, or an

³⁴ Dick Russell, "Ecologically Sound Architecture Gains Ground," *The Amicus Journal* (1993): 14-17.

eco-aesthetic building could also be aligned with eco-cultural values. Although each logic has its drawbacks, having a knowledge of this logical framework can assist in exploring the question of what makes a sustainable building.

Why do we need to focus on creating more sustainable buildings?

Why are we paying so much attention to buildings in particular? Scientifically speaking, the building sector is responsible for an enormous portion of environmentally harmful practices all around the world. According to the European Commission, in the European Union, the building sector alone accounts for an estimated half of the total extracted materials, half of the total energy consumed, a third of the total water consumed, and another third of the total waste generated.³⁵ These staggering proportions were estimated when taking into account the most of buildings' life cycle stages into account—from the raw material extraction, the manufacturing process for the building materials, the actual construction of the buildings, to finally the actual occupancy and use period of the buildings. Statistics from other continents also reflect the building sector's significant contributions to environmental degradation. In the year 2015, the U.S. Energy Information Administration (EIA) reported that roughly 40% of the total energy consumed in the U.S. went towards residential and commercial buildings.³⁶ A Sankey diagram that the Lawrence Livermore National Laboratory developed in 2015 revealed that a large majority of the energy that is consumed in the commercial and residential sectors, which are primarily a result of buildings' operations, is ultimately sourced from carbon-emitting, non-renewable resources such as

³⁵ "Sustainable Buildings," European Commission, <http://ec.europa.eu/environment/eussd/buildings.htm>, 2016

³⁶ "How much energy is consumed in residential and commercial buildings in the United States?", U.S. EIA, <http://www.eia.gov/tools/faqs/faq.cfm?id=86&t=1>, 2016.

natural gas and coal.³⁷ Therefore, buildings are responsible for a considerable amount of greenhouse gases released into the atmosphere in the United States.

In China, the end of life stage of buildings is already—and predicted to become more of—a problem. An article by Mingming Hu et al. claims that 50% of all materials that are extracted from the earth’s crust go towards constructing buildings, which in turn means that enormous amount of construction and demolition waste (CDW) is generated. In 2010, the city of Beijing alone generated roughly 35 million metric tons of CDW. Unfortunately, this number is expected to increase dramatically when the burst of buildings developed in the 1990s are expected to be decommissioned.³⁸ Chinese experts estimate that the average lifetimes of urban buildings to be approximately between a short 15 and 30 years.³⁹ This relatively brief lifespan is heavily influenced by the Cultural Revolution in China, during which quick and cheap urban housing projects were developed, resulting in low-quality buildings that rapidly are becoming dysfunctional and must be replaced.⁴⁰ At the current growth rate of building demolition, in 2050, China will have to manage CDW levels over six times as high as the CDW levels in 2010.⁴¹

The Environmental Affairs and Tourism Department in in 2009 put a different spin on this data, noting that at that time, 15% of the world’s freshwater, 40% of the world’s energy, and 23-40% of the world’s greenhouse gas emissions could all be attributed to the

³⁷ “Energy, Water, and Carbon Informatics,” Lawrence Livermore National Laboratory, <https://flowcharts.llnl.gov/>, 2015.

³⁸ Ming Ming Hu, Ester Van Der Voet, Gjal Huppel, “Dynamic Material Flow Analysis for Strategic Construction and Demolition Waste Management in Beijing,” *Journal of Industrial Ecology* 14 (2010): 440-456, doi: 10.1111/j.1530-9290.2010.00245.x.

³⁹ Ch. H. Song, “Whole Life and Highgrade Quality: Stick to the Implement Housing Performance Certification,” *Housing Science* 290 (2005): 287-302.

⁴⁰ “Ren min sheng huo zhi [Life of the people] in Bei Jing Zhi,” Beijing Municipal Chorography Compiling Council, 1999.

⁴¹ Ming Ming Hu, “Dynamic Material Flow Analysis,” 448.

construction, operation, and destruction of buildings. In South Africa specifically, the operation stage of the building sector was responsible for 23 percent of the country's yearly greenhouse gas emissions. A lesser 4% of CO₂ emissions could attributed to the materials manufactured to be used in buildings' constructions.⁴² Although in 2015 South Africa was not even included in the top 10 emitters of greenhouse gases,⁴³ the Department of Environmental Affairs and Tourism highly encouraged the widespread adoption of green building policies and practices.

Around the world, people are starting to realize the importance of making conscious efforts to reduce the negative impacts associated with the building construction sector. Some of those at the forefront of these efforts are the ones who are creating and implementing green and sustainable building standards—a few of which will be discussed in the subsequent chapters.

⁴² Kelly Gunnell, "Green Building in South Africa: Emerging Trends," Department of Environmental Affairs and Tourism, http://www.academia.edu/327098/GREEN_BUILDING_IN_SOUTH_AFRICA_EMERGING_TRENDS, 2009.

⁴³ "The largest producers of CO₂ emissions worldwide in 2015, based on their share of global CO₂ emissions," Statista, <https://www.statista.com/statistics/271748/the-largest-emitters-of-co2-in-the-world/>, 2016.

LEADERSHIP IN ENERGY & ENVIRONMENTAL DESIGN (LEED):



“Better buildings are our legacy” —US Green Building Council

LEED v4, the latest version of LEED, can be adapted to fit several project types, including Building Design and Construction (BD+C), Interior Design and Construction (ID+C), Building Operations and Maintenance (O+M), Neighborhood Development (ND), and finally Homes.⁴⁴ The breadth of projects pursuing and obtaining LEED certifications are contributing to USGBC’s goal to leave behind a legacy of “better buildings.” But under what criteria are buildings considered to be “better”?

USGBC’s answer to this question is encapsulated in their LEED credit library manuals. LEED v4 splits up credits into nine categories: Integrative Process, Location & Transportation, Sustainable Sites, Water Efficiency, Energy & Atmosphere, Material & Resources, Indoor Environmental Quality, Innovation, and Regional Priority. Within these categories, there are points that the project can earn by having certain features. An altogether score of 40–49 points would earn a certified status, a score of 50–59 points would earn a silver status, a score of 60–79 points would earn a gold status, and a score of 80 points or more would earn a platinum status.⁴⁵ The design teams compile thorough plans and evidence of how they will achieve these before they submit all documentation to the USGBC for certification. Figure 2 below depicts how many points are allocated to each of the nine categories. Evidently, much of the emphasis is placed on the “Energy and Atmosphere” category illustrated in red, as this section makes up 33 of the 110 possible points. Because energy generation is a leading contributor to

⁴⁴ “About LEED,” USGBC, <http://www.usgbc.org/leed>, 2016.

⁴⁵ *Ibid.*

climate change and energy use is easily quantifiable and measurable, energy is a common category in several green building standards.

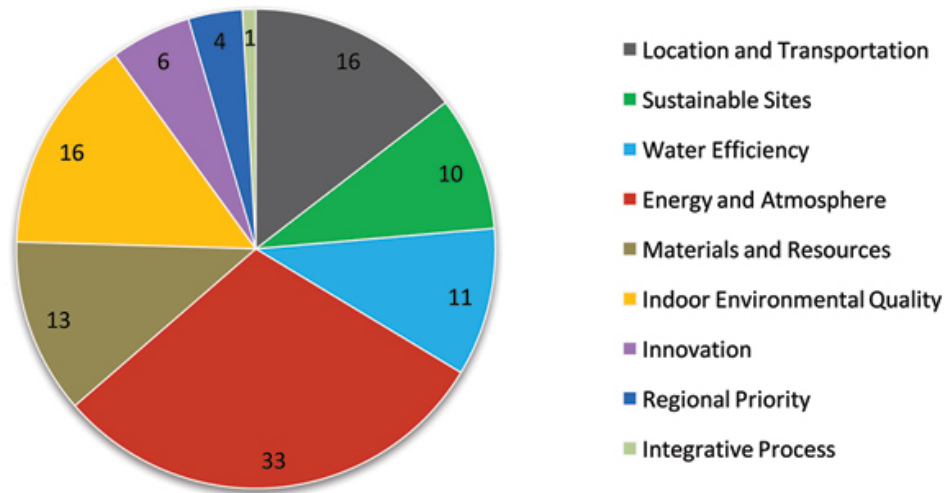


Figure 2: A breakdown of possible points per category⁴⁶

Some of the credits and points are specific to certain project types, but the majority of the credits can apply to each of the project types. An overview of these credits in the context of BD+C projects follows.

Integrative Process



The Integrative Process portion of the LEED v4 certification only accounts for one of the 110 possible points. Earning this credit requires that project teams begin the integrative process extremely early on in even the project’s pre-design stage by conducting water and energy analyses. Using an energy-modeling analysis, the project team must demonstrate how this assessment of the site’s preliminary design informs decisions about the building form. Similarly, after conducting a water budget analysis after the preliminary design stage, the

⁴⁶ “LEED Essentials for Mason Contractors,” Masonry Magazine, <http://www.masonrymagazine.com/leed-essentials-mason-contractors/>, 2016.

project team must demonstrate how this analysis informed their decisions surrounding water system designs in the project.⁴⁷

Location and Transportation (LT)



The Location and Transportation (LT) section is new in LEED v4, and it accounts for 16 of the 110 possible points—tied with Indoor Environmental Quality for the second-highest weighted category. The Location and Transportation category encompasses matters that do not necessarily have to do with physical features of a building, but rather have more to do with the building’s positioning in a wider context. For example, points are awarded if the building site successfully avoids “sensitive lands.”⁴⁸ Conversely, points are also awarded if the building is purposefully built on a former brownfield site and remediates it in the process.⁴⁹ Moreover, to encourage consideration for the copious amounts of greenhouse gases released by the transportation sector each year, several of the credits also encourage alternative transportation. For instance, points are awarded based on the building site’s proximity to existing infrastructure. This credit is based on the assumption that being in closer proximity to food-selling areas or recreational areas would encourage walking or bicycling over driving. To further encourage this active lifestyle, another possible point is awarded to projects that incorporate a specific on-site bicycle storage area and showers for bicycle riders to use. However, realistically, some people would not be able to cycle the entire distance to their destinations, so more points are awarded to sites that have convenient public transit nearby.

⁴⁷ “Integrative Process,” USGBC, <http://www.usgbc.org/node/2613097?return=/credits/new-construction/v4/integrative-process-credits>, 2016.

⁴⁸ Prime farmlands, areas subject to flooding, threatened or endangered species habitats

⁴⁹ A site (usually previously developed and abandoned) that has contaminated soil and groundwater

Yet even so, some people will still have to drive their own passenger cars. So to discourage this as much as possible, points are awarded for projects that allow only the bare minimum amount of parking spaces mandated by the zoning codes, with a certain percentage of these spaces allocated for green vehicles.⁵⁰

Sustainable Sites (SS)



The Sustainable Sites (SS) section contributes a maximum of 10 points to a project's score. Like the LT section, the SS section focuses on how a project is situated in a larger context, but it specifically focuses on the project's role as part of an ecosystem. To encourage thinking around the ecological context of the buildings, one credit rewards an in-depth assessment of the site's geographical features before the designing phase even begins. This includes an analysis of the site's topography, hydrology, climate, and vegetation. With this context in mind, the purpose and importance of the SS section becomes clearer. This context simultaneously reveals conditions of the site's surroundings that could influence the building's design and the potential of the building to affect its surroundings. To reduce the harmful effects of buildings on the existing biodiversity in the area, this section attempts to curb disruptive issues such as light pollution, rainwater runoff pollution, and heat islands. Besides rewarding attempts to just reduce negative effects, this section also rewards attempts to actually create positive effects on the local ecosystem. This can be achieved by either physical means of restoring native vegetation, or by financial means by donating to local conservation organizations.⁵¹

⁵⁰ "Location and Transportation (LT)," USGBC, <http://www.usgbc.org/credits/new-construction/v4/location-%26-transportation>, 2016.

⁵¹ "Sustainable Sites (SS)," USGBC, <http://www.usgbc.org/credits/new-construction/v4/sustainable-sites>, 2016.



Water Efficiency (WE)

The Water Efficiency (WE) section weighs in at 11 possible points. The name of this section speaks for itself, as it concerns reducing on-site water usage. This reduction is aimed at indoor and outdoor water usage. For the project to even qualify for LEED certification, it must reduce its outdoor water and indoor water use by a certain amount—and only if the project goes above and beyond these reductions can it begin to actually earn points. Outdoor water use is essentially concerned with irrigation. A decrease in potable water used for irrigation can be brought about by a variety of methods. The use of alternative water sources, such as harvested rainwater or water treated by living machines, could assist in these reductions. Also, intentional selection of the types of plants and vegetation chosen in the site’s landscaping could also influence how much irrigated water is needed. These methods also translate into water reduction inside of the building as well—the same alternative water sources could be used for toilet flushing, which is a huge contributor to the amount of water used in a functional building. Also, instead of intentionality in landscaping, intentionality in appliance selection could greatly impact the amount of indoor water used. The use of low-flow appliances can often significantly reduce the amount of water consumed indoors. Finally, to monitor if reductions in overall water usage is actually occurring, LEED requires the installation of water meters.⁵²



Energy and Atmosphere (EA)

The Energy and Atmosphere (EA) section makes up the bulk of the points in LEED certification. One aspect of the EA section is energy reduction, which also translates into

⁵² “Water Efficiency (WE),” USGBC, <http://www.usgbc.org/credits/new-construction/v4/water-efficiency>, 2016.

reduction of greenhouse gases emitted into the atmosphere. The World Energy Council of 2013 estimated that in the year 2011, 82 percent of the total energy supplied worldwide came from carbon-emitting fossil fuels. Unfortunately, they predict that by the year 2020, the amount of worldwide energy sourced from fossil fuels will only drop to 76 percent.⁵³ This means that energy consumed by the building sector is, more often than not, strongly contributing to greenhouse gas emissions that lead to climate change. This section seeks to ameliorate the amount of emissions by requiring a minimum energy performance for the building based on energy models and simulations. A huge emphasis is placed the conduction of these energy simulations to optimize performance, as this step makes up 18 of the 33 possible points. Another part of this credit involves compliance with American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) standards, which lists out energy-saving features of buildings. Ideally, projects would also have on-site renewable energy generation, and the more renewable energy that can be generated on-site, the more points can be earned. But besides seeking to reduce greenhouse gas emissions, the EA section also seeks to reduce other harmful emissions, such as chlorofluorocarbons (CFC) found in refrigerants that can cause damage to the ozone. Finally, like in the WE category, metering must be installed. These meters make it possible to determine whether or not energy reduction efforts are actually making a considerable difference.⁵⁴

⁵³ “World Energy Resources,” World Energy Council, https://www.worldenergy.org/wp-content/uploads/2013/09/Complete_WER_2013_Survey.pdf, 2013.

⁵⁴ “Energy and Atmosphere,” USGBC, <http://www.usgbc.org/credits/new-construction/v4/energy-%26-atmosphere>, 2016.



Materials and Resources (MR)

The Materials and Resources section is worth 13 of the 110 possible points. The purpose of this section is to encourage a more comprehensive awareness of buildings' life cycles.

While the MR section does not call for complete cradle-to-cradle net-zero impacts, it takes steps to reduce the environmental impacts of each life cycle stage—from the raw material sourcing and manufacturing phases to the operation and demolition phases. In terms of the raw material sourcing stage, more points are awarded to projects that use resources verified to be extracted in a responsible way. Furthermore, more benefits are rewarded to those projects that source, manufacture, and buy their materials all within a 100-mile radius of the project site to reduce the amount of fuel needed to transport the materials. In consideration of the end of life cycle stage, more points are awarded to buildings that reuse parts of buildings that would otherwise be sent to a landfill. Points are awarded as well to buildings that reuse the structures of existing historic or run-down buildings. Finally, to remain cognizant of the amount of waste generated in a building's lifetime, this section requires that a portion of the building be devoted to the collection of recyclables in to ideally increase the amount of diverted waste.⁵⁵



Indoor Environmental Quality (EQ)

The Indoor Environmental Quality (EQ) section accounts for 16 possible points. This section embodies the eco-medical logic as it focuses on improving human health and productivity. Interestingly, the EQ section actually *requires* buildings pursuing LEED certification to have a no-smoking policy inside the building. This is the first real prerequisite

⁵⁵ “Materials and Resources,” USGBC, <http://www.usgbc.org/credits/new-construction/v4/material-%26-resources>, 2016.

that directly tries to influence human behaviors. Other credits mostly serve the purpose of ensuring occupants' physical and psychological comfort. In terms of biological health, the section offers points for using volatile organic compound (VOC) free materials since these are known to contribute to sick-building syndrome. It offers points for installing or implementing proper ventilation systems, which could also effectively decrease the chance of sick-building syndrome. In terms of psychological health, points are offered for thermal control. Everyone has experienced the feeling of either being too hot or too cold, and constant exposure to either of these feelings can negatively affect biological and psychological health. Another point is offered for access to daylight in the building because natural light has been shown to be more beneficial for people's circadian rhythms than artificial lighting. Access to "quality views" is another part of the section, which is an attempt to connect a building's inhabitants to the outdoor environment visually. Finally, providing acoustic comfort and noise control in the buildings is worth another point because distracting or unpleasant noises can also affect the mental health of building inhabitants.⁵⁶

Innovation (IN)



The Innovation contributes six points maximum out of the total 110 points. Five of these six points reward projects that achieve a significant improvement in environmental performance—*but* this improvement must be achieved by means not detailed in the LEED manual. These five points aim to allow room for new ideas so that LEED does not become completely prescriptive. The one other point is awarded to projects that hire a LEED Accredited Professional or LEED AP. A LEED AP is someone who is well versed in a certain

⁵⁶ "Indoor Environmental Quality (EQ)," USGBC, <http://www.usgbc.org/credits/new-construction/v4/indoor-environmental-quality>, 2016.

project type of LEED and has extensive experience guiding projects through the certification process.⁵⁷

Regional Priority (RP)



The Regional Priority (RP) category is a new addition to LEED certification that is a nod toward the fact that certain environmental issues are more-dire in certain areas than others. However, it accounts for only four of the 110 possible points. The USGBC website has an online tool to help those applying for LEED certification to find out which credits are particularly important in their project’s area. For example, after entering “Los Angeles, California” into the tool’s search bar, the following credits appeared:

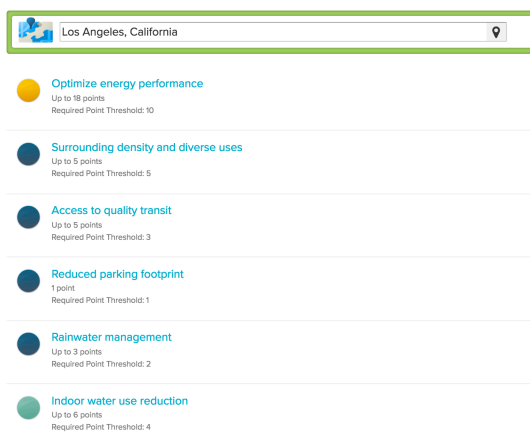


Figure 3: A screenshot of the RP online tool set for Los Angeles, California⁵⁸

These regional priority credits imply that in Los Angeles, the “optimize energy performance, surrounding density and diverse uses, access to quality transit, reduced parking footprint, rainwater management, and indoor water use reduction” credits are particularly of importance.

⁵⁷ “Innovation (IN),” USGBC, <http://www.usgbc.org/credits/new-construction/v4/innovation>, 2016.

⁵⁸ “Regional Priority credit lookup,” USGBC, <http://www.usgbc.org/rpc/LEED%20v4%20BD+C:%20NC/v4/1528?location=Los%20Angeles,%20California&lat=34.0522342&lng=-118.2436849>, 2016.

Bank of America Tower at One Bryant Park

The Bank of America Tower in Manhattan, the first commercial skyscraper to attain LEED platinum level certification, was praised as “The World’s Most Environmentally Responsible High-Rise Office Building.”⁵⁹ The towering building was designed to economically revitalize the area of Bryant Park—an area that had formerly fallen into a state of neglect due to a temporary but very protracted period of closure beginning in the 1920s. Although the Architects’ Emergency Committee attempted a remodeling of the site in the 1930s, by the 1970s “New York seemed to have given up on Bryant Park for lost as an urban amenity, as well as a historic site.”⁶⁰ Unfortunately, as a result of its lack of maintenance and use, the mid-1970s marked a time when the park became much less of a public destination and more of a center where drug traffickers gathered to conduct their businesses. A plan implemented in 1980 strove to correct these issues and transform the park back into a place of public enjoyment and recreation.⁶¹ When the Bank of America Tower officially opened its tall glass doors in the year 2010, it was just one of the many renovations already in the immediate area surrounding Bryant Park. For some, this building not only symbolized the complete transition out of Bryant Park’s troubled past, but also a move into a cleaner and more environmentally conscious future.

The enormous 55-story, 22 million square foot building was refurbished with the latest technologies and design features of its time, several of which enabled it to achieve the highest LEED certification possible. It uses “filtered under-floor displacement air ventilation and

⁵⁹ “Builders Break Ground on ‘World’s Most Environmentally Responsible High-Rise Office Building,” GreenBiz, <https://www.greenbiz.com/news/2004/08/03/builders-break-ground-worlds-most-environmentally-responsible-high-rise-office-build>, 2004.

⁶⁰ “Bryant Park Today,” Bryant Park Corporation, <http://www.bryantpark.org/about-us/today.html>, 2016.

⁶¹ *Ibid.*

advanced double-wall technology”⁶² to maintain occupant comfort, and carbon dioxide monitors were installed to maintain a certain level of “fresh air” within the space. Its extensive integration of glass into the façade of the building both lets in natural lighting and connects its occupants with Bryant Park and the outdoors, and it also makes ample use of landscaping both in and on the building—with both an “Urban Garden Room” and a green roof.



*Figure 4: Indoor landscaping and natural lighting in the building*⁶³

LED lights are also used in the building and are designed to automatically dim in the daytime. To address water-use reduction, waterless urinals, greywater recycling systems, and rainwater harvesting systems were installed. Several measures were taken to reduce the amount of energy that the building has to draw from the city’s grid as well, including the installation of an on-site, state-of-the-art cogeneration plant intended to provide for much of the building’s energy demands. This cogeneration plant works in conjunction with an on-site thermal

⁶² “Builders Break Ground on ‘World’s Most Environmentally Responsible High-Rise Office Building,” GreenBiz, 2004.

⁶³ Irina Vinnitskaya, “Bank of America Tower at One Bryant Park / Cook + Fox Architects,” ArchDaily, <http://www.archdaily.com/247880/bank-of-america-tower-at-one-bryant-park-cook-fox-architects>, 2012.

storage system that “produce[s] ice in the evenings, which will reduce the building’s peak demand loads on the city’s electrical grid.”⁶⁴

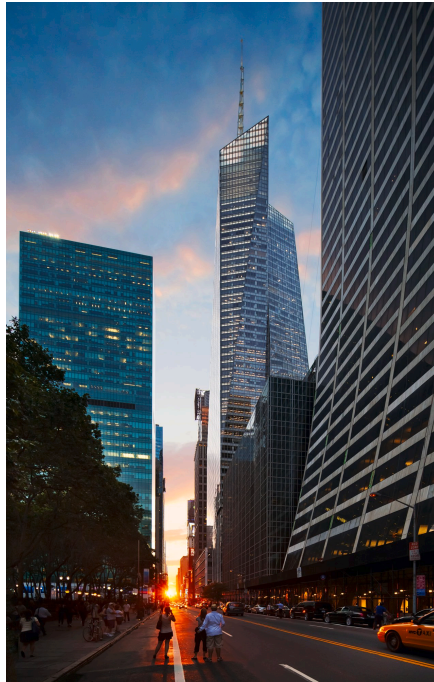


Figure 5: A view of the Bank of America Tower from the outside⁶⁵

Yet a few years into the building’s operation, according to *New Republic* writer Sam Roudman, New York City released data that revealed that the Bank of America Tower actually “produces more greenhouse gases and uses more energy per square foot than any comparably sized office building in Manhattan,” and even uses “more than twice as much energy per square foot as the 80-year-old Empire State Building.”⁶⁶ With the highest possible LEED rating, and with the Energy and Atmosphere category pulling the most weight in the LEED standard, how could this happen?

⁶⁴ “Builders Break Ground on ‘World’s Most Environmentally Responsible High-Rise Office Building,” *GreenBiz*, 2004.

⁶⁵ Irina Vinnitskaya, “Bank of America Tower at One Bryant Park / Cook + Fox Architects,” *ArchDaily*, 2012.

⁶⁶ Sam Roudman, “Bank of America’s Toxic Tower,” <https://newrepublic.com/article/113942/bank-america-tower-and-leed-ratings-racket>, 2013.

The reason lies in the way that LEED certification functions: it ensures that the building is constructed according to the submitted design, but it does not evaluate its post-construction operations.⁶⁷ Once LEED certified, that newly constructed building can retain its title without having to periodically renew its certification. While this less stringent policy is more convenient for building owners and perhaps allows more of them to develop an interest in green buildings, it also means that LEED requires no proof that the buildings actually reduce their impacts on the environment. And the Bank of America Tower is not the only LEED certified building to be accused of higher-than-predicted energy use. According to Walker Wells, LEED AP and Vice President of Programs at Global Green, one of the most common arguments against the LEED standard is that the actual energy usage of the building is greater than what energy models predict. However, he also pointed out that initial energy models and estimates are based on several assumptions—and while these assumptions may be chosen carefully, not all of them actually carry out in reality. Therefore, it is quite difficult to completely accurately forecast the amount of energy used in the building.⁶⁸

In the case of the Bank of America Tower, while there were measures taken and technologies implemented to try to reduce the amount energy from the grid used, an enormous amount of energy was still consumed due to the services the building provides. A *TIME Magazine* article by Bryan Walsh also acknowledged the shortcomings of the LEED standard, but it took a less-harsh stance against it by also acknowledging that:

...it's not the Bank of America building itself that's responsible for that massive carbon footprint. It's what's being done inside the building, as those hardworking computers

⁶⁷ That is, unless, the project team is pursuing LEED Existing Buildings Operations and Maintenance certification—in which case renewal is required every five years.

⁶⁸ Walker Wells (LEED AP and Vice President of Programs at Global green) in discussion with the author, November 2016.

suck electricity 24 hours a day, seven days a week. The fact that a skyscraper with so many cutting-edge, energy-efficient features can still use so much energy because it needs to play a full-time role in the cloud underscores just how electricity-intensive the digital economy can be.⁶⁹

While it is a valid point that LEED does not adequately monitor actual building performance, it could also be said without the energy-saving technologies and strategies that contribute to a LEED platinum certification, buildings would be performing exponentially worse.

Developer of the building Douglas Durst brought up another common criticism when he told the *Wall Street Journal* that “We found [LEED] to be a little confining. There are things we want to do that don’t give us a benefit under LEED.”⁷⁰ The LEED standard attempts to allow room for creative solutions through the Innovation category, however, some still find it to be too prescriptive. But this is not unique to LEED—many green building standards draw the same criticisms for limiting creative designs and solutions.

But despite all of these valid criticisms, the design of the building itself seems to be generally well-received. On the Bank of America Tower’s Facebook page, several people comment praising the architecture and design of the building. One commenter called the building “inspiring,” while another called it a “perfect place to work in.”⁷¹ The same types of positive reviews can be found on the Bryant Park page on TripAdvisor, with one calling the

⁶⁹ Bryan Walsh, “The Surprisingly Large Energy Footprint of the Digital Economy [UPDATE],” *TIME Magazine*, <http://science.time.com/2013/08/14/power-drain-the-digital-cloud-is-using-more-energy-than-you-think/>, August 2013.

⁷⁰ Kevin Brass, “Is New York’s Greenest Building Really Green?”, *World Property Journal*, <http://www.worldpropertyjournal.com/featured-columnists/global-property-beat/skyscrapers-green-building-bank-of-america-tower-new-york-architecture-leed-building-design-7176.php>, August 2013.

⁷¹ “Bank of America Tower,” *Facebook*, <https://www.facebook.com/pages/Bank-of-America-Tower/139188412771866?fref=ts>, 2016.

building “stunning” and another appreciating its “amazing architecture.”⁷² So while it is important to acknowledge that the building has its flaws, it would be unfair to classify it as a failure.

⁷² “Bryant Park,” *TripAdvisor*, https://www.tripadvisor.com/Attraction_Review-g60763-d136347-Reviews-or10-Bryant_Park-New_York_City_New_York.html#REVIEWS, 2015.

Building Research Establishment Environmental Assessment Method (BREEAM):



The BREEAM standard, the very first green building standard published in the world, can also apply to a depth of project types: communities, infrastructure, new construction, in-use, and refurbishment and fit-out. Like LEED, each of these different project types has a different technical standard, but each is measured based on their performance in similar categories. These categories focus on different aspects of sustainability embedded in the built environment—energy, health and wellbeing, innovation, land use and ecology, materials, management, pollution, transport, waste, and water. Within these categories, the projects’ features can earn credits, and these credits can cumulatively contribute to the project’s ranking. The lowest BREEAM certification is Pass; and from there it increases to Good, Very Good, Excellent, and finally Outstanding.

In a similar fashion to LEED, much of the BREEAM certification depends on the design and plan of a building. However, BREEAM also takes the post-construction stage and the very beginning of the occupancy stage into account. After the design stage assessment, an “interim BREEAM certification” is awarded to a project. However, the final BREEAM certification does not occur until construction is completed and the building enters its early occupational stage. Figure 5 below, courtesy of UK based consulting company Peak Sustainability Ltd, visually depicts the BREEAM certification process.

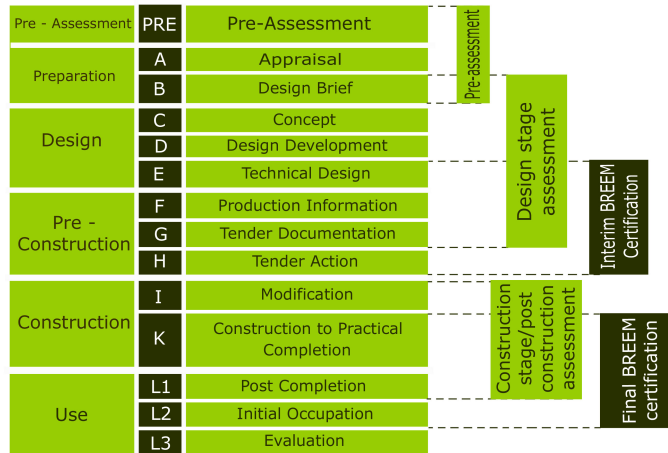


Figure 6: A diagram of the BREEAM certification process (excuse the BREEAM typographical error)⁷³

In LEED, the use of a LEED AP is a credit, but it is not mandatory since design teams are the ones to actually gather documentation, and the actual reviewing process is done by the USGBC.⁷⁴ In the BREEAM standard, BREEAM APs or qualified assessors are the ones required to compile all assessment documentation to submit to the BRE for certification. They also determine a project’s certification ranking: a Passing status requires a score of at least 30%, a Good status requires a score of at least 45%, a Very Good status requires a score of at least 55%, an Excellent status requires a score of at least 70%, and an Outstanding status requires a score of at least 85%.⁷⁵ While achieving a high score ideally requires high-quality performance in all 10 categories, the categories are weighted differently so that performing well in one could impact the resulting score far more than performing well in another.

⁷³ “The BREEAM assessment process,” Peak Sustainability Ltd, <http://www.peaksustainability.co.uk/the-breeam-assessment-process/>, 2012.

⁷⁴ “BREEAM or LEED – strengths and weaknesses of the two main environmental assessment methods,” Building Services Research and Information Association (BSRIA), <https://www.bsria.co.uk/news/article/breeam-or-leed-strengths-and-weaknesses-of-the-two-main-environmental-assessment-methods/>, 2016.

⁷⁵ “Scoring and Rating BREEAM assessed buildings,” BRE, http://www.breeam.com/BREEAM2011SchemeDocument/Content/o3_ScoringRating/scoring.htm, 2016.

Figure 5 below displays an example of how the 10 categories are weighted and how a project’s performance can translate into a final BREEAM score. As shown by the “section weighting” column of the table, like in the LEED standard, the energy section pulls the most weight at 19% of the total. The credits available for new construction projects will be explained in greater depth in the upcoming sections.

BREEAM Section	Credits Achieved	Credits Available	% of Credits Achieved	Section Weighting	Section score
Management	10	22	45%	0.12	5.45%
Health & Wellbeing	8	10	80.00%	0.15	12.00%
Energy	16	30	53.33%	0.19	10.13%
Transport	5	9	55.56%	0.08	4.44%
Water	5	9	55.56	0.06	3.33%
Materials	6	12	50.00%	0.125	6.25%
Waste	3	7	42.86%	0.075	3.21%
Land Use & Ecology	5	10	50.00%	0.10	5.00%
Pollution	5	13	38.50%	0.10	3.85%
Innovation	2	10	20%	0.10	2%
Final BREEAM score				55.66%	
BREEAM Rating				VERY GOOD	

Figure 7: An example of a BREEAM score calculation⁷⁶

Energy



The primary aim of the energy category is the reduction of emissions. The credits in this category each strive to change the fact that a building’s energy consumption is one of the leading contributors to greenhouse gas emissions. One credit requires that an Energy Performance Ratio (EPR) be calculated. The EPR takes into account several factors; including building floor area, the energy consumption of the building as modeled by an accredited energy assessor, and then how this energy consumption translates into carbon dioxide emissions. Essentially, the more the project is able to cut its energy demand and carbon

⁷⁶ *Ibid.*

emissions, the more credits are awarded. The BREEAM standard also offers a credit for the installation of energy monitoring devices.

This category emphasizes the importance of using energy-efficient, low-carbon fixtures for both the indoors and outdoors of buildings. The energy it takes to power these fixtures is also taken into consideration as credits are offered for having either local renewable energy generation or a renewable energy supply contract. Since a significant amount of the energy in a building goes into heating and cooling, another credit is offered for the use of “free cooling,” or types of cooling and ventilation that are not connected to an active central air system.

Then the BREEAM offers credits for very site-specific projects. For example, for larger buildings with elevators, escalators, or moving walkways, BREEAM awards points for energy-efficiency in these indoor transportation methods. Another credit is offered to the projects that analyze peak hours of the transportation use to determine times that the transportation can be turned off. For moving walkways or escalators, the installation of a passenger sensor could also save energy by only activating the transport when necessary. BREEAM also offers a site-specific credit for more residential projects by requiring an area where washed clothing can be left out to dry, thereby bypassing the energy needed to operate a clothes dryer.⁷⁷ Therefore, although the LEED and BREEAM standards agree that energy is a main focus in green building design, their approaches to grading the energy category have overlapping and diverging points.

⁷⁷ “BREEAM New Construction Non-Domestic Buildings Technical Manual,” BREEAM, http://www.breeam.com/breeamGeneralPrint/breeam_non_dom_manual_3_o.pdf, 2011.

Health & Wellbeing



The health and wellbeing category is the second-highest weighted section after Energy, coming in at 15% of the total score possible. Some of the credits offered are similar to the LEED credits offered in the “Indoor Environmental Quality” section, such as access to daylight, glare control, proper ventilation, use of low-emitting materials, thermal comfort, and acoustical comfort. However, certain credits in this category are unique to the BREEAM standard. For instance, interestingly, a credit within the “visual comfort” section is offered for the use of a visual arts coordinator to enhance the aesthetics of the project. Another credit rewards the assurance of high water quality supplied to the buildings’ inhabitants. Another credit, entitled “safety and security,” which encourages low risk design strategies to ensure safe access to and operation of the building. This can be achieved, for example, by having dedicated bicycle lanes in the area surrounding the building, having designated pedestrian walkways that are easily accessible, and having proper lighting of the public areas surrounding the building. It also takes into account the safety of those driving by encouraging simple and easy-to-manuever parking area designs. Another credit in this section is given to those projects that have consulted with a security consultant to ensure that the appropriate measures are taken to maximize the safety of the site.⁷⁸

Innovation



BREEAM’s innovation category is responsible for 10% of the total credits available. This section is similar to LEED’s innovation category, but it is given more weight in BREEAM. Just as in LEED, credits in BREEAM are available for levels of performance that transcend those outlined by the BREEAM guidelines. Here too, credits are awarded to projects that use

⁷⁸ *Ibid.*

creative means to achieve significant improvements in some aspect of environmental performance.⁷⁹

Land Use and Ecology



The land use and ecology category also makes up 10% of the total credits offered. Again, some of the credits overlap with those explained earlier in the LEED sections. For instance, projects are rewarded for building on land that has already been developed and rewarded even further for remediating and building on land that has previously been contaminated; and projects are rewarded for building on sites of no “ecological value.” It is also ideal if a project team appoints a suitably qualified ecologist (SQE) to help them to consider and minimize their ecological impacts. The SQE can help the project team to earn a variety of credits, such as guiding the project team to potentially increase the biodiversity on the site and to minimize the long term impacts that the site could have on surrounding biodiversity.⁸⁰

Materials



About 12.5% of the total amount of credits can be attributed to the materials category. Just as with LEED, life cycle assessment plays a significant role in the materials section. Credits are given to those project teams that conduct a life cycle assessment for the building’s environmental impact. However, the life cycle impact of all materials must be considered—including outdoor hard landscaping and thermal insulation. These materials must be approved by the Green Guide to Specification, an online tool for BRE projects that provides grades for different construction products based on environmental impact. Interestingly this

⁷⁹ *Ibid.*

⁸⁰ *Ibid.*

section also takes into consideration the protection of exposed building parts to minimize the need for material replacement.⁸¹

Management



The management category contributes to 12% of the total possible BREEAM credits. This category focuses largely on the more “behind-the-scenes” parts of executing a successful project. This is the category that ensures that the building is actually built to the performance standard intended in the project plan and design. It first offers points for the presentation of a thorough design plan that outlines how the project will achieve its goals and which responsibilities will be delegated to which parties. Then, BREEAM’s management category offers a credit for the use of a BREEAM AP to monitor the project team from its goal setting through its goal-attaining process.

Another credit is only awarded to buildings after they have been occupied for some time. For buildings that are machine ventilated, a “specialist commissioning manager” conducts tests on a building for its seasonal energy usage over the course of a minimum of 12 months. Qualitative data is also collected as building occupants are interviewed for feedback on the effectiveness of certain systems in the building. For buildings that use natural ventilation instead, an external consultant must return periodically to review the indoor quality of the building. With the data collected by these specialists, an analysis must be conducted to see whether or not the actual performance is comparable with what was expected. If there are discrepancies, some of the systems can be adjusted.

This section also recognizes the potentially harmful effects of construction and seeks to reduce them through active monitoring. Credits are offered for both energy use, carbon

⁸¹ *Ibid.*

dioxide emission, and potable water use monitoring during the construction phase. Since material delivery to the construction can also have a strong environmental impact, another credit is given to those projects that monitor the transport of materials from the factories to the distribution center, then finally to the building site. Then, in the opposite direction, the project team must also monitor the transport of construction waste from the building site to wherever the waste is processed.

A unique set of credits offered in BREEAM's management category emphasizes the importance of stakeholder participation in the building development process. One credit is offered to project teams that organize an initial consultation with all those relevant to and affected by the newly proposed building—and the feedback given during this consultation must be taken into account in a revision of the proposed design. Another credit is offered to project designs that intentionally design for accessibility by all building users. This means designing with those with disabilities, those of all age groups, and those of all fitness levels in mind.

In consideration of the economic aspect of green buildings, one credit is also offered for carrying out a Life Cycle Cost (LCC) analysis, which basically follows the costs of developing a building throughout its construction, operation, and maintenance. This LCCA compares different building elements to help inform a decision that will both meet performance standards and save costs in the process.⁸²

Pollution



The pollution category contributes to 10% of the total available credits. The first type of pollution that this category strives to mitigate is the emissions that are released as a result of

⁸² *Ibid.*

refrigerants escaping the buildings. Refrigerants are commonly found in air conditioning systems and are known to be damaging to the ozone layer. To minimize the amount of refrigerant leakage, credits are offered, for example, for the placement of systems using refrigerants in air tight areas or for the installation of leak detection systems. Another type of emission pollution that this category seeks to minimize is the NO_x emissions that are normally caused by fossil fuel combustion. These emissions can react with heat to produce a toxic ozone known to cause respiratory issues. This is also the type of emission to combine with precipitation to form “acid rain.” The BREEAM manual awards more credits to buildings that have lower emission levels.

Another type of pollution that is sometimes overlooked or less considered is light pollution. In the BREEAM standard, one credit is offered for reducing the obtrusiveness of outdoor lighting in the evening hours. This can be achieved by putting the lights on a timer and having them automatically shut off in hours that the building is not in operation. However, some projects may require lighting throughout the evening hours as well; and in this case, all outdoor lights should be downward facing or low-level lights. The second form of intangible pollution addressed in this section is noise pollution. This credit involves yet another site assessment by a qualified acoustic consultant to ensure that both the construction and the operation of the building do not disrupt the surrounding areas.

Besides attempting to reduce harmful emissions, this category also attempts to curb the amount of more tangible forms of pollution as well, such as surface water runoff. This means that the projects pursuing certification must properly plan for potential flooding. A consultant must approve the site’s drainage in order to make sure that run-off and polluting discharge from the site will not increase with the new development.⁸³

⁸³ *Ibid.*

Transport



The transport category only contributes 8% of the total credits offered. The types of credits in this category are relatively similar to those offered in LEED. Like in the LEED standard, part of the credits in this section comes from assessing the project's proximity to public transportation. The proximity to public transportation, the public transportation type, and the frequency of the public transport are all factors that contribute to a site's Accessibility Index. A greater Accessibility Index corresponds to a greater amount of credits awarded. However, if a building naturally has a low Accessibility Index, the project can redeem a credit by providing a bus service during peak transportation hours connecting the building with a public transportation stop. Also similarly to LEED, BREEAM awards more credits to projects that in close proximity to local amenities. But to further encourage alternative transportation, BREEAM has credits for bicyclist facilities as well as for the reduction of passenger car parking spaces. In general, the project will be rewarded a credit for having a plan on how it will accommodate for several types of alternative transportation, as long as they affirm that the plan will actually be implemented and maintained during the building's operation phase.⁸⁴

Waste



The waste category contributes a small 7.5% to the overall credits offered in BREEAM. Essentially, this category seeks to reduce the amount of waste that a building generates throughout its life stages. A credit is given to those projects in their construction stage that have high resource efficiencies, meaning that they have a small tonnes of waste to cubic

⁸⁴ *Ibid.*

meters of floor area ratio. Then another credit is awarded if significant amounts of construction waste are diverted from the landfill. Projects that use a certain amount of recycled materials are awarded another credit as well so that the demand for new raw materials decreases. To consider the waste generated during the operation phase buildings, another credit is available for those projects that designate clear spaces for the storage of recyclable wastes. Finally, one last credit is awarded to projects that have their occupants approve the type of ceiling and floor finishes before the building is constructed in order to eliminate the immediate need to change out these materials.⁸⁵

Water



In the BREEAM standard, the water category actually pulls the least weight with only 6% of the total available credits. The types of credits in this section are also fairly similar to the types of the water credits offered in the LEED standard. The first set of credits emphasizes the need to reduce potable water consumption. In order to calculate the amount of BREEAM credits that will be awarded to a project for reduced potable water consumption, the project's water consumption will be compared with a baseline performance. The higher the percentage of improvement, the higher the number of awarded credits. To reduce potable water consumption, projects can install code-compliant rainwater systems to offset the need for potable water or make use of recycled greywater wherever allowed. They can also earn a further credit for the use of water efficient equipment in place of conventional equipment.

Just as in the LEED standard, the installation or maintenance of water monitors is essential. More credits are given to those projects that also install leak detection technology to

⁸⁵ *Ibid.*

ensure that no water is wasted in this manner. Another credit is awarded to buildings that install flow-control devices to reduce leakage and wasted water.

Midpark Hospital (Dumfries and Galloway Acute Mental Health Unit)

The Midpark Hospital, formerly known as the Dumfries and Galloway Acute Mental Health Unit, is an example of a BREEAM project where environmental design and human health intersect. The facility opened in 2012 in Dumfries, Scotland, after earning an “excellent” rating of 74.3% during the design phase. The hospital contains a total of six wards and 85 beds for patients, as shown below by the site plan:



Figure 8: A color-coded site plan of the Midpark Hospital wards⁸⁶

The site spans 6,930 square meters and boasts several green features. It makes ample use of natural daylighting and ventilation techniques, which—according to Arup’s Sarah Jane

⁸⁶ “Midpark Hospital: A Case Study,” Architecture + Design Scotland, <http://www.slideshare.net/NORRltd/crichton-midpark-case-study>, 2012.

Stewart—is “essential for the health, wellbeing and treatment of patients,” and for “keeping utility and maintenance costs and carbon emissions low for the client / owner occupier.”⁸⁷ All water appliances are low-flow, and metering for water and energy was also installed. The energy used on site for heating the air as well as water is sourced from biomass, which earned the project an Energy Performance Certificate “A” rating. However, while biomass energy produces a fraction of the carbon dioxide emissions of fossil fuel energy; unlike with solar or wind energy, it still must be burned. Therefore, carbon dioxide emission of some amount in the use of biomass is unavoidable.

According to a study conducted by Aspinal et al. in 2012, one of the main criticisms of the BREEAM standard is that it focuses significantly on the environmental impact aspect of sustainability and not so much on the social and economic aspects.⁸⁸ While the BREEAM standard may not do a lot to actually address these aspects, the Midpark Hospital project team did take steps to consider these aspects. For example, during the preliminary design phase, the project team made sure to devote a large amount of time to discussing the proposed designs with staff members and patient groups: the people that would actually be using the space. The Design Manager of the project, Stephen Howie, said that, “...I think a huge benefit in how the building was received was that staff had felt engaged with the design process... by the time they were moving in they felt familiar with the building and it was theirs.”⁸⁹ Moreover, the design of the space seemed to very intentionally take the wellbeing of its occupants into account—besides using natural lighting and ventilation, the design team also

⁸⁷ “Dumfries and Galloway Acute Mental Health Unit (Midpark Hospital),” *BRE Ltd*, <http://www.breeam.com/case-study-dumfries-and-galloway-acute-mental-health-unit>, 2016.

⁸⁸ Sarah Aspinal, Begum Sertyesilisik, Amr Sourani, Ashley Tunstall, “How Accurately Does BREEAM Measure Sustainability?” *Scientific Research* 3 (2012): 1-8, doi: 10.4236/ce.2012.37B001.

⁸⁹ “Midpark Hospital: A Case Study,” Architecture + Design Scotland, <http://www.slideshare.net/NORRltd/crichton-midpark-case-study>, 2012.

creatively designed around a 14 meter drop in the site. Instead of spending a large quantity of time, energy, and expense leveling the site, the design team opted to build on three leveled terraces. They also made a point to emphasize constructing single-story housings, because these foster more of a home-like, residential feeling rather than multiple-storied buildings that have more of an institutional feel. Moreover, while on one of the terraces, the other terraces are not as visible—contributing once again to its more small-scale and home-like rather than large-scale and institutional feel. Each terrace has both single-story housing units and landscaped gardens, as well as universal access to green landscape views.⁹⁰



Figure 9: A view of the terraced landscape and “Double Walk” at Midpark Hospital⁹¹

As shown by Figure 7 above, rather than constructing demure, understated buildings that are often associated with medical buildings, the designers chose to use brightly-colored panels in the buildings to reflect the colors found in the meadows before the site’s development, as well as the colors that appear in the patients’ gardens. While some lauded the bold color palette, others believed that the brightly-colored panels were not “sympathetic enough for a mental health facility.” Design Manager Howie defended the bold choice, saying, “Dumfries and

⁹⁰ *Ibid.*

⁹¹ “DOUBLEWALK,” *Lily Jencks Studio*, <http://www.lilyjencksstudio.com/ljs---double-walk>, 2012.

Galloway is not hiding away their mental health hospital and trying to think that it doesn't exist. We're quite happy to shout about it and be proud of the facility."⁹²

The bright palette continues into the interior of the buildings as well as doors and walls are painted in vibrant colors. But these colored doors and walls do not solely serve aesthetic purposes, they also help with patient wayfinding—for example, in the Dementia Unit, where some patients have difficulty navigating, these brightly colored walls and doors can help give hints or signals for place identification. Finally, colors continue back into the outdoors with the courtyards provided for each ward. These courtyards provide spaces for patients to interact and connect with their outdoor environment through gardening, exercising, socializing, or even just observing. Several trees are planted to provide shade, as well as native species from the area to connect the courtyards with their ecological heritage. These plants are maintained without the use of potentially harmful chemicals as much as possible. To also stay true to the original state of the site, the project team took into account the existing water tables and watersheds and existing vegetation, trying to reduce the effects on these as much as possible as well.⁹³

⁹² "Midpark Hospital: A Case Study," Architecture + Design Scotland, <http://www.slideshare.net/NORRltd/crichton-midpark-case-study>, 2012.

⁹³ "Dumfries and Galloway Health Board Acute Mental Health Development Full Business Case," *NHS Dumfries & Galloway*, http://www.nhsdg.scot.nhs.uk/files/master_fbc_issued_to_cig_with_planning_decision.pdf, 2009.



Figure 10: An example of one of the ward's courtyards⁹⁴

Despite the several praiseworthy design features of the Midpark Hospital, it is not without its shortcomings. Upon entering the main entrance of the facility after passing through the playful, colorful Double Walk, a blank wall at the end of the room provides a somewhat abrupt end to the welcoming atmosphere. The view in the upper levels in the main entrance room is also partially blocked, but the view is restored in the pathways that go towards the different wards. While this may seem like a rather minor stumble in design, the entrance room gives the first impression of the facility's interior; therefore, it is important to make that space welcoming. Also, while several of the design features strive towards a more organic and less institutional feeling, the linoleum and formica laminated finishes to the floors and doors in the wards still give off the feeling of sterility. However, because these materials are far cheaper than stone or other more organic materials, this shortcoming in design does make economic sense.⁹⁵ Some of the shortcomings that occur in the use of the spaces are also unfortunately due to favorable design features. For example, due to the natural ventilation feature of the project, staff sometimes may have to open windows to increase

⁹⁴ "Midpark Hospital Dumfries," *Erz Studio*, <http://www.erzstudio.co.uk/projects/mid-park-hospital-dumfries>, 2016.

⁹⁵ "Midpark Hospital: A Case Study," *Architecture + Design Scotland*, <http://www.slideshare.net/NORRltd/crichton-midpark-case-study>, 2012.

ventilation. In places like the intensive treatment room, the noise from the outside public areas can easily enter and cause distress to visitors and patients inside the intensive treatment rooms.⁹⁶

However, despite the successes and failures in design, the real test that the project faces is whether it actually works. According to a senior charge nurse, “the amounts of incidents of aggression [and] self-harming have dropped dramatically right down,” and other staff members agree that this is, at least in part, due to the successful design of the multiple environments that patients can interact with—including outdoor areas and private areas. Patient length of stay has also, on average, been reduced by 25%, and the rate of recovery has increased as well. The decreased length of stay also relieves some of the economic pressure on patients and their families. In general, staff and patients seem to react much more positively to the environment design created by the Midpark Hospital than the hospital that was formerly at the same site.⁹⁷ Regarding the facility’s environmental performance, in BREEAM’s 25th annual award ceremony, the Midpark Hospital was awarded the title of “best performing healthcare building,” on top of its Energy Performance Certificate “A” rating.⁹⁸ However, no data is easily available to the public on the building’s actual environmental performance. Although the use of natural ventilation, natural lighting, low-flow appliances, and ample landscaping are all features that definitely contribute to the greenness of the site, without data, it is difficult to judge exactly how successful the building is in this regard.

The Midpark Hospital could be deemed a success story—at least in terms of building design—but this does not mean that the project did not encounter any issues in the BREEAM

⁹⁶ *Ibid.*

⁹⁷ *Ibid.*

⁹⁸ “Midpark Hospital UK’s ‘Most Sustainable Healthcare Building’ — BREEAM,” *Laing O’Rourke*, <http://www.laingorourke.com/media/news-releases/2015/breeam-names-midpark-hospital-uks-most-sustainable-healthcare-building.aspx>, 2015.

standard. Some BREEAM assessors, not necessarily those that worked on this particular project, have reported that they are met with confusion and frustration when the BREEAM credits require the use of an “expert,” but what the expert says is at odds with what BRE says. Several BREEAM assessors also said that parts of the BREEAM manual are rather ambiguous, leading to problems due to interpretation differences. Finally, another more common complaint about the BREEAM standard is that it too prescriptive—not allowing much flexibility and room for creativity. Although adding credits for innovation was an attempt to address the rigidity in the standard, Aspinal et al. concluded that at times, “BRE assessors do not have the experience to recognise true sustainable innovation and that the whole process has become too much of a box ticking exercise.” However, the same study also emphasized that, “BREEAM is a necessary tool in today’s sustainability conscious society.”⁹⁹

⁹⁹ Sarah Aspinal, Begum Sertyesilisik, Amr Sourani, Ashley Tunstall, “How Accurately Does BREEAM Measure Sustainability?” *Scientific Research 3* (2012): 1-8, doi: 10.4236/ce.2012.37B001.

Ecology / Energy Saving / Waste Reduction / Health (EEWH):



The Ecology, Energy Saving, Waste Reduction, and Health (EEWH) standard was written and formulated specifically with the Taiwanese climate in mind. The use of a specified standard stems from ABRI's belief that "a truly green building should be able to adapt to the local climate, adjusting to the seasons on its own rather than relying on energy-consuming modern machinery."¹⁰⁰ The Taiwanese green building philosophy does not think of green buildings as expensive structures that must have the newest cutting-edge technology. In fact, it actually argues for the exact opposite idea:

The spirit of green building lies within the most modest, basic and approachable design techniques. Reducing energy used for air-conditioning and lighting with natural ventilation and lighting. Replacing sprawling, expensive curtain walls with sensible exterior shading design. Minimizing extraneous overdesign and interior decoration. Designing maintenance- and irrigation-free green spaces instead of thirsty manicured lawns. All these are readily accessible living wisdom that embodies the true spirit of green building.¹⁰¹

Rather than the creative but ostentatious designs that sometimes emerge in modern architecture, the Taiwanese green building philosophy places an emphasis on simple design.

The EEWH green building label can apply to five different types of projects: basic building certification, eco-community certification, factory certification, building renovation certification, and residential building certification. The first green building manual published

¹⁰⁰ "About Green Building Labeling," ABRI, <http://twgbqanda.com/english/index.php>, 2015.

¹⁰¹ *Ibid.*

1999 in Taiwan defined a green building as “a building that consumes minimal resources of the planet and produces the minimal waste.”¹⁰² To create a standard that produces these types of buildings, ABRI divided indicators of biodiversity, greenery, on-site water retention, daily energy saving, CO₂ reduction, construction waste reduction, water resource, indoor environment, and sewage and garbage improvement into four categories. These four categories are what give this standard its title—ecology, energy saving, waste reduction, and health.

Four categories	Nine Indicators		New Grading Score		
			Benchmark Score	Highest Score	Subtotal
Ecology	1.Biodiversity		2	9	27
	2.Greenery		2	9	
	3.On-site Water Retention		2	9	
Energy Saving	4.Daily Energy Saving	Envelope	2	12	28
		AC	2	10	
		Lighting	2	6	
Waste Reduction	5.CO ₂ Reduction		2	9	18
	6.Construction Waste Reduction		2	9	
Health	7.Indoor Environment		2	12	27
	8.Water Resource		2	9	
	9.Sewage & Garbage Improvement		2	6	

Figure 11: A table depicting the category breakdown of EEWH¹⁰³

Figure 6 reveals how these seven indicators are divided amongst the four categories, as well as the point breakdown per category. As shown, energy saving is yet again the highest weighted section contributing 28 total points. The ecology and health categories contribute 27 points each, and waste contributes a lesser 18 points. Just like in the BREEAM standard, the five levels of EEWH certification are determined by calculating score percentages. Projects that earn less than 30% of the points are deemed “Qualified,” projects that earn between 30%

¹⁰² *Ibid*

¹⁰³ *Ibid.*

and 60% are deemed “Bronze,” projects that earn between 60% and 80% are deemed “Silver,” projects that earn between 80% and 95% are deemed “Gold,” and projects that manage to score above 95% are deemed “Diamond.”¹⁰⁴ Like BREEAM, the EEWH standard has two parts to the certification process. The first, called “candidate certification,” is given after the project’s design plan is submitted. The second part, called “final certification,” is given after the construction of the project is completed. However, more similarly to the LEED standard, the project team is the one to prepare and assemble the proper documents to submit to the certification institute: the Taiwan Architecture & Building Center. But unlike LEED both and BREEAM, no specific qualified individual, like a LEED or BREEAM AP, is required or encouraged to lead the project team through the process. Most project teams hire an “EEWH consultant” to take care of the document gathering throughout the certification process.¹⁰⁵ The new construction standards of EEWH will be discussed in the subsequent sections.

Ecology — Biodiversity

Biodiversity, the first indicator in the ecology category, is meant to assess a site’s potential as a habitat for living organisms. Within this indicator, there are six sub-categories: assessment of ecological green network, assessment of habitat for small creatures, assessment of botanical diversity, assessment of soil ecology, assessment of light pollution, and assessment of migration obstacles. Immediately, the content of this indicator distinguishes itself from both the LEED and BREEAM standard. Instead of a straightforward point or credit system, the summation of each of the sub-category scores are compared to a benchmark score. The benchmark score varies with the type of landscape that the site is located on. As long as

¹⁰⁴ *Ibid.*

¹⁰⁵ Annie Shao (Building Physics and Sustainability Engineer at ARUP Taipei) in discussion with the author, November 2016.

the sub-category total score is *greater* than the site's respective benchmark score, then the project passes the indicator.

In the assessment of ecological green network, scores are assigned according to the amount of green space in the site, green space surrounding the site, and the presence of biological corridors. In the assessment of habitat for small creatures, points are given to places that incorporate habitat conducive features into their design. For example, in an aquatic setting, the presence of natural banks or eco-islands are awarded points. Or, in a green habitat, the presence of mixed woods or wild shrubbery is awarded points. In the assessment of botanical diversity, tree and shrub varieties are translated into points. The ratio of indigenous or bird and butterfly attracting plants to other plants is another factor in the botanical diversity score to encourage animal-friendly native landscapes. Then, to further encourage a wide range of biodiversity, more points are awarded for the ratio of mixed-species greenery. In the assessment of soil ecology, a field assessment is conducted. If the site takes the proper measures to protect its topsoil, it is rewarded with points. If the site also engages in organic farming and composting, it is given more points. But EEWH is unique in that some sub-categories can actually deduct points—in the light pollution assessment, a project loses points if street lamp glare or sky-facing light is too great. Also, the assessment of migration obstacles can deduct points for having sizable spreads of road, parking lot, or artificial paving since these man-made infrastructures could disrupt areas where living organisms could interact. As long as these deductions still allow the sum of the sub-category scores to be greater than the respective benchmark score, the project will pass the biodiversity indicator.¹⁰⁶

¹⁰⁶ “About Green Building Labeling,” ABRI, <http://twgbqanda.com/english/index.php>, 2015.

Ecology — Greenery

The greenery indicator essentially ensures that the project's total carbon dioxide capture is greater than another certain benchmark value. However, the calculation of the total carbon dioxide captured by the site along with the calculation of the benchmark value it will be compared to is slightly complicated. Both the benchmark value and the total carbon dioxide capture value of the site rely on several varying factors, each of which is calculated with its own set of equations. The benchmark value is essentially based on zoning type of the site, the site area, the unplantable area of the site, and the ratio of the amount of allowable building coverage as defined by zoning codes. Meanwhile, the total carbon dioxide captured on the site essentially relies on the carbon dioxide capture per unit area for a specific plant type, the benchmark area for that specific planting type, as well as the “preferential factor” for greenery. The values for some of these variables can be found in tables provided in the manual. The greenery indicator is one of many that reveal how much more technical and complex the navigation of the EEWH standard is in comparison to the LEED and BREEAM standards.¹⁰⁷

Ecology — On-site Water Retention

The on-site water retention indicator is the last indicator in the ecology category. This indicator involves the calculation of λ , a value that is calculated by taking into account the water retention capacity of the site both before and after development. In order for a project to pass this indicator, the value of λ must be greater than that of λ_c , the benchmark value of water retention. The water retention capacity before development is calculated by multiplying

¹⁰⁷ *Ibid.*

the total site area by the final permeability of the site, a value found in a provided table based on the site's soil classification, and finally by the maximum time delay following rainfall, which is defined as 24 hours. On the other hand, the water retention capacity after development is calculated by adding up the water retention capacities of various design elements throughout the site. There are nine different design features addressed by the standard, a few of which include grassed swales, permeable pavement, permeable drainpipes, or landscaped ponds.¹⁰⁸ Again, EEWB delves further into the scientific particularities of the site than BREEAM or LEED, taking details like soil grain size into account. While this tailors the standard to accommodate each project's location features, the inclusion of so many particularities and calculations can make the standard very overwhelming, unapproachable, or difficult to work with.¹⁰⁹

Energy Saving — Daily Energy Saving

The first and only indicator of the energy saving category is daily energy saving. Within this indicator, there are three sub-categories of building envelope, AC system, and lighting system. In the building envelope sub-category, the criteria that the buildings must fulfill vary based on the project's elevation above sea level. One criteria in the assessment of building envelope is the shading requirements for horizontal glazing. Horizontal glazing is defined as any sort of glazing that is less than 80 degrees upright. Any glazed area that meets this description and is larger than one square meter must conform to a certain value of solar emissivity. Solar emissivity is the ability for a certain material to transfer thermal energy, therefore ideally, glazing would have a low solar emissivity to keep too much heat from

¹⁰⁸ *Ibid.*

¹⁰⁹ *Ibid.*

entering the building site. Since much of energy in a building goes towards heating and cooling, reducing the amount of excess heat in the building could save a significant amount of energy that would potentially go towards cooling. All buildings seeking certification must outperform current energy building codes by 20%. Then the assessment of the AC system, aims to “(1) prevent chiller overdesign (2) encourage High-efficiency chiller (3) reward energy saving AC technology.”¹¹⁰ This assessment relates back to the Taiwanese definition of a green building as it attempts to reduce the need for machines as much as possible by relying more on simplistic, natural designs. Finally, the assessment of lighting system attempts to reduce energy through increasing the efficiency of lighting systems.¹¹¹

Waste Reduction — CO₂ Reduction

The carbon dioxide reduction indicator is divided into sub-categories of rational structure, lightweight, building durability, and use of recycled materials. This indicator requires the calculation of what is called a “green structure coefficient,” which is a measurement that is based on the “shape coefficient” based on the shape of the building, the “lightweight coefficient,” the “durability coefficient,” and the “usage coefficient of non-metallic recycled material,” all of which are available in provided tables. The usage coefficient of non-metallic recycled material is calculated using a “CO₂ emission influence ratio.” After all of these factors are taken into account, the project must reduce carbon dioxide emissions by at least 18 percent. This indicator makes use of several different coefficients defined within the standard, however, based on the information provided on the website, it is unclear how some of these values are assigned. Again, tailoring equations and coefficients to each project is

¹¹⁰ *Ibid.*

¹¹¹ *Ibid.*

beneficial because it does not try to prescribe a single standard onto all projects. But on the other hand, it causes projects to jump through several complicated hoops to attain certification.

Waste Reduction — Construction Waste Reduction

The construction waste reduction indicator strives to reduce the pollution that occurs in during the construction phase of a building. Specifically, this indicator addresses the pollution by calculating a construction pollution indicator that includes the unbalanced cut-and-fill ratio, the construction waste ratio, the ratio of solid waste from demolition, the construction air pollution ratio, and the weighted coefficient for public hazard. Cut-and-fill refers to the construction practice of moving earth material in one place and depositing it in another place to even out a site.¹¹² The unbalanced cut-and-fill ratio tries to reduce the amount of excess cut or fill for any given project, but it also allows projects with significant amounts of excess to redeem themselves by putting the excess material towards balancing out the cut-and-fill of another project. The construction waste ratio is calculated using what is called a “preferential factor” that rewards projects that use prefabricated materials. The solid waste from demolition ratio, like the LEED and BREEAM standards, rewards sites for using recycled materials to decrease the amount of virgin materials needed. Finally, the construction air pollution ratio rewards projects that take specific measures to reduce the amount of air pollution caused by their construction, such as washing their machinery, spraying their site with water to prevent the release of dust, and adding a fence around the site to contain any unsettled particles. Again, the calculated construction pollution indicator value is then

¹¹² “Cut and fill,” Merriam-Webster Dictionary, <http://www.merriam-webster.com/dictionary/cut%20and%20fill>, 2016.

compared to a benchmark value, and only if it is *less* than the benchmark value can the project pass the construction waste reduction indicator.¹¹³

Health — Indoor Environment

The indoor environment indicator assesses similar features as the indoor environmental quality category in LEED and the health and wellbeing section in BREEAM. Specifically, this indicator focuses on the acoustics, light, ventilation, and interior finishing. The acoustic section essentially focuses on how noise-proof walls, windows, and floors in the project are. The light section focuses on ensuring that areas within the building have adequate access to natural lighting, but also artificial lighting wherever necessary. The ventilation section encourages natural ventilation wherever possible—again, striving to reduce the amount of machinery and technology needed. Finally, the interior finishing section encourages the use of eco-friendly and low-emitting adhesives, fillers, coatings, wirings, or insulation materials.¹¹⁴

Health — Water Resource

While in other standards, water conservation was its own separate category, in the EEWH standard, the water resource indicator falls under the health category. This is likely because a large majority of water-using fixtures in a building are used for sanitation of hygienic purposes. A project's ability to pass this indicator relies almost completely on its use of water-saving bathroom fixtures. These water-saving fixtures include toilets, urinals, public taps, and bathtubs or showers. However, outside of the installation of these fixtures, a score

¹¹³ “About Green Building Labeling,” ABRI, <http://twgbqanda.com/english/index.php>, 2015.

¹¹⁴ *Ibid.*

could also be increased by the use of water recycling systems—for both captured rainwater and on-site generated graywater.¹¹⁵

Health — Sewage & Garbage Improvement

The sewage and garbage improvement indicator is split up into two very self-explanatory sub-categories: sewage improvement and garbage improvement. This section covers some requirements not focused on in other standards. The criteria for sewage improvement have mostly to do with the different types of water receiving their respective proper management. For example, to properly handle laundry wastewater, interceptors must first be installed to filter out any lint, sediments, or otherwise that may contaminate the water. Other types of interceptors that could be installed are grease interceptors, which are of particular importance when installed in any food-related areas. In each type of facility, all drainpipes are required to lead to sewage treatment plants.

The garbage improvement criteria includes a variety of requirements. Part of them were briefly touched upon in other sections—such as the food scrap and fallen leaves composting or recycling areas. However, while other standards only awarded points based on the recycling facilities in a project, the EEWH focuses more on the garbage facilities. Although it does offer a couple of points to incentivize recycling programs, the vast majority of the points actually focus instead on the hygiene of garbage facilities. This extends from rewarding points for “animal-proof, hygienic and reliable sealed garbage bins” to rewarding projects “with central garbage collection facilities that are regularly cleaned, sanitized and maintained.” However, the standard also considers the aesthetics of the garbage facilities by

¹¹⁵ *Ibid.*

even offering points for “projects equipped with planted, beautified or landscaped garbage collection facilities.”¹¹⁶

Taipei Tennis Center for 2017 Universiade

The Taipei Tennis Center is being built because Taipei, Taiwan, was selected as the host city for the 2017 Universiade. Tennis will be one of the several sporting events offered at the 2017 Universiade—an international gathering organized by the International University Sports Federation (FISU) that occurs every two years. The word “Universiade” is derived from the words “university” and “olympiade,” which makes the purpose of the competition self-explanatory: it is like the Olympic Games, except that its participants are solely university student athletes.¹¹⁷ The competition spans for 12 days and has over 9,000 participants from over 170 countries worldwide.¹¹⁸

In Taiwan, the Ministry of the Interior requires that “all new public buildings owned by the central government or receiving more than half of their funding therefrom, with a total construction cost of over NT\$50,000,000, [are] required to obtain a green building candidate certificate before being granted a construction permit.”¹¹⁹ Since an article published by the *Taipei Times* in 2010 said that the Taipei Tennis Center’s construction is estimated to cost about NT\$3.5 billion, the project was selected to pursue EEWB certification. Although the EEWB website asserts that green building design does not constitute higher construction costs, this project’s pursuit of the highest level of certification will undoubtedly make the

¹¹⁶ *Ibid.*

¹¹⁷ “History of Universiade,” Taipei City Government, <http://www.taipei2017.com.tw/files/13-1000-276.php>, 2013.

¹¹⁸ “Summer Universiade,” FISU, <http://www.fisu.net/en/Summer-Universiades-3490.html>, 2016.

¹¹⁹ “History of Green Building Labeling,” ABRI, http://twgbqanda.com/english/e_features.php?Type=1&menu=e_features_class, 2015.

upfront construction costs a significantly greater than that of the project if it only strove to achieve the lowest level of certification.¹²⁰ As of the fall of 2016, the Taipei Tennis Center began its construction phase in the Neihu District after earning a Diamond level candidate certification after the design phase. It is scheduled to be completed in the spring of 2017.



Figure 12: Proposed visuals of how the Taipei Tennis Center will look when completed¹²¹

When completed, the Taipei Tennis Center will be enormous—with a gross floor area of 44,385 square meters. It will have 20 different tennis courts, including one main court, one first court, four indoor courts, and fourteen outdoor courts. The first court can accommodate 1,000 spectators and the main central court can accommodate up to 4,000 spectators. Some of the features that helped it to achieve its Diamond level candidate certification is its ample use of natural daylighting, solar chimney design for natural ventilation, and rainwater harvesting. The challenge is that all of these features must be implemented on a large scale, since the project is a gigantic event facility. As emulated by the Taiwanese green building philosophy,

¹²⁰ Annie Shao (Building Physics and Sustainability Engineer at ARUP Taipei) in discussion with the author, November 2016.

¹²¹ “Taipei City Tennis Center,” Taipei City Government, <http://www.taipei2017.com.tw/files/13-1000-320.php?Lang=en>, 2013.

many of the site's sustainable features rely mostly on natural systems and simple designs rather than on state-of-the-art technology.

The EEWH standard is specialized to accommodate local regulations and building codes. It requires that certified buildings outperform what is outlined in the local building codes by at least 20%. This aspect of the EEWH standard is very commendable, as region specificity in standards is extremely important due to the variation in climate, geography, infrastructure, social and cultural dynamics, and more from place to place. But the standard is not without its shortcomings. The different requirements in EEWH are not well integrated, meaning that certain features of a project could earn points in one category, but that very same feature could count against the project in another category. For example, the use of metal curtain wall facades is favorable because they are extremely light-weight and thus reduce the amount of material used. Yet at the same time, the metal curtain walls are unfavorable due to their inability to effectively reduce heat gain. Similarly, horizontal skylights are credited for being wonderful inlets of natural light, but they too are penalized for being very unideal for thermal control. Navigating these kinds of contradictions in the EEWH standard can be rather confusing, as is navigating the EEWH standard itself due to its complex calculations. Also, the government requested that project achieve the highest certification level. However, the review committee from TABC does not always thoroughly understand the project's inherent limitations, therefore the imposition of the highest level of certification adds a large amount of stress to design and construction teams.¹²²

¹²² Annie Shao (Building Physics and Sustainability Engineer at ARUP Taipei) in discussion with the author, November 2016.

Living Building Challenge (LBC):



The Living Building Challenge is one of the newest green building standards. It has come to be known as the most demanding one, too. Unlike LEED, LBC requires that the building seeking certification be in operation for a full year before the certification status can actually be administered. This method ensures that the building is performing up to standards with how it was designed. The philosophy of LBC extends from the imagination of “a building designed and constructed to function as elegantly and efficiently as a flower: a building informed by its bioregion’s characteristics, that generates all of its own energy with renewable resources, captures and treats all of its water, and that operates efficiently and for maximum beauty.”¹²³ Because of this philosophical analogy between buildings and flowers, the criteria used to evaluate buildings seeking LBC certification are called “petals.” In the latest version of LBC, there are a total of seven petals: place, water, energy, health and happiness, materials, equity, and beauty. However, rather than having each of these petals providing points or earnable credits, each of these petals instead only contain imperatives, or features that are absolutely required. Another way that LBC differs from the other standards is that it does not use a classic hierarchical ranking for certification levels. Instead, it offers three types of “pathways to certification”: living certification, petal certification, and net zero energy certification. Petal certification recognizes projects that did not necessarily fulfill *all* of the petal requirements, but have fulfilled at least three of them. At least one of these three petals has to be either water, energy, or materials. This reveals how LBC prioritizes these categories in its definition of a green or sustainable building. The net zero energy certification

¹²³ “Living Building Challenge 3.0,” International Living Future Institute, https://living-future.org/sites/default/files/reports/FINAL%20LBC%203.0_WebOptimized_low.pdf, 2012.

only certifies buildings that have demonstrably generated enough on-site renewable energy to sustain itself on an annual basis. However, net zero energy certified projects must also have a “beauty + spirit” and “inspiration + education” component to them as well, demonstrating the belief that there is more to a green or sustainable building than just being able to generate its own energy. Finally, full Living Certified projects must meet all imperatives outlined for its project type.¹²⁴

Place



The place petal somewhat overlaps with the location and transportation and sustainable sites categories in LEED as well as the land use and ecology category in BREEAM. However, the first imperative in this section, called “limits to growth,” asserts that projects must *only* be built on former greyfields or brownfields. Moreover, projects must avoid ecologically significant areas completely. There also is a restoration aspect to this imperative as the project must also incorporate either native or naturalized vegetation to provide habitat for potential wildlife in the area. This landscape must be maintained without the use of pesticides.

The second imperative of the place petal is called “urban agriculture”—it requires all projects to have some sort of agricultural component. Based on a project’s floor area ratio (FAR), a certain percentage of the total project area must be devoted to food production. The lower the FAR, which implies a larger amount of area outside of a building on a project’s site, the higher the required food-producing land percentage. This imperative seeks to combat the

¹²⁴ *Ibid.*

modern phenomenon of people being far removed from their food sources and instead seeks to bring that connection back into people's daily lives.

The third imperative in the place petal is called "habitat exchange," and it requires participation in a program that advances conservation causes. One such program is the Habitat Exchange Program that is operated by the International Living Future Institute itself. This imperative requires that, "for each hectare of development, an equal amount of land away from the project site must be set aside in perpetuity [. . .]" to help protect the habitats of endangered or threatened species. The Habitat Exchange Program works with in conjunction with several established conservation organizations. This imperative is unique in that it strives to create a positive impact on places even outside of the project's boundaries.

The fourth place petal imperative is "human powered living," and it essentially embodies concepts explained in both the LEED and BREEAM standards of encouraging alternative forms of transportation. Some of these encouraging methods include providing safe on-site bicycle storage, showering and changing rooms for bicyclists, and weather protected pedestrian walkways. Wherever applicable, subsidies for building occupants to use public transportation are also required.¹²⁵

Water



The water petal seeks to eliminate a building's need to draw from municipal potable water sources. The single imperative number five in this petal, called "net positive water," requires a closed-loop water system to supply 100% of the building's water. This means that the water used onsite must either be captured precipitation or recycled water. However, it also means that all storm water, grey water, and black water generated by a building must also be

¹²⁵ *Ibid.*

managed and treated in an onsite closed-loop water system. Exceptions to this imperative are allowed for projects that are required by local codes or regulations to be connected to municipal potable water sources.¹²⁶

Energy



The energy petal concentrates on transitioning buildings' energy sources to entirely onsite generated renewable energies. The energy petal only has one imperative—the sixth called “net positive energy.” This imperative requires that all of the energy consumed in a building must also be generated onsite with renewable energy on a net annual basis. In other words, the amount of energy annually consumed should be less than or equal to the amount of clean energy produced onsite that same year. This energy cannot be created through potentially harmful processes like combustion or fission—therefore, most projects turn to photovoltaic panels to generate clean solar energy. Some even install wind turbines, but the majority of the energy still comes from the solar panels. Also, a portion of the energy generated by the renewable sources must also be able to be stored onsite for back-up purposes. This energy could potentially go towards lighting or refrigeration in the case of an emergency.¹²⁷

Health & Happiness



The health and happiness petal strives to construct healthy environments in which people can thrive. This petal covers topics similar to the ones covered by the indoor environmental quality category of LEED, the health and wellbeing category of BREEAM, and the indoor environment category of EEWH. The inclusion of human health-centered

¹²⁶ *Ibid.*

¹²⁷ *Ibid.*

categories in all four standards emphasizes how human health has become an undeniable component of the construction of green and sustainable buildings. The seventh imperative and the first to lie under the health and happiness petal is called “civilized environment,” and it requires spaces within the building that are regularly occupied to have operable windows. These operable windows can allow occupants to have access to daylight, but also fresh air whenever needed.

The eighth imperative, called “healthy interior environment,” focuses on the quality of the indoor air. Several of the components of this indicator are similar to prerequisites and credits offered by LEED. For example, LBC also requires compliance with the latest ASHRAE standards and requires the prohibition of smoking within the project boundaries. It also goes into more particular details, such as the required use of EPA approved environmental cleaning products and the use of entry and exit mats to reduce the amount of contaminants that enter clinging to shoes. Some parts of the imperative are more unique to LBC—for example, to see if the actual air quality of the building is up to standards, LBC requires an EPA protocol level air quality test nine months into the building’s occupancy.

The ninth imperative, “biophilic environment,” focuses on the inclusion of natural elements throughout the project space to foster a connection between building occupants and nature. This connection to nature is known to boost the mental health of occupants, which is why this imperative falls under the health and happiness petal. Therefore, the imperative requires that a full day in the planning process must be devoted to the “exploration of the biophilic design potential for the project.”¹²⁸ At the end of that day, the project team must submit a plan on how they aim to implement biophilic features into the space—through shapes, forms, patterns, and processes. They also must describe how their project will fit into

¹²⁸ *Ibid.*

the greater surrounding area through cultural, climatic, and ecological lenses. Finally, the plan should also include how the project team proposes to create easily accessible direct interactions with nature.¹²⁹



Materials

The materials petal once again considers the life cycle of the parts that go into constructing the project, as well as the health implications of using these materials. As the tenth “red list” imperative, LBC developed an extensive list of common building materials that are damaging to human health. Part of the most difficult part of receiving living building certification is successfully avoiding *all* of the over twenty materials on this “red list.”

The eleventh imperative, “embodied carbon footprint,” takes into consideration the fact that it would be impossible to avoid carbon dioxide emissions throughout the construction process. Therefore, the project must offset the amount of carbon dioxide released in the construction process through a LBC approved carbon offset provider.

Imperative twelve called “responsible industry” ensures that all of the natural resources extracted for use in the project are extracted responsibly—socially and environmentally. These natural resources must be certified by a verified third party. For example, all timber must be Forest Stewardship Council (FSC) verified, meaning that it either is salvaged wood or from sites that are deforested for construction or ecological maintenance purposes. LBC also requires participation in the Declare program, which is almost like a nutrition fact labeling system for products used in buildings. The declare label includes information like benign or potentially harmful ingredients, the name of the product, the name

¹²⁹ *Ibid.*

of the manufacturer, the life expectancy of the product, and whether or not it can be recycled or salvaged at the end of its life.

“Living economy sourcing,” the thirteenth imperative, is meant to mostly draw from the local regional economy. This imperative requires the use of more local materials in projects’ constructions. For example, 20% of the cost of all materials must go to materials within 500 km of the construction site, while 30% of the cost of all materials must go towards materials within 1000 km of the construction site, and 25% of the cost of all materials must go towards materials within 5000 km of the construction site. Finally, the remaining 25% of the cost can go towards materials sourced from any place. This imperative is meant to stimulate the regional economy, but also the use of more local materials reduces the distance and the energy needed to transport the materials to the construction site. Even project consultants must be local as well—coming from within 2500 km of the construction site. Hiring local consultants would also stimulate local economy, but they would also be more familiar with the area and could give more place-specific advice.

The fourteenth imperative, called “net positive waste,” embodies the cradle-to-cradle philosophy of eliminating the concept of waste. This imperative attempts to bend the currently linear life stage progression into a more circular progression. The project team must compile yet another plan to detail how the project will “[optimize] materials” in each of its life cycle stages. The plan for the design phase focuses on durability to reduce the frequency of material replacement. The construction phase plan includes how waste materials will be diverted, as over 90% of each type of material needs to be diverted from landfills. The operation phase requires a plan for the collection of waste, as well as for the collection of

recyclable and compostable materials. Finally, the end of life phase plan details how the project plans to deconstruct and reuse materials.¹³⁰

Equity



The equity petal is LBC’s attempt to address the social leg of the sustainability tripod. The first imperative in this petal and the fifteenth overall imperative is called “human scale and humane places,” and it forces project teams to take walkability into account when designing their sites. Constructing a more pedestrian-friendly project can increase human interactions and exchanges that would be otherwise nonexistent in a more automobile-centric layout. To regulate the human-friendliness of the design, the “human scale and humane places” imperative poses several rules limiting things like paved areas, street dimensions, or dimensions of signage.

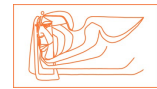
The sixteenth imperative, “universal access to nature & place,” ensures that all infrastructure located outside of the project’s building, such as roads, are accessible to all people regardless of their backgrounds or ability level. For non-residential projects, the exterior public portion of the project should also include spaces to encourage either human-to-human or human-to-nature interactions through the inclusion of public features like furniture, art displays, or gardens. While this petal also tries to safeguard equal accessibility to infrastructure and physical places, it also tries to safeguard equal accessibility to natural resources. This means that the project cannot in any way compromise the ability of all members of society to access fresh air, sunlight, and natural waterways.

Imperative number seventeen, “equitable investment,” also requires the project to participate in an offset program. Basically, this imperative requires that the equivalent of at

¹³⁰ *Ibid.*

least half of the project’s total cost be donated to either a charity or an ILFI program. This is another part of the project that requires the project to give back and extend its potential to create change outside of the site boundaries.

The eighteenth imperative “just organization” attempts to guarantee the just actions of the organizations involved in the project by requiring them to practice transparency and make accessible their business practices. Also, LBC requires at least one of the main project team members to have a JUST label, which contains information like the organization name and type, where it is located, how many employees it has, worker benefits, worker diversity, equality in pay, work safety, and the organization’s stewardship. This JUST label will be distributed to project consultants.¹³¹



Beauty

Beauty is one of the hardest things to measure, which is why the beauty petal can only recognize genuine, intentional efforts to introduce spirit-lifting and culturally relevant designs into the project. The nineteenth imperative, called “beauty & spirit,” requires that features of the must be designed specifically for the purpose of aesthetics that helps to give the project a sense of culture and spirit. It also requires that public art be somehow incorporated into the design as well.

However, not all beauty comes from aesthetics. Part of the beauty of a site comes from its influence and ability to inspire. That is why the twentieth and last imperative, called “inspiration & education,” requires that the building be a resource to the public as well for its tenants. This means that information about the building’s environmental performance should be made available to the public so that all people can learn from both the successes and

¹³¹ *Ibid.*

failures of the building. It also means that at least for one day per year, the building operators should host an “open day” for members of the public to visit the building and learn about its sustainability efforts.

Hawai'i Preparatory Academy Energy Lab

Nestled in the middle of the Pacific Ocean on the Big Island of Hawai'i is a private boarding school called Hawai'i Preparatory Academy. In 2010, a new building was added to its campus—the 5,902 square foot “Energy Lab” designed to meet the standards of Living Building Challenge version 1.3. The Energy Lab embodies the philosophy of collaborative, hands-on learning as it strives to pass on an “understanding of environmentally conscious, sustainable living systems”¹³² to the next generation of students. The building itself is an essential and active participant in the education curriculum, indicating how the built environment has the potential to have a profound influence on its occupants and users. After a year of monitored operation, the Energy Lab project was granted full living certification in 2011.



Figure 13: An outside view of the HPA Energy Lab¹³³

The building sits on a remediated greyfield on the windward corner of HPA where the school buried bio waste from a former building endeavor. It is situated to also take advantage

¹³² “Hawaii Preparatory Academy Energy Lab,” *International Living Future Institute*, <http://living-future.org/case-study/hpaenergylab>, 2016.

¹³³ *Ibid.*

of multiple types of potential energy, namely wind and solar. Hawai'i's signature trade winds are particularly present at the project site due to its location at the bottom of a sloping hill, therefore a wind turbine was installed to help to contribute to the building's energy needs. However, the bulk of the building's energy needs are met by three sizable solar arrays. The site also is situated facing south to maximize the amount of sun exposure on the photovoltaic panels. Between the three solar arrays on the site, almost 40,000 kilowatt-hours of energy are generated for the Energy Lab to use each year. The building itself only uses roughly half of that amount, so the excess energy is returned to the grid to power the rest of the buildings on campus.¹³⁴ Much of the reason why the solar arrays can easily cover the building's energy demands is due to the building's reliance on natural ventilation and a radiant cooling system. While fans were installed just as a back-up, the abundance of trade winds in the area lets the building be primarily naturally ventilated as the winds are let into the building and then subsequently circulated throughout the spaces.

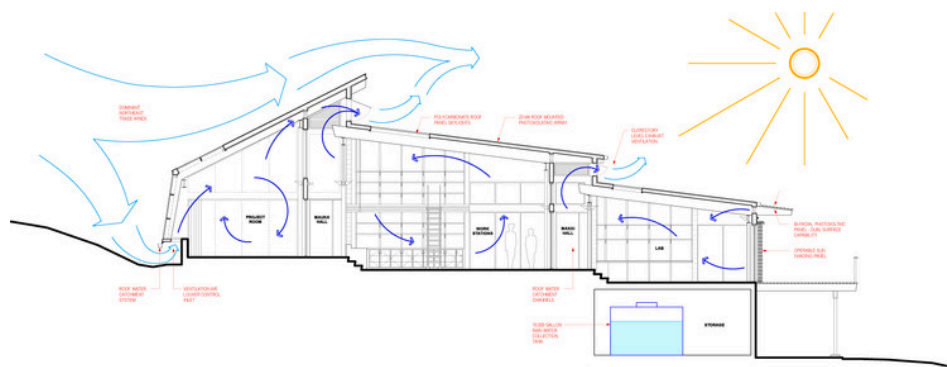


Figure 14: A diagram portraying the movement of trade wind ventilation through the building¹³⁵

The radiant cooling system functions by circulating water through roof panels during evenings to cool water and then store it underground for use with air units on hot days. Since

¹³⁴ *Ibid.*

¹³⁵ Kat Hoy, "Hawaii Preparatory Academy Energy Laboratory / Flansburgh Architects," *ArchDaily*, <http://www.archdaily.com/64732/hawaii-preparatory-academy-energy-laboratory-flansburgh-architects>, 2010.

a sizable amount of energy in conventional buildings goes towards heating and cooling, eliminating the energy needed to perform this task reduces the building's energy demands drastically. Finally, the use of skylights and reflecting wood screens to bring copious amounts of natural daylight into the space also help to cut down on the amount of energy needed to power indoor lighting.

The tropical climate of Hawai'i also means that rainfall is plentiful, meaning that the building should be theoretically able to obtain much of its water from either captured rainwater or recycled water. Low-flow fixtures were installed to try to reduce the building's water demand. Several pipes from the roof lead into an 1,800-gallon cistern for rainwater storage located below the building. This cistern, in conjunction with an onsite wastewater treatment system, should be able to remove the building's reliance on municipal water. However, this is where local policies get in the way of sustainability efforts. Since the volcanoes on the island emit a harmful emission called "vog," a combination of volcano, smog, and fog that can potentially react with roofing materials to release metals, a regulation states that buildings must provide municipal water for buildings with more than 80 occupants. Conventional rainwater catchments are also sometimes susceptible to vog, and although the project team intentionally used materials that would not react in the same way, the authorities still did not allow them to use the catchment system to cover their potable water usage. Instead, the catchment system is used as a back-up in the event that municipal water flow is disrupted due to natural disaster. Therefore, while the building did make a significant effort to reach net zero water usage, and while the building is technically certified as a full living building, it still draws from municipal water sources.¹³⁶ Over 450 sensors in the Energy Lab

¹³⁶ "Hawaii Preparatory Academy Energy Lab," *International Living Future Institute*, <http://living-future.org/case-study/hpaenergylab>, 2016.

keep up-to-date tabs on energy usage, water usage, as well as carbon dioxide levels. The data from these sensors is then published online, although the data seems as though it is only available to those in the school community.

Over 90% of HPA students “like their new Energy Lab building, think it is beautiful, like having classes there and feel inspired by it.”¹³⁷ This strongly positive student response to the building makes the Energy Lab an undeniable triumph. However, there is one area in particular that the building can still improve upon: its scope of influence. The building’s mission is profound—passing on an environmental awareness and knowledge to the next generation can have powerful cascading effects. However, the number of people that can actually interact with the building and learn about its sustainability efforts is relatively few. The International Living Future Institute website states that the building has an average of 25 occupants, a number that is presumably made up of students and teachers.¹³⁸ As the most expensive high school in the state,¹³⁹ it is safe to say that a very select few have the chance to really experience the building. While the Energy Lab was opened to the public as a celebration on the day of its completion and smaller tours have also been offered since then, it seems as though these tours are mostly only arranged if people first initiate contact with the institution. Although HPA is a private institution that should put its students first, it could also be extremely rewarding and beneficial for the Energy Lab to extend its influence and philosophy to other members in the community as well. This could help to demystify “sustainable buildings,” or at least help to introduce some possible strategies and approaches

¹³⁷ *Ibid.*

¹³⁸ *Ibid.*

¹³⁹ “What’s Hawaii’s Most Expensive High School? It’s not Punahou School,” *Honolulu Magazine*, <http://www.honolulumagazine.com/Honolulu-Magazine/February-2013/Whats-Hawaiis-Most-Expensive-High-School-Its-not-Punahou-School/>, 2013.

to promoting environmental-consciousness in the built environment that can be applied elsewhere.

Conclusions

Each building standard implies a different picture of what makes a green or sustainable building. They also have differing approaches to the process and administration of certification. LEED, BREEAM, and EEWH all go by a point-based system, but LEED and BREEAM award points for having certain features while EEWH awards points based on how well calculated characteristics of the site compare with benchmark values. On the other hand, while each standard has its own set of required prerequisites, LBC essentially has *only* requirements, with a few concessions made for areas with limited feasibility. LBC also waits a year into a building's operation phase to ensure that a building is actually performing up to par, while the other standards only keep track of buildings through their construction and possibly early operational stages. Also, while most standards do acknowledge the importance of place specificity, EEWH is the only standard that is completely specified to a place's climatic and legislative conditions.

But despite the several discrepancies between all of the four described standards, there is a consensus on improving buildings in the areas of energy, water, indoor air quality, and waste. Therefore, an analysis of the four standards would imply that these are the areas that a green building should address. In terms of the sustainability tripod, the majority of these standards focus heavily on the environmental leg and sometimes slightly the other two legs. Only LBC really attempts to also incorporate the social justice leg as well through its equity and beauty petals. However, whether or not LBC could be considered a sustainable, rather than just green, building standard is still questionable. While LBC incorporates petals dedicated to both environmental and social conscious design, it does not explicitly address the

economic aspect. In general, projects that choose to pursue LBC certification are those with a more substantial budget and those that are willing to spend more on upfront costs. While saved money pays off the cost over the course of buildings' lifetimes, the pursuit of certification is still a considerable investment. Thus, the concept of the sustainability tripod is over-simplified—it fails to recognize the strong connection between each of the legs. To visualize these connections, Global Green's Walker Wells proposed that the sustainability tripod should instead be pictured as a tripod with a rubber band encircling all three of the legs.¹⁴⁰ This way, while it may be feasible to achieve a certain equal level of each, if one leg is then tried to be extended even further, then at least one of the other two legs must be pulled in to compensate. For example, if one project attempted to achieve a high level of environmental performance, it may have to make concessions in either the economic or social categories. Or if a project strove to be extremely economical, it would have to make concessions in its environmental and social performances.

Should, then, all building certification standards only certify buildings that are striving for sustainability in every aspect? Are green buildings not good enough? Some, like the critics of the Bank of America Tower in Manhattan, do not think that standards like LEED or BREEAM are meaningful because they are not creating fully sustainable buildings. However, while these standards mainly focus on making building's environmental impacts "less bad"—which is just one part of sustainability—this does not necessarily mean that these standards are ineffective. LEED and BREEAM are responsible for increasing the popularity of green buildings all around the world, which is something a more demanding standard like LBC would not have been able to accomplish as quickly. The EEWH standard is targeting a specific

¹⁴⁰ Walker Wells (LEED AP and Vice President of Programs at Global green) in discussion with the author, November 2016.

area to grow the presence of green buildings. By making green buildings more common and widespread, perhaps then some of the environmental technologies will become more inexpensive and accessible. Ideally in the near future, each of the green building standards will grow closer to becoming *sustainable* building standards, but a more gradual transition could actually get more people on board since it uses a psychological technique called “foot-in-the-door.” The foot-in-the-door technique operates on the assumption that “once a person has been induced to comply with a small request he is more likely to comply with a larger demand.”¹⁴¹ So while the presence of a more radical standard such as LBC is definitely useful for those who are willing to commit to and pursue certification, the presence of less demanding standards is also useful for those still becoming acquainted with green building strategies.

There is also the question of whether more region-specific standards, like EEWH, would be more appropriate than more generalized standards like LBC, LEED, or BREEAM. In many ways, creating region-specific standards would be tedious and difficult—the time it would take to develop functional standards custom fit to each specific region would be great, therefore having a more universal standard to turn to in the meantime is essential. It would also be a complicated task to delineate which regions should require their own standards, since even a country-sized scope could have huge variances in conditions. Furthermore, having fewer but more universally recognizable standards would make the process simpler and more manageable.

But while it would be easy for one universal *green* building standard to demand net zero water, waste, and energy, a *sustainable* building standard would not be able to—and even

¹⁴¹ Jonathan L. Freedman, Scott C. Fraser, “Compliance Without Pressure: The Foot-in-the-Door Technique” *Journal of Personality and Social Psychology* 4, no. 2 (1965): 195-202.

should not be able to—be encompassed in a single universal standard. To increase the amount of truly sustainable buildings, region-specific standards would make much more sense because each region varies so much either climatically, geographically, culturally, politically, or otherwise. Region-specific standards could navigate these conditions with far more sensitivity than a universal standard could. This is because the features that make a sustainable building in one place are not necessarily the same ones that would make a sustainable building in another place. For example, in locations with limited year-round sunlight, a project team may not necessarily want to invest in photovoltaic panels because their payoff for the amount of energy generated would not be great. Instead, if that area has abundant winds, the project team might want to invest in wind turbines instead. Or, if a project team was building in an area with abundant and renewable forests, they may choose to build primarily with wood while another project team in an area with abundant mud may choose to build primarily with adobe. Or, if a certain project site lies within a cultural area, the project team would need to know the details of how to respectfully design with or around the site since sustainable design takes into account social justice as well. With all of these features that can vary by region, it is impossible to say *exactly* what features make a sustainable building—but that is the beauty of it. Thence, while some are concerned that a sustainable building design movement could homogenize buildings, in actuality, there is no single face of sustainable design. It is, inherently, required to be as unique and diverse as the lands that we inhabit and the peoples that inhabit them.

Notes

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