The Living Building Challenge

In Pursuit of True Sustainability in the Built Environment

Version 1.3
August 2008

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AUTHORSHIP

The *Living Building Challenge* was authored and conceived by Jason F. McLennan prior to joining Cascadia. McLennan serves as the Principal Investigator overseeing the development of the standard and associated tools, together with Cascadia staff Eden Brukman and Thor Peterson.

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Imagine a building designed and constructed to function as elegantly and efficiently as a flower.

Imagine a building informed by its eco-region's characteristics, and that generates all of its own energy with renewable resources, captures and treats all of its water, and operates efficiently and for maximum beauty.

The Cascadia Region Green Building Council (Cascadia) issues a challenge to all building owners, architects, design professionals, engineers and contractors to build in a way that provides for a sustainable future.

Now is the right time for Living Buildings.

The Living Building Challenge

Executive Summary

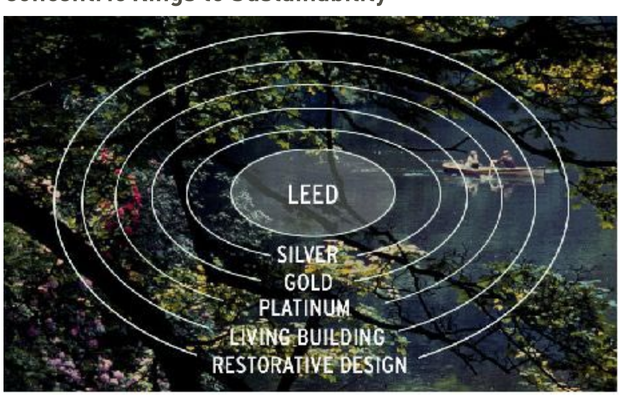
No credits, just prerequisites.

The *Living Building Challenge* is attempting to raise the bar and define the most advanced measure of sustainability in the built environment, using a benchmark of what is currently possible and given the best knowledge available today. Projects that achieve this level of performance can claim to be among the 'greenest' anywhere, and will serve as role models to others that follow. Although it may be difficult to achieve the *Living Building Challenge*, understanding the standard and documenting compliance with the requirements is inherently easy: Just sixteen simple and profound requirements that must be met.

This standard is in no way meant to compete with the LEED® Green Building Rating System, the United States Green Building Council (USGBC) or the Canada Green Building Council (CaGBC). Cascadia, as a chapter of both of these national organizations, views the *Living Building Challenge* as an additional outlet to promote the goals set by the USGBC and CaGBC – it establishes a vision for a project's environmental and social responsibilities from a new vantage point. It is our sincere hope that the ideas captured in the *Living Building Challenge* will influence program and project outcomes towards greater ecological benefit and that this standard provides additional unifying power for our organizations.

When LEED® emerged in the late 1990's, it filled a huge void in the building industry: designers all over the country were trying to understand how to effectively define 'green building' and measure it in a consistent way. With a focused goal on market transformation, LEED® has done more for the national green building movement than anything previously conceived. When the Platinum certification level was defined, it was widely accepted as the highest rank of environmental performance possible for buildings, and indeed it is significant. Yet, completing the requirements for LEED® Platinum certification does not fulfill the ultimate obligations of the building industry towards the pursuit for sustainability. Rather, it was defined by the changes that seemed possible at the inception of the LEED® program for the majority of projects. The main focus of LEED® is to make green building mainstream and to move the bulk of buildings being built towards higher standards. The *Living Building Challenge's* aim is to push projects even further to provide models for the industry to follow.

Concentric Rings to Sustainability[1]



1 Image courtesy of BNIM Architects

Several milestones have transpired in the last decade that put the *Living Building Challenge* in context:

1. LEED® has been broadly adopted at a considerable rate and has begun to reform the entire building industry. Many municipalities have adopted LEED® certification at the Silver level as a baseline standard.

2. Multiple LEED® certified buildings at the Platinum level have been constructed around the country, some with zero or small first-cost premiums, signaling that the market has evolved and is ready to take the next course of action.

3. The USGBC is in the process of a major restructuring of the LEED® system, modifying the weightings of credits based on potential life cycle impact and adding a focus on regionalization. Minimum performance requirements for energy have also been set.

4. Decentralized buildings that operate solely using onsite renewable energy or that have a closed loop wastewater reuse capacity are being developed across the country. Wind, solar and other sustainable technologies continue to become more economically sound options because we have passed the point of peak oil and cheap fossil-fuel energy is increasingly difficult to procure. Carbon neutral building construction will no doubt follow.

5. Most significantly, it is clear that major environmental trends, such as climate change, are directly linked to human expenditure of natural resources and to the building industry itself. The rate of change and potential disastrous scenarios for our communities and quality of life are increasing. It is also clear that there is a broad societal awakening to this reality, as evidenced by the shift in mass media attention to the issues, the Clinton Climate Initiative, the Mayor's Climate Initiative, the 2030 Challenge and governmental efforts led by the State of California and elsewhere.

At the heart of the *Living Building Challenge* is the belief that our society needs to quickly find a state of balance between the natural and built environments. Cascadia views the release of the *Living Building Challenge* as an act of optimism and faith in the marketplace to reach high-level goals and project teams are already responding: In the short time since it was unveiled at Greenbuild in 2006, dozens of building owners, designers, developers and contractors throughout North America and around the world have embarked on the *Challenge*.

The race is on.

Despite the rigor encapsulated in the *Living Building Challenge*, project teams are confident that the theoretical requirements are solvable. However, there are two primary perceived limitations to success: code restrictions and first costs. In response to this impression, Cascadia has initiated several studies to shed some light on these influencing factors. Findings will be posted as available to the Resources section of the *Living Building Challenge* website: www.cascadiagbc.org/lbc.

Code Studies

In early 2008, Cascadia teamed with David Eisenberg, Director of the Development Center for Appropriate Technology (DCAT) and King County, Washington, to evaluate codes and standards across North America using the *Living Building Challenge* requirements as a guide. To augment this effort, more than a dozen case studies were selected and contributing team members shared their experiences designing buildings to meet the *Challenge* or tackling aspects of the program in projects completed prior to the release of the standard. In this context, the resulting White Paper discusses at a conceptual level the various barriers to creating Living Buildings. It also identifies creative solutions by municipalities and opportunities for modification of and incentives for the adoption of new 'greener' standards. This initial effort to analyze codes and standards is complete and available to download from the Cascadia website.

The City of Vancouver and Clark County, Washington, have also embarked on a study with Cascadia to simulate the code review process using six prototypical affordable housing projects with Living Building characteristics. The goal of this mock-review is to identify specific City, County and State constraints as a way to expand the implementation of sustainable design strategies. Due to the partnership with these agencies, this research project is not merely an academic exercise, but a template for broad institutional change. The completion of this study is anticipated for Spring 2009.

Financial Study

A subsequent endeavor to the widely distributed 'Packard Sustainability Matrix', published by the David and Lucile Packard Foundation in 1999, the purpose of Cascadia's Financial Study is to investigate the economic obstacles to creating Living Buildings, and determine how these vary based on building type and location. Using an RFP process, Cascadia contracted with a multi-disciplinary team, including SERA Architects, Gerding/Edlen Development, Skanska Construction, Interface Engineering, and New Buildings Institute. Nine building types, ranging from residential to commercial and institutional, will be evaluated in five different climate zones: cold; mixed; temperate; hot humid; and hot arid. Ultimately, the research will be compiled into a matrix that includes a cost estimate and payback calculation, savings, and net present value of the buildings through time accounting for energy and water costs, maintenance and repairs. The completion of this study is anticipated for late 2008.

How the Living Building Challenge Works

not what you are going to do.... but what you've done

not baby steps... but giant leaps

The purpose of the *Living Building Challenge* is straightforward – to define the highest measure of sustainability possible in the built environment based on the best current thinking – recognizing that 'true sustainability' is not yet possible. The *Living Building Challenge* is by definition difficult to achieve. Although facets of this standard have been accomplished in numerous projects around the world, to date, no single project has integrated the *Challenge* in its entirety. With this standard, Cascadia aims to encourage dialogue on the necessary evolution of the building industry and engender support for the first pilot projects, until more and more Living Buildings emerge.

Two rules govern the standard:

1. All elements of the *Living Building Challenge* are mandatory. Many of the requirements have temporary exceptions to acknowledge current market limitations. These are listed in the footnotes of each section. Exceptions will be modified or removed as the market changes.

2. Living Building designation is based on actual, rather than modeled or anticipated, performance. Therefore, buildings must be operational for at least twelve consecutive months prior to evaluation.

Some useful guiding information:

- This standard is an evolving tool. Periodically, new releases that update or provide clarification for the prerequisites will be made available.

- The implementation of this standard requires leading-edge technical knowledge, an integrated design approach, and design and construction teams well versed in advanced practices related to green building.

- The Living Building is performance-based instead of prescriptive in nature and for the most part does not concentrate on *how* prerequisites are met. This should be the domain of the design team and owner.

- The *Living Building Challenge* is suitable for any building type since it is performance-based. As a result, the strategies to create Living Buildings will vary widely by occupancy, construction type and location, which is appropriate.

- The standard can be applied to existing buildings as well as to new buildings. Specific modifications of the standard to heighten relevance for existing buildings will be specified in this document or in the User's Guide.

- The *Living Building Challenge* does not dwell on basic best practice issues so it can instead focus on fewer, high level needs. It is assumed that to achieve this progressive standard, typical best practices are being met.[2]

2 It is highly encouraged that projects that cannot achieve the *Living Building Challenge* pursue LEED certification at a Platinum or Gold level, since LEED remains the market's premier rating system.

- The internal logic of the *Living Building Challenge* is based on pragmatic experience with what has been built in the marketplace. The standard is difficult – but not impossible – to fulfill.

There will not be a uniform ease of achieving the *Living Building Challenge* due to a number of variables, including climate factors and building characteristics. For example, becoming water-independent in the desert demands "evolving" building design to be more like a cactus and less like a tree. Making a 30-story building energy independent requires great investments in efficiency and in a building skin that fundamentally harnesses energy. Architecture will be richer because of this response to place.

Living Buildings have their own 'utility,' generating their own energy and processing their own waste. They more appropriately match scale to technology and end use, and result in greater self-sufficiency and security. Yet, the ideal scale for solutions is not always at the level of a single building. Depending on the technology, the optimal scale can vary when considering environmental impact, first cost and operating costs. To address these realities, the *Living Building Challenge* has inserted the concept of Scale-Jumping to allow multiple buildings or projects to operate in a symbiotic state – sharing green infrastructure as appropriate and allowing for Living Building status to be achieved as elegantly and efficiently as possible. For more information on Scale Jumping, refer to the User's Guide.

There are a variety of tools available that provide insight to and assistance with the successful implementation of the *Living Building Challenge*. Cascadia strongly recommends that project teams make use of these to have a well-rounded understanding of the standard.

The User's Guide

The companion guide to this document, The User's Guide provides technical information and support for the *Living Building Challenge*. Throughout these pages you will find references to the User's Guide to flesh out specific parameters of the standard. In-depth commentaries, compliance paths and documentation requirements are also located in the User's Guide. It, too, is a burgeoning component of the *Living Building Challenge*, and is available through the Community, described below.

The Community

The online presence for the *Living Building Challenge*, the Community is the site for all key resources for the program. In addition to housing the published standard and the User's Guide, other documents such as Cascadia-initiated studies, articles about projects pursuing the *Challenge*, project team generated support information, and other tools are also available. Some areas of the website are accessible solely to Community members, and subscriptions are available for an annual fee and include one 'living' t-shirt:

$125 Cascadia Members, $150 Non-Cascadia members

(Please note that Cascadia individual membership is separate from USGBC and CaGBC corporate membership, although some discounts apply. Refer to our website for more information: www.cascadiagbc.org/membership.)

Primarily, the Community is intended to be a key starting point for increased cooperation and communication across disciplines to generate Inter-organizational Collaboration. The building industry and all its sectors must transcend beyond the typical constraints imposed by traditional competition and 'trade secrets', and find ways to educate each other, train each other, and push each other. Indeed, more important than any single project is the spirit of helping a network of projects achieve Living Building status.

The Community Dialogue

Ultimately, the success of the *Living Building Challenge* will rely on the active engagement of project teams and creative input from knowledgeable individuals. The Dialogue website was created to support general discussion and channel feedback and constructive criticism about the standard. Using the six Petals of the *Living Building Challenge* to organize and encourage conversations, this forum will not only yield modifications to future releases of the standard itself, but it will also serve as a platform for distributing strategies for success.

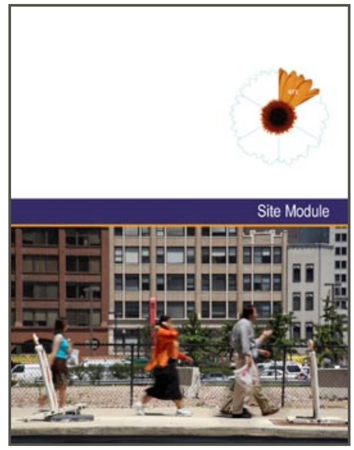
The Living Building Leader Program

The goal of the Living Building Leader program is to cultivate thought and action leaders to help shepherd in a new era where humanity works in concert with the natural environment. A series of online courses taught by experts in the diverse fields that underpin the multidisciplinary effort that is green building, the program provides educational support to the industry as a means to develop the intensive skill set required to create Living Buildings and effect transformative change. Individuals who successfully complete all courses may use Living Building Leader designation behind their name. More information about this program can be found online at www.livingbuildingleader.org.

The internal logic of the Living Building Challenge is based on pragmatic experience with what has been built in the marketplace. The standard is difficult, but not impossible, to fulfill.

Site

Humanity has co-opted enough land; it is time to draw boundaries and declare it enough.



Major Environmental Issues/Petal Intent

The continued outward spread of development and sprawl threatens the few wild places that remain. The decentralized nature of our communities increases transportation impacts and pollution. As flat, prime land for construction diminishes, more and more development tends to occur in sensitive areas that are easily harmed or destroyed. Invasive species threaten ecosystems, which are already weakened by the constant pressure of existing development. The intent of this Petal is to clearly articulate where it is acceptable to build and how to protect and restore a place once it has been developed and degraded.

Ideal Conditions and Current Limitations

The *Living Building Challenge* envisions a moratorium on the seemingly never-ending growth outward and a focus on compact, connected communities, which is an inherent conservation tool for the natural resource systems that support human health. As previously disturbed areas are restored, the trend is reversed and nature's functions are invited back into a healthy interface with the built environment.

Prerequisites

Prerequisite One – Responsible Site Selection

You may not build on the following locations:

- On or adjacent to sensitive ecological habitats[3] such as:
  - Wetlands[4]: maintain at least 50-feet, and up to 225-feet[5] of separation
  - primary dunes[6]: maintain at least 120-feet of separation
  - old growth forest[7]: maintain at least 200-feet of separation
  - virgin prairie[8]: maintain at least 100-feet of separation
- Prime farmland[9]
- Within the 100 year flood plain[10]

Prerequisite Two – Limits to Growth

Projects may only be built on greyfield or brownfield[11] sites that have been previously developed[12] prior to December 31, 2007. Project teams must document conditions prior to start of work..

Prerequisite Three - Habitat Exchange

For each acre of development, an equal amount of land must be set-aside for at least 100 years as part of a habitat exchange[13].

3 Increased setbacks my be appropriate on specific sites. The following are minimum distances to property line boundaries. For the definition of Sensitive Ecological Habitats and other terms used herein, refer to the Glossary in the User's Guide.

4 Unless the building's purpose is related to wetland protection or interpretation.

5 Minimum buffer widths vary, depending on the wetland classification. See the User's Guide for more information. Also see the wetland Considerations factsheet for King County, Washington: www.metrokc.gov/ddes/cao/#factsheets.

6 Unless the building's purpose is related to primary dune protection or interpretation and demonstrates that the site's ecological systems are not disturbed.

7 Unless the building's purpose is related to forest protection or interpretation and demonstrates that the site's ecological systems are not disturbed.

8 Unless the building's purpose is related to prairie protection or interpretation and demonstrates that the site's ecological systems are not disturbed.

9 Unless the building is related to farming or is a working farm/farmhouse.

10 Unless part of an existing historic community core developed prior to 1945, or a location classified by Walk Score (www.walkscore.com) with a minimum rating of 70. For more information, refer to the User's Guide.

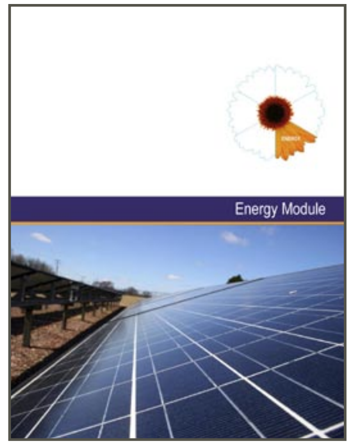
11 Previously developed sites will be defined in the User's Guide.

12 Unless the building purpose is related to the protection or interpretation of the virgin land.

13 One acre is the minimum offset amount. Compliance path and acceptable habitat exchange programs will be provided in the User's Guide.

Energy

A living building relies solely on current solar income.



Major Environmental Issues/Petal Intent

The majority of energy generated today is from unsustainable sources including coal, gas, oil and nuclear energy. Large-scale hydro, while inherently cleaner, brings widespread damaging ecosystem impact. The effects of these energy sources on regional and planetary health is becoming more and more evident, with climate change being the most worrisome of major global trends due to human activity. The intent of this prerequisite is to signal a new age of design, whereby all buildings rely solely on renewable forms of energy and operate year in and year out in a pollution-free manner. Since renewable energy sources are inherently more expensive than energy efficiency measures, efficiency as a first step is assumed.

Ideal Conditions and Current Limitations

The *Living Building Challenge* envisions a safe, reliable decentralized power grid relying completely on renewable energy powering incredibly efficient buildings. The major limitation currently is cost.

Prerequisites

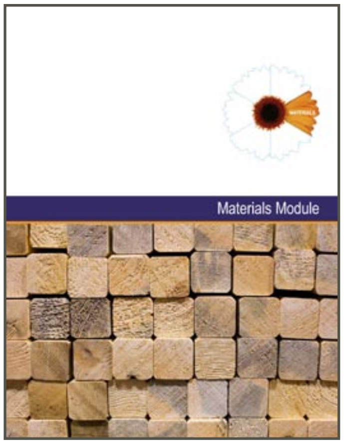
Prerequisite Four – Net Zero Energy[14]

One hundred percent of the building's energy[15] needs supplied by on-site renewable energy[16] on a net annual basis.

14 This prerequisite may be attempted using the Scale Jumping design overlay, which endorses the implementation of solutions beyond the building scale that maximize ecological benefit while maintaining self-sufficiency at the city block, neighborhood, or community scale. For more information on Scale Jumping, refer to the User's Guide.

15 Must include all electricity, heating and cooling requirements. Back-up generators are excluded. System may be grid-tied or off the grid.

16 Renewable energy is defined as photovoltaics, wind turbines, water-powered microturbines, methane from composting only, direct geothermal or fuel cells powered by hydrogen generated from renewably powered electrolysis.



Materials

Safe, healthy and responsible for all species.

Major Environmental Issues/Petal Intent

The environmental issues surrounding materials are numerous and include health and toxicity, embodied energy, pollution and resource depletion. The intent of these prerequisites are to remove, from a health and pollution standpoint, the worst known offending materials, and to reduce and offset the environmental impacts associated with the construction process. At the present time it is impossible to gauge the true environmental impact and toxicity of the buildings we create.

Ideal Conditions and Current Limitations

The *Living Building Challenge* envisions a future where all materials in the built environment are safe and replenishable and have no negative impact on human and ecosystem health. The precautionary principle guides all materials decisions.

There are significant limitations to achieving the level of the Living Building in the materials realm. The biggest limitation is due to the market itself. While there are a huge number of "green" products on the market, there is a shortage of good data that sufficiently backs up manufacturer claims and provides consumers with the ability to make conscious, informed choices. Cascadia recognizes the Pharos Project[17] protocol developed by the Healthy Building Network, University of Tennessee Center for Clean Products and Cascadia as the best framework for evaluating materials and the most progressive tool for consumer benefit. Project teams are encouraged to eliminate all known persistent bio-accumulative toxins (PBTs), carcinogens and reproductive toxicants from their specifications.[18]

At the present time it is impossible to gauge the true environmental impact and toxicity of the buildings we create.

17 www.PharosProject.net

18 For more information see: http://www.healthybuilding.net/healthcare/HCWH-CHD-POP_PBT_list.pdf and http://www.oehha.ca.gov/prop65.html

Prerequisites

Prerequisite Five – Materials Red List[19]

The project cannot contain any of the following Red List materials or chemicals.[20]

- Cadmium
- Chlorinated Polyethylene and Chlorosulfonated Polyethlene[21]
- Chlorofluorocarbons (CFCs)
- Chloroprene (Neoprene)
- Formaldehyde (added)[22]
- Halogenated Flame Retardants[23]
- Hydrochlorofluorocarbons (HCFCs)
- Lead[24]
- Mercury[25]
- Petrochemical Fertilizers and Pesticides[26]
- Phthalates
- Polyvinyl Chloride (PVC)[27]
- Wood treatments containing Creosote, Arsenic or Pentachlorophenol

Prerequisite Six – Construction Carbon Footprint[28]

The project must account for the embodied carbon footprint of its construction through a one-time[29] carbon offset tied to the building's square footage and general construction type.[30]

19 Cascadia has adopted a Red List of materials that we believe should be phased out of production due to health/toxicity concerns. This list will be updated as new science emerges. Due to manifold manufacturing processes, there is a Small Component exception for complex products made from more than ten constituent parts. Small components must be less than ten percent of a product by both weight *and* volume. Refer to the User's Guide for more information.

20 It is acceptable to jump one Zone, as defined in Prerequisite 8, if compliant materials or products are not procurable within apportioned Zones. Once a compliant product is available within the Zone as originally designated in this standard, the exception will be removed. Refer to the User's Guide for more information.

21 HDPE and LDPE are excluded.

22 A temporary exception is made for glulam beams made using phenol formaldehyde. Refer to the User's Guide for documentation requirements.

23 Halogenated flame retardants include: PBDE, TBBPA, HBCD, Deca-BDE, TCPP, TCEP, Dechlorane Plus and other retardants with bromine or chlorine.

24 An exception is made for solder and grid-tied solar battery systems only.

25 A temporary exception is made for low-mercury fluorescent lighting.

26 To attain Living Building status, petrochemical fertilizers and pesticides may not be used for the duration of the certification period or be needed for subsequent operations and maintenance.

27 A temporary exception is made for PVC in wiring applications where it is mandated by code or where the Small Component exception applies.

28 This number can be reduced by 50 percent for retrofits of existing buildings, which will be described in the User's Guide.

29 It should be recognized that buildings continue to accrue embodied energy as systems are replaced and repaired over time. It is recommended that additional offsets be purchased at 7-10 year intervals; however, this is not currently a *Living Building Challenge* requirement.

30 This offset formula will be presented in the User's Guide.

Prerequisite Seven – Responsible Industry[31]

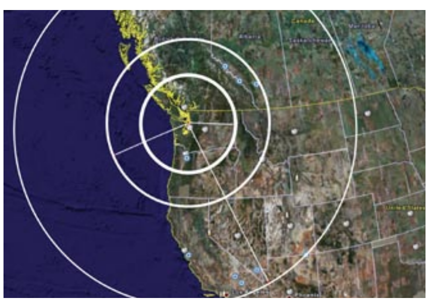
All wood must be certified by the Forest Stewardship Council (FSC),[32] from salvaged sources, or the intentional harvest of timber onsite for the purpose of clearing the area for construction [33].

Prerequisite Eight – Appropriate Materials/Services Radius

Source locations for Materials and Services must adhere to the following restrictions[34]:

Weight/Distance List

ZONE	MATERIAL OR SERVICE	MAXIMUM DISTANCE
7	Ideas	12,429.91 miles
6	Renewable Energy Technologies[35]	9000 miles
5	Assemblies that actively contribute to building performance once installed[36]	3000 miles
4	Consultant Travel[37]	1500 miles
3	Light, low density materials[38]	1000 miles
2	Medium Weight and density materials	500 miles
1	Heavy, high density materials[39]	250 miles



Materials radius determined by shipping weight. Image of sample radius for Seattle, Washington, courtesy of Bassetti Architects, overlaid on a Google map.

31 Subsequent iterations of this standard will include regulations for other industries as they become available. All regulations referenced must be from independent third party organizations and not funded by the industries themselves.

32 An exception is made for wood in situ in existing buildings undergoing retrofit.

33 It is acceptable to jump one Zone, as defined in Prerequisite 8, if compliant materials or products are not procurable within apportioned Zones. Once a compliant product is available within the Zone as originally designated in this standard, the exception will be removed. Refer to the User's Guide for more information.

34 There is a variance for remote locations, such as Alaska, Hawaii and Yukon that modifies the Zone distances as follows: Zone 1 - 1,000 miles, Zones 2 and 3 - 3,000 miles. For all other project locations, it is also acceptable to jump one Zone to comply with either Prerequisite 5 or 7 if compliant materials or products are not procurable within apportioned Zones. Once a compliant product is available within the Zone as originally designated in this standard, the exception will be removed. Refer to the User's Guide for more information.

35 Defined as wind, solar thermal, photovoltaics or fuel cells – also see footnote 16.

36 Assemblies include products that contribute to the successful attainment of the Energy and Water Petals over time, such as high performance windows, mechanical equipment and decentralized water systems. Refer to the User's Guide for a complete listing and rationale of this Zone distinction.

37 Applies only to major project team members including the architect of record, mechanical, electrical, plumbing and structural engineers of record. A temporary exception is made for specialty consultants, who may travel up to 3000 miles.

38 The scale for weight designations will be in the User's Guide. The Small Component exception for complex products may apply - see Footnote 19.

39 There is an exception for metal products (such as steel, aluminum and its alloys, copper, and nickel) that typically are composed from globally-sourced recycled content. Fabrication of these products must be domestic and within Zone radius per density class. Refer to the User's Guide for more information.

Prerequisite Nine   Leadership in Construction Waste

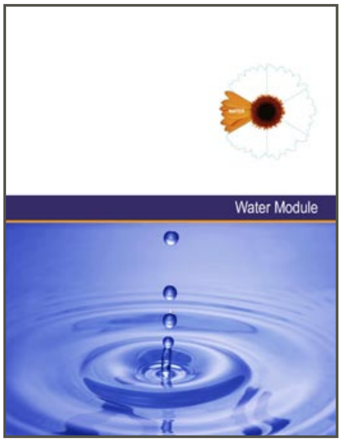
Construction Waste must be diverted from landfills[40] to the following levels:

MATERIAL	MINIMUM Diverted/Weight
Metals	95%
Paper and Cardboard	95%
Soil, and biomass	100%
Rigid Foam, carpet & insulation	90%
All others - combined weighted average[41]	80%
Asphalt	
Concrete and concrete masonry units (CMUs)	
Brick, tile and masonry materials	
Untreated lumber	
Plywood, oriented strand board (OSB) and particle board	
Gypsum wallboard scrap	
Glass	
Plumbing fixtures	
Windows	
Doors	
Cabinets	
Architectural fixtures	
Millwork, paneling and similar	
Electric fixtures, motors, switch gear and similar	
HVAC equipment, duct work, control systems, switches	

Hazardous materials in demolition waste, such as lead-based paint, asbestos, and polychlorinated biphenyls (PCBs), are exempt from percentage calculations.

40 Diverted waste includes those that are: recycled, reused, salvaged or composted. Incineration is not permitted.

41 Weighted average is lower to account for lack of diversion markets in certain jurisdictions.



Water

A Living Building is water independent.

Major Environmental Issues/Petal Intent

Scarcity of clean potable water is quickly becoming a serious issue in many countries around the world. Most regions of the United States and Canada have avoided the majority of these limitations and problems to-date due to the presence of abundant fresh water, but highly unsustainable water use patterns and the continued draw-down of major aquifers portent significant problems ahead. These prerequisites realign how people use water in the built environment, so that water is respected as a precious resource.

Ideal Conditions and Current Limitations

The *Living Building Challenge* envisions a future whereby all buildings are designed to harvest sufficient water to meet the needs of occupants, while respecting the natural hydrology of the site, the water needs of neighbors and the ecosystem it inhabits. Indeed, water can be used and purified and then used again. Currently, such practices are often illegal due to health code regulations in North America, which arose precisely because people were not properly safeguarding the quality of their water. Therefore, reaching the ideal for water use presently is dependent on what is allowable by code.

Prerequisites

Prerequisite Ten – Net Zero Water[42]

100 percent of occupants' water use[43] must come from captured precipitation or closed loop water systems that account for downstream ecosystem impacts and that are appropriately purified without the use of chemicals[44].

Prerequisite Eleven – Sustainable Water Discharge

One hundred percent of storm water and building water discharge must be managed[45] on-site and integrated into a comprehensive system to feed the project's demands.

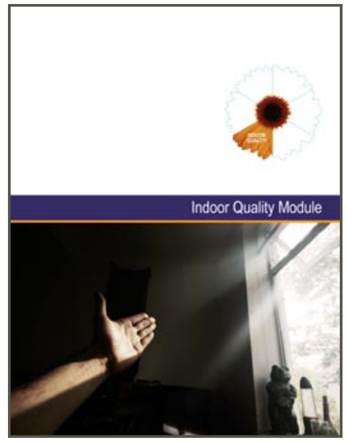
42 This prerequisite may be attempted using the Scale Jumping design overlay, which endorses the implementation of solutions beyond the building scale that maximize ecological benefit while maintaining self-sufficiency at the city block, neighborhood, or community scale. For more information on Scale Jumping, refer to the User's Guide.

43 There is an exception for water that must be from potable sources due to local health regulations, including sinks, faucets and showers but excluding irrigation, toilet flushing, janitorial uses and equipment uses. However, due diligence to comply with this prerequisite must be demonstrated through filing an appeal(s) with the appropriate agency (or agencies).

44 An exception is made for an initial water purchase to get cisterns topped off. A Living Building only buys water once.

45 Acceptable onsite stormwater management practice will be defined in the User's Guide.

Indoor Quality



Maximize health, minimize impact.

Major Environmental Issues/Petal Intent

Most buildings provide far less than ideal conditions for maximum health and productivity. As comfort decreases, environmental impact often increases, as people find inefficient and wasteful solutions to improve their physical environment. The intent of these prerequisites is not to address all of the potential ways that an interior environment could be compromised, but to focus on best practices to create a healthy interior environment.

Ideal Conditions and Current Limitations

The *Living Building Challenge* envisions an indoor environment that enhances physical and emotional well being. However, it is difficult to ensure that these places will remain vibrant for people - especially over time - as sensory aspects such as air quality, thermal control and visual comfort can easily be compromised in numerous ways. Further, it is difficult to insure optimal conditions due to the unpredictable nature of how people operate and maintain a building.

Prerequisites

Prerequisite Twelve – A Civilized Environment

Every occupiable space must have operable windows[46] that provide access to fresh air and daylight[47].

46 There are exceptions for spaces where the absence of daylight is critical to the performance of the space (such as a theatre) or where operable windows could pose a health risk (such as laboratory spaces with fume hoods where air flow could be compromised). A list of exempt spaces is in the User's Guide.

47 Minimum requirements for window sizes and placement relative to interior spaces and program are defined in the User's Guide.

Prerequisite Thirteen – Healthy Air: Source Control

All buildings must meet the following criteria:

- Entryways must have an external dirt track-in system and an internal one contained within a separate entry space.[48]
- All kitchens, bathrooms, copy rooms, janitorial closets and chemical storage spaces must be separately ventilated.
- All interior finishes, paints and adhesives must comply with SCAQMD 2007/2008 standards[49]. All other interior materials such as flooring and case works must comply with California Standard 01350 for IAQ emissions[50].
- The building must be a non-smoking facility.

Prerequisite Fourteen – Healthy Air: Ventilation

The building must be designed to deliver air change rates in compliance with California Title 24 requirements.

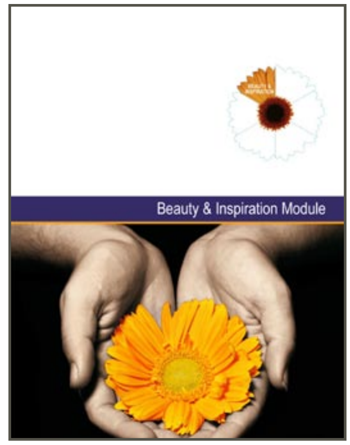
As comfort decreases, environmental impact often increases, as people find inefficient and wasteful solutions to improve their physical environment.

48 Acceptable Dirt track in systems are defined in the User's Guide.

49 South Coast Air Quality Management District http://www.aqmd.gov/

50 Based on Title 24 requirements at the time of construction.

Beauty & Inspiration



A Living Building tells a story.

Major Environmental Issues/Petal Intent

As a society we are often surrounded by ugly and inhumane physical environments. If we do not care for our homes, streets and offices then why should we extend care outward to our farms, forests and fields? When we accept billboards, parking lots and strip malls as being aesthetically acceptable, in the same breath we accept clear-cuts, factory farms and strip mines. The *Living Building Challenge* recognizes the need for beauty as a precursor to caring enough to preserve, conserve and serve the greater good.

Ideal Conditions and Current Limitations

The *Living Building Challenge* envisions designs that elevate our spirits. Mandating beauty is, by definition, an impossible task. And yet, the level of discussion and, ultimately, the results are elevated through attempting difficult but critical tasks. In this Petal, the prerequisites are based merely on genuine efforts. We do not begin to assume we can judge beauty and project our own aesthetic values on others. But we do want to understand people's objectives and know that an effort was made to enrich people's lives with each square foot of construction on each project. This intentionality must carry forth into a program for educating the public about the environmental qualities of their Living Building.

Prerequisites

Prerequisite Fifteen – Beauty and Spirit

The project must contain design features intended solely for human delight and the celebration of culture, spirit and place appropriate to the function of the building.

Prerequisite Sixteen – Inspiration and Education

Educational materials about the performance and operation of the project must be provided to the public[51] to share successful solutions and to motivate others to make change. Non-sensitive areas of the building must be open to the public at least one day per year, to facilitate direct contact with a Living Building.

51 Sample educational materials tailored to building occupancy will be provided in the User's Guide.

Next Steps and Protocol

The *Living Building Challenge* is intended to be a living document. This version is merely a starting point in the continual development of the standard. As new ideas emerge, Cascadia will update and improve upon the tools and its supporting documentation. Major modifications to the standard will be made periodically as new science emerges or as conditions in the marketplace change, thereby affecting what is possible. Specific developments that Cascadia is initiating include the following:

- Continue the development of the Living Building User's Guide.
- Increase online learning sessions and course topics available through the Living Building Leader program
- Update the Community Dialogue to ease discussion and feedback.
- Create a Living Communities standard based on this document.

How to Get Involved

Continued advancement of the *Living Building Challenge* will require many minds and great ideas. Cascadia will be looking for help in various ways, including:

- Providing informal feedback on version 1.3
- Joining the Living Building Community and contributing to the Dialogue.
- Sharing information, documents and tools that help facilitate the design and construction process
- Researching various support documentation.
- Making charitable donations to help sponsor the progress of the standard and its subsidiary programs.
- Participating in the creation of project review committees.

The Living Building Challenge is intended to be a living document. This version is merely a starting point in the continual development of the standard.

Appendix

A Brief History

The idea for the Living Building first emerged in the mid-nineties during the creation of the NIST[52]-funded EpiCenter project in Bozeman, Montana. The goal of this project, led by Bob Berkebile and Kath Williams, was to produce the most advanced sustainable design project in the world. Jason F. McLennan guided the research and technology efforts on the project, and originally conceptualized and began developing the requirements for what is now known as the Living Building. Following EpiCenter, Berkebile and McLennan continued to develop these ideas and publish several articles on the concept.[53]

In 2000, BNIM Architects[54] was selected to design the new headquarters of the David and Lucile Packard Foundation and, as part of this work, researched the economic and environmental implications of the Living Building concept along with levels of LEED® certification. In 2001, findings were presented in a document called the Packard Matrix. KEEN Engineering also significantly contributed to this effort. The Packard Matrix demonstrated that the level of the Living Building was the smartest long-term choice economically, although it carried a hefty first-cost premium. An updated study a year later showed this premium to be a bit smaller. It is projected that the first-cost premiums will continue to diminish and Living Buildings will soon emerge in response to the issuance of this standard.

In 2005, McLennan began to turn the conceptual idea of a 'living' building into a codified standard that became the *Living Building Challenge* version 1.0. He presented this standard to Cascadia in August 2006, and three months later the *Challenge* was launched.

The ideal of the Living Building continues to be mentioned within the green building movement, although a true Living Building has yet to emerge. That said, every single aspect of the *Living Building Challenge* has been implemented successfully in multiple projects. Indeed, it has been proven that the concept is possible today; it was only the specific standard that unites the requirements that was missing until now.

About the Cascadia Region Green Building Council

The Cascadia Region Green Building Council is named for the Cascadia bioregion, which covers land that drains to the Pacific Ocean through the greatest temperate rain forests on the planet. The Chapter promotes the design, construction and operation of buildings that are environmentally responsible, profitable and healthy places to live, work and learn throughout Alaska, British Columbia, Washington and Oregon. Incorporated as a 501(c)(3) charitable organization in December 1999, and incorporated in British Columbia under the Society Act in 2008, Cascadia is one of three original chapters of the United States Green Building Council. It is also the largest chapter of the Canada Green Building Council.

52 The National Institute of Standards and Technology

53 See Bibliography for an abbreviated list of articles

54 www.bnim.com

Summary of Prerequisites

Number	Petal	Prerequisite
One	Site	Responsible Site Selection
Two	Site	Limits to Growth
Three	Site	Habitat Exchange
Four	Energy	Net Zero Energy
Five	Materials	Materials Red List
Six	Materials	Construction Carbon Footprint
Seven	Materials	Responsible Industry
Eight	Materials	Appropriate Materials/Services Radius
Nine	Materials	Leadership in Construction Waste
Ten	Water	Net Zero Water
Eleven	Water	Sustainable Water Discharge
Twelve	Indoor Quality	A Civilized Environment
Thirteen	Indoor Quality	Healthy Air: Source Control
Fourteen	Indoor Quality	Healthy Air: Ventilation
Fifteen	Beauty & Inspiration	Beauty and Spirit
Sixteen	Beauty & Inspiration	Inspiration and Education

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Gail Vittori, Center for Maximum Potential Building Systems
Kath Williams, Kath Williams + Associates
Jessica Woolliams, Cascadia

It is our intention to fully develop the technical team for the *Living Building Challenge* moving forward.

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Williams, Kath, Robert Berkebile, Jason McLennan, Kathy Achelpohl, and Phaedra Svec. *The NIST Report for the MSU EPICenter*. National Institute of Standards and Technology: Washington, DC, September 2000.

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CASCADIA
REGION GREEN BUILDING COUNCIL

Cascadia's mission is to promote the design, construction and operation of buildings in Alaska, British Columbia, Washington and Oregon that are environmentally responsible, profitable and healthy places to live, work and learn.

2030 Implementation Guidelines

A Resource for Firms and Organizations Adopting The 2030 °Challenge

Prepared by:
Architecture 2030

Synopsis

Buildings are the major source of demand for energy and materials that produce by-product greenhouse gases (GHG). Slowing the growth rate of GHG emissions and then reversing it over the next ten years is the key to keeping global warming under one degree centigrade (°C) above today's level. It will require immediate action and a concerted global effort.

To accomplish this, Architecture 2030 has issued The 2030 °Challenge asking the global architecture and building community to adopt the following targets:

- All new buildings, developments and major renovations shall be designed to meet a fossil fuel, GHG-emitting, energy consumption performance standard of 50% of the regional (or country) average for that building type.

- At a minimum, an equal amount of existing building area shall be renovated annually to meet a fossil fuel, GHG-emitting, energy consumption performance standard of 50% of the regional (or country) average for that building type.

- The fossil fuel reduction standard for all new buildings shall be increased to:
  60% in 2010
  70% in 2015
  80% in 2020
  90% in 2025
  Carbon-neutral in 2030 (using no fossil fuel GHG emitting energy to operate).

These targets may be accomplished by implementing innovative sustainable design strategies, generating on-site renewable power and/or purchasing (20% maximum) renewable energy and/or certified renewable energy credits.

Responsibilities of Adoptees

Architecture 2030 asks that all firms, organizations and individuals choosing to adopt The 2030 °Challenge commit to design all of their projects to meet the targets outlined by the initiative. This requires each new building project or major renovation to be designed to achieve an energy consumption performance standard of 50% of the regional (or country) average for that project's buildings type. For new building projects, this performance standard will increase to 60% of the regional (or country) average in the year 2010. Every five years the standard will increase by an additional 10%, achieving carbon-neutral buildings in the year 2030. Major renovations are only required to meet the 50% target throughout this timeline, but are encouraged to achieve the increased reductions.

If a firm or office is unable to achieve the targeted reductions for 100% of its projects, there are no penalties. However, Architecture 2030 urges firms who wish to adopt to have a clear implementation plan that will assist designers and team members in reaching the goals outlined by The 2030 °Challenge.

Implementation Plan

The 2030 °Challenge outlines real and obtainable targets for the building sector to curb global warming. In order to meet the described timeline, Architecture 2030 recommends that each firm or organization adopting The 2030 Challenge prepare a plan of action for implementing the initiative's targets.

Each implementation plan will be different and unique to suit the adopting firm or organization's structure and philosophy. However, each plan should contain the following key elements:

• Inform all partners, employees, consultants and clients that the firm has adopted The 2030 °Challenge. Explain what The °Challenge entails and why the firm has committed to its targets.

• Establish energy-efficiency as a central tenet of your firm's design philosophy. Require energy-wise practices in the firm's day-to-day activities.

• Require that all employees become educated in the design of energy-efficient buildings. Outline energy-efficient design strategies, technologies, and opportunities for each project. Organize regularly scheduled meetings to discuss how this information can be applied to all projects.

• Engage clients in discussions relating to energy efficiency. Explain that reducing carbon emissions from the building sector is now a major focus for the firm and that the firm plans to incorporate cost-effective design strategies that should not increase the overall cost of the work. Provide a life-cycle cost analysis for each project and encourage clients to review those costs to ascertain the true cost of each project.

• Establish a portfolio of the firm's work that highlights energy efficiency. Demonstrate that the firm's designers are knowledgeable professionals, with regard to energy-efficient design, who can produce quality projects within an allotted budget that meet an agreed upon schedule.

• Hire consultants and engineers who have adopted The 2030 °Challenge and have a similar implementation plan within their firm. Approach every project with an energy focus and review the project for further energy reductions at every stage of development.

• Create a database that contains energy-consumption statistics for your projects. Include outside projects as a reference if your firm does not have a portfolio of energy-efficient work yet. Use this information as a tool to analyze strategies that work and those that may need improvement. Share this information with clients and collaborators. Include each completed project's energy achievements in the database.

• Verify that your project meets The 2030 °Challenge targets, either through a final energy-analysis or through post-occupancy measured consumption. Document this data for future reference and in the firm's portfolio to establish an energy priority.

National Renewable Energy Laboratory
Innovation for Our Energy Future
A national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy

Zero Energy Buildings: A Critical Look at the Definition

Preprint

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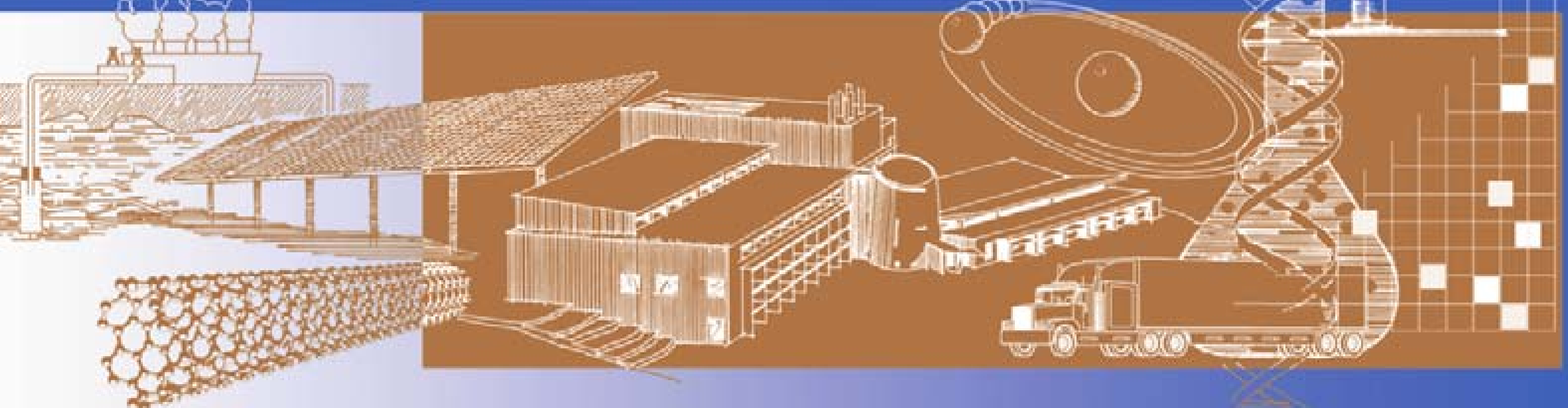

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Zero Energy Buildings: A Critical Look at the Definition[1]

Paul Torcellini, Shanti Pless, and Michael Deru, National Renewable Energy Laboratory
Drury Crawley, U.S. Department of Energy

ABSTRACT

A net zero-energy building (ZEB) is a residential or commercial building with greatly reduced energy needs through efficiency gains such that the balance of energy needs can be supplied with renewable technologies. Despite the excitement over the phrase "zero energy," we lack a common definition, or even a common understanding, of what it means. In this paper, we use a sample of current generation low-energy buildings to explore the concept of zero energy: what it means, why a clear and measurable definition is needed, and how we have progressed toward the ZEB goal.

The way the zero energy goal is defined affects the choices designers make to achieve this goal and whether they can claim success. The ZEB definition can emphasize demand-side or supply strategies and whether fuel switching and conversion accounting are appropriate to meet a ZEB goal. Four well-documented definitions—net-zero site energy, net-zero source energy, net-zero energy costs, and net-zero energy emissions—are studied; pluses and minuses of each are discussed. These definitions are applied to a set of low-energy buildings for which extensive energy data are available. This study shows the design impacts of the definition used for ZEB and the large difference between definitions. It also looks at sample utility rate structures and their impact on the zero energy scenarios.

Introduction

Buildings have a significant impact on energy use and the environment. Commercial and residential buildings use almost 40% of the primary energy and approximately 70% of the electricity in the United States (EIA 2005). The energy used by the building sector continues to increase, primarily because new buildings are constructed faster than old ones are retired. Electricity consumption in the commercial building sector doubled between 1980 and 2000, and is expected to increase another 50% by 2025 (EIA 2005). Energy consumption in the commercial building sector will continue to increase until buildings can be designed to produce enough energy to offset the growing energy demand of these buildings. Toward this end, the U.S. Department of Energy (DOE) has established an aggressive goal to create the technology and knowledge base for cost-effective zero-energy commercial buildings (ZEBs) by 2025.

In concept, a net ZEB is a building with greatly reduced energy needs through efficiency gains such that the balance of the energy needs can be supplied by renewable technologies. Despite our use of the phrase "zero energy," we lack a common definition—or a common understanding—of what it means. In this paper, we use a sample of current generation low-energy buildings to explore the concept of zero energy—what it means, why a clear and measurable definition is needed, and how we have progressed toward the ZEB goal.

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[1] This work has been authored by an employee or employees of the Midwest Research Institute under Contract No. DE-AC36-99GO10337 with the U.S. Department of Energy. The United States Government retains and the publisher, by accepting the article for publication, acknowledges that the United States Government retains a non-exclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for United States Government purposes.

Using ZEB design goals takes us out of designing low-energy buildings with a percent energy savings goal and into the realm of a sustainable energy endpoint. The goals that are set and how those goals are defined are critical to the design process. The definition of the goal will influence designers who strive to meet it (Deru and Torcellini 2004). Because design goals are so important to achieving high-performance buildings, the way a ZEB goal is defined is crucial to understanding the combination of applicable efficiency measures and renewable energy supply options.

Zero-Energy Buildings: Boundary Definitions and Energy Flows

At the heart of the ZEB concept is the idea that buildings can meet all their energy requirements from low-cost, locally available, nonpolluting, renewable sources. At the strictest level, a ZEB generates enough renewable energy on site to equal or exceed its annual energy use. The following concepts and assumptions have been established to help guide definitions for ZEBs.

Grid Connection Is Allowed and Necessary for Energy Balances

A ZEB typically uses traditional energy sources such as the electric and natural gas utilities when on-site generation does not meet the loads. When the on-site generation is greater than the building's loads, excess electricity is exported to the utility grid. By using the grid to account for the energy balance, excess production can offset later energy use. Achieving a ZEB without the grid would be very difficult, as the current generation of storage technologies is limited. Despite the electric energy independence of off-grid buildings, they usually rely on outside energy sources such as propane (and other fuels) for cooking, space heating, water heating, and backup generators. Off-grid buildings cannot feed their excess energy production back onto the grid to offset other energy uses. As a result, the energy production from renewable resources must be oversized. In many cases (especially during the summer), excess generated energy cannot be used.

We assume that excess on-site generation can always be sent to the grid. However, in high market penetration scenarios, the grid may not always need the excess energy. In this scenario, on-site energy storage would become necessary.

Prioritize Supply-Side Technologies to Those Available On Site and within the Footprint

Various supply-side renewable energy technologies are available for ZEBs. Typical examples of technologies available today include PV, solar hot water, wind, hydroelectric, and biofuels. All these renewable sources are favorable over conventional energy sources such as coal and natural gas; however, we have developed a ranking of renewable energy sources in the ZEB context. Table 1 shows this ranking in order of preferred application. The principles we have applied to develop this ranking are based on technologies that:

- Minimize overall environmental impact by encouraging energy-efficient building designs and reducing transportation and conversion losses.
- Will be available over the lifetime of the building.
- Are widely available and have high replication potential for future ZEBs.

This hierarchy is weighted toward renewable technologies that are available within the building footprint and at the site. Rooftop PV and solar water heating are the most applicable supply-side technologies for widespread application of ZEBs. Other supply-side technologies such as parking lot-based wind or PV systems may be available for limited applications. Renewable energy resources from outside the boundary of the building site could arguably also be used to achieve a ZEB. This approach may achieve a building with net zero energy consumption, but it is not the same as one that generates the energy on site and should be classified as such. We will use the term "off-site ZEB" for buildings that use renewable energy from sources outside the boundaries of the building site.

Table 1. ZEB Renewable Energy Supply Option Hierarchy

Option Number	ZEB Supply-Side Options	Examples
0	Reduce site energy use through low-energy building technologies	Daylighting, high-efficiency HVAC equipment, natural ventilation, evaporative cooling, etc.
	On-Site Supply Options	
1	Use renewable energy sources available within the building's footprint	PV, solar hot water, and wind located on the building.
2	Use renewable energy sources available at the site	PV, solar hot water, low-impact hydro, and wind located on-site, but not on the building.
	Off-Site Supply Options	
3	Use renewable energy sources available off site to generate energy on site	Biomass, wood pellets, ethanol, or biodiesel that can be imported from off site, or waste streams from on-site processes that can be used on-site to generate electricity and heat.
4	Purchase off-site renewable energy sources	Utility-based wind, PV, emissions credits, or other "green" purchasing options. Hydroelectric is sometimes considered.

A good ZEB definition should first encourage energy efficiency, and then use renewable energy sources available on site. A building that buys all its energy from a wind farm or other central location has little incentive to reduce building loads, which is why we refer to this as an off-site ZEB. Efficiency measures or energy conversion devices such as daylighting or combined heat and power devices cannot be considered on-site production in the ZEB context. Fuel cells and microturbines do not generate energy; rather they typically transform purchased fossil fuels into heat and electricity. Passive solar heating and daylighting are demand-side technologies and are considered efficiency measures. Energy efficiency is usually available for the life of the building; however, efficiency measures must have good persistence and should be "checked" to make sure they continue to save energy. It is almost always easier to save energy than to produce energy.

Determining a project's boundary, which can be substantially larger than the building footprint, is an important part of defining on-site generation sources. The question arises as to whether this larger area should be considered for on-site renewable energy production. Typically, the only area available for on-site energy production that a building has guaranteed as "its own" over its lifetime is within its footprint. To ensure this area is available for on-site production, many states, counties, and cities have solar access ordinances, which declare that the right to use the natural resource of solar energy is a property right. For example, the City of

Boulder, Colorado has a solar access ordinance that guarantees access to sunlight for homeowners and renters in the city. This ordinance protects the solar access of existing buildings by limiting the amount of shadow new development may cast on neighboring buildings, and maintains the potential for using renewable energy systems in buildings (City of Boulder 2006). Using a neighboring field to generate electricity is not as favorable as a roof-mounted PV system; the area outside the building's footprint could be developed in the future; thus, it cannot be guaranteed to provide long-term generation.

Wind resources for ZEBs are limited because of structural, noise, and wind pattern considerations, and are not typically installed on buildings. Some parking lots or adjacent areas may be used to produce energy from wind, but this resource is site specific and not widely available. Similar to PV generation in an adjacent parking lot, the wind resource is not necessarily guaranteed because it could be superseded by future development.

Renewable sources imported to the site, such as wood pellets, ethanol, or biodiesel can be valuable, but do not count as on-site renewable sources. Biofuels such as waste vegetable oil from waste streams and methane from human and animal wastes can also be valuable energy sources, but these materials are typically imported for the on-site processes.

The final option for supply-side renewable energy sources includes purchasing "green credits" or renewable sources such as wind power or utility PV systems that are available to the electrical grid. These central resources require infrastructure to move the energy to the building and are not always available. Buildings employing resources 3 and 4 in Table 1 to achieve zero energy are considered off-site ZEBs. For example, a building can achieve an off-site ZEB for all these definitions by purchasing wind energy. Although becoming an off-site ZEB can have little to do with design and a lot to do with the different sources of purchased off-site renewable energy, an off-site ZEB is still in line with the general concept of a ZEB.

Zero-Energy Buildings: Definitions

A zero energy building can be defined in several ways, depending on the boundary and the metric. Different definitions may be appropriate, depending on the project goals and the values of the design team and building owner. For example, building owners typically care about energy costs. Organizations such as DOE are concerned with national energy numbers, and are typically interested in primary or source energy. A building designer may be interested in site energy use for energy code requirements. Finally, those who are concerned about pollution from power plants and the burning of fossil fuels may be interested in reducing emissions. Four commonly used definitions are: net zero site energy, net zero source energy, net zero energy costs, and net zero energy emissions.

Each definition uses the grid for net use accounting and has different applicable renewable energy sources. The definitions do apply for grid independent structures. For all definitions, supply-side option 2 can be used if this resource will be available for the life of the building. Off-site ZEBs can be achieved by purchasing renewable energy from off-site sources, or in the case of an off-site zero emissions building, purchasing emissions credits. In support of DOE's ZEB research needs, the following definitions refer to ZEBs that use supply-side options available on site. For ZEBs that have a portion of the renewable generation supplied by off-site sources, these buildings are referred to as "off-site ZEBs."

- **Net Zero Site Energy:** A site ZEB produces at least as much energy as it uses in a year, when accounted for at the site.
- **Net Zero Source Energy:** A source ZEB produces at least as much energy as it uses in a year, when accounted for at the source. Source energy refers to the primary energy used to generate and deliver the energy to the site. To calculate a building's total source energy, imported and exported energy is multiplied by the appropriate site-to-source conversion multipliers.
- **Net Zero Energy Costs:** In a cost ZEB, the amount of money the utility pays the building owner for the energy the building exports to the grid is at least equal to the amount the owner pays the utility for the energy services and energy used over the year.
- **Net Zero Energy Emissions:** A net-zero emissions building produces at least as much emissions-free renewable energy as it uses from emissions-producing energy sources.

Low- and Zero-Energy Buildings: Examples

To study the impacts of these ZEB definitions, we examined seven low-energy commercial buildings that had been monitored extensively with respect to the definitions. Each was designed to minimize energy and environmental impacts and used a combination of low-energy and renewable energy technologies. The buildings represent several climates and uses. They are all good energy performers; site energy savings range from 25% to 68% compared to conventional buildings that are minimally energy-code compliant (ASHRAE 2001). Understanding the energy performance of the current stock of high-performance buildings is an important step toward reaching the ZEB goal. The lessons learned from these seven buildings are used to guide future research to meet DOE's goal for facilitating marketable ZEBs by 2025. The buildings studied are (Torcellini et al. 2004; Barley et al. 2005):

- "Oberlin"—The Adam Joseph Lewis Center for Environmental Studies, Oberlin College.
- "Zion"—The Visitor Center at Zion National Park, Springdale, Utah.
- "Cambria"—The Cambria Department of Environmental Protection Office Building, Ebensburg, Pennsylvania.
- "CBF"—The Philip Merrill Environmental Center, Chesapeake Bay Foundation, Annapolis, Maryland.
- "TTF"—The Thermal Test Facility, National Renewable Energy Laboratory, Golden, Colorado.
- "BigHorn"—The BigHorn Home Improvement Center, Silverthorne, Colorado.
- "Science House" Science Museum of Minnesota, St. Paul, Minnesota.

These buildings were further investigated to determine additional PV system array area and capacity requirements to meet the ZEB goals (see Table 2). Annual electricity and natural gas site-to-source conversion multipliers (3.2 for electricity and 1.07 for natural gas) were applied to each building to determine source energy use (EIA 2005). For the all-electric buildings (Oberlin, Zion, Cambria, and the Science House), the site ZEB and source ZEB are the same. CBF used a minimal amount of propane, and the TTF and BigHorn used natural gas for space and water heating. Zion, TTF, BigHorn, and the Science House are single-story buildings; Oberlin, Cambria, and CBF are two stories. We used the PV system simulation tool PVSyst v3.3

(Mermoud 1996) to calculate the expected annual performance of the PV system. Single-crystalline PV modules were modeled with 0.0° tilt, as we assumed the PV system would be mounted on a flat roof of each building. These modules provide the best available output per unit area of commercially available PV modules. The Science House is the only building in this list that is currently a site, source, and emissions ZEB; it is a net exporter with approximately 30% more generation than consumption.

Table 2. ZEB Example Summary

Building and PV System (DC Rating Size)	Site Energy Use (w/o PV) (MWh/yr)	Source Energy Use (w/o PV) (MWh/yr)	Actual Roof Area (footprint) (ft^2)	Flat Roof Area (ft^2) Needed for Source ZEB and Site ZEB with PV	PV System DC Size Needed for Source ZEB and Site ZEB
Oberlin-60 kW	118.8	380.2	8,500	10,800	120 kW
Zion-7.2 kW	91.6	293.1	11,726	6,100	73 kW
Cambria-17.2 kW	372.1	1,190.7	17,250	37,210	415 kW
CBF-4.2 kW	365.2	1,142.0	15,500	25,316 Source ZEB 25,640 Site ZEB	282 kW Source ZEB 286 kW Site ZEB
TTF-No PV	83.5	192.5	10,000	4,010 Source ZEB 5,550 Site ZEB	45 kW Source ZEB 62 kW Site ZEB
BigHorn-8.9 kW	490.4	901.0	38,923	18,449 Source ZEB 31,742 Site ZEB	206 KW Source ZEB 354 kW Site ZEB
Science House-8.7 kW	5.9	18.8	1,370	1,000	6 kW

Zero-Energy Buildings: How Definition Influences Design

Depending on the ZEB definition, the results can vary substantially. Each definition has advantages and disadvantages, which are discussed below.

Net Zero Site Energy Building

A site ZEB produces as much energy as it uses, when accounted for at the site. Generation examples include roof-mounted PV or solar hot water collectors (Table 1, Option 1). Other site-specific on-site generation options such as small-scale wind power, parking lot-mounted PV systems, and low-impact hydro (Table 1, Option 2), may be available. As discussed earlier, having the on-site generation within the building footprint is preferable.

A limitation of a site ZEB definition is that the values of various fuels at the source are not considered. For example, one energy unit of electricity used at the site is equivalent to one energy unit of natural gas at the site, but electricity is more than three times as valuable at the source. For all-electric buildings, a site ZEB is equivalent to a source ZEB. For buildings with significant gas use, a site ZEB will need to generate much more on-site electricity than a source ZEB. As an example, the TTF would require a 62-kWDC PV system to be a site ZEB, but only a 45-kWDC PV system for a source ZEB (Table 2); this is because gas heating is a major end use. The net site definition encourages aggressive energy efficiency designs because on-site generated electricity has to offset gas use on a 1 to 1 basis.

A site ZEB can be easily verified through on-site measurements, whereas source energy or emissions ZEBs cannot be measured directly because site-to-source factors need to be determined. An easily measurable definition is important to accurately determine the progress toward meeting a ZEB goal.

A site ZEB has the fewest external fluctuations that influence the ZEB goal, and therefore provides the most repeatable and consistent definition. This is not the case for the cost ZEB definition because fluctuations in energy costs and rate structures over the life of a building affect the success in reaching net zero energy costs. For example, at BigHorn, natural gas prices varied 40% during the three-year monitoring period and electricity prices varied widely, mainly because of a partial shift from coal to natural gas for utility electricity production. Similarly, source energy conversion rates may change over the life of a building, depending on the type of power plant or power source mix the utility uses to provide electricity. However, for all the ZEB definitions, the impact of energy performance can affect the success in meeting a ZEB goal.

A building could be a site ZEB but not realize comparable energy cost savings. If peak demands and utility bills are not managed, the energy costs may or may not be similarly reduced. This was the case at Oberlin, which realized a 79% energy saving, but did not reduce peak demand charges. Uncontrolled demand charges resulted in a disproportionate energy cost saving of only 35%.

An additional design implication of a site ZEB is that this definition favors electric equipment that is more efficient at the site than its gas counterpart. For example, in a net site ZEB, electric heat pumps would be favored over natural gas furnaces for heating because they have a coefficient of performance from 2 to 4; natural gas furnaces are about 90% efficient. This was the case at Oberlin, which had a net site ZEB goal that influenced the design decision for an all-electric ground source heat pump system.

Net Zero Source Energy Building

A source ZEB produces as much energy as it uses as measured at the source. To calculate a building's total source energy, both imported and exported energy are multiplied by the appropriate site-to-source energy factors. To make this calculation, power generation and transmission factors are needed. *Source Energy and Emission Factors for Energy Use in Buildings* (Deru and Torcellini 2006) used a life cycle assessment approach and determined national electricity and natural gas site-to-source energy factors of 3.37 and 1.12. Site gas energy use will have to be offset with on-site electricity generation on a 3.37 to 1 ratio (one unit of exported electricity for 3.37 units of site gas use) for a source ZEB. This definition could encourage the use of gas in as many end uses as possible (boilers, domestic hot water, dryers, desiccant dehumidifiers) to take advantage of this fuel switching and source accounting to reach this ZEB goal. For example, the higher the percent of total energy used at a site that is gas, the smaller the PV system required to be a source ZEB. At BigHorn, for a source ZEB, 18,500 ft^2 of PV are required; however, 31,750 ft^2 of PV are required for a site ZEB (Table 2).

This definition also depends on the method used to calculate site-to-source electricity energy factors. National averages do not account for regional electricity generation differences. For example, in the Northwest, where hydropower is used to generate significant electricity, the site-to-source multiplier is lower than the national number. In addition, national site-to-source energy factors do not account for hourly variations in the heat rate of power plants or how utilities dispatch generation facilities for peak loading. Electricity use at night could have fewer source impacts than electricity used during the peak utility time of day. Further work is needed to determine how utilities dispatch various forms of generation and the corresponding daily variations of heat rates and source rates. Using regional time-dependent valuations (TDVs) for determining time-of-use source energy is one way to account for variations in how and when energy is used. TDVs have been developed by the California Energy Commission to determine the hourly value of delivered energy for 16 zones in California (CEC 2005). Similar national TDVs would be valuable to accurately calculate source energy use to determine a building's success in reaching a source ZEB goal. A first step in understanding regional site-to-source multiplier differences is available (Deru and Torcellini 2006); multipliers are provided for the three primary grid interconnects and for each state.

There may be issues with the source ZEB definition when electricity is generated on site with gas from fossil fuels. The ZEB definitions state that the building must use renewable energy sources to achieve the ZEB goal; therefore, electricity generated on site from fossil fuels cannot be exported and count toward a ZEB goal. However, this is unlikely, because buildings are unlikely to need more heat than electricity and the inefficiencies of on-site electricity generation and exportation make this economically very unattractive. The best cost or energy pathways will determine the optimal combination of energy efficiency, on-site cogeneration, and on-site renewable energy generation.

The issue of unmanaged energy costs in a site ZEB is similar for a source ZEB. A building could be a source ZEB and not realize comparable energy cost savings. If peak demands and utility bills are not managed, the energy costs may or may not be similarly reduced.

Net Zero Energy Cost Building

A cost ZEB receives as much financial credit for exported energy as it is charged on the utility bills. The credit received for exported electricity (often referred to net energy generation) will have to offset energy, distribution, peak demand, taxes, and metering charges for electricity and gas use. A cost ZEB provides a relatively even comparison of fuel types used at the site as well as a surrogate for infrastructure. Therefore, the energy availability specific to the site and the competing fuel costs would determine the optimal solutions. However, as utility rates can vary widely, a building with consistent energy performance could meet the cost ZEB goal one year and not the next.

In wide-scale implementation scenarios, this definition may be ineffective because utility rates will change dramatically. As energy-efficient building technologies and renewable energy installations increase, the effects of large numbers of energy-efficient buildings must be considered in a given utility's service area. In addition to purchasing fuel to generate electricity, electric utilities must provide dependable service, maintain capacity to meet potential loads, meet obligations for maintaining and expanding infrastructure, and provide profitability for shareholders. The fixed costs associated with these activities result in rate structures that provide only limited incentive for consumers to create cost ZEBs. Trends in other utility sectors, such as water districts, indicate that as buildings become more efficient, and consequently have lower consumptive charges, the costs associated with infrastructure are increased. If significant numbers of buildings achieved a zero energy cost, financial resources would not be available to maintain the infrastructure, and the utility companies would have to raise the fixed and demand charges.

For commercial buildings, a cost ZEB is typically the hardest to reach, and is very dependent on how a utility credits net electricity generation and the utility rate structure the building uses. One way to reach this goal in a small commercial building might be to use a utility rate that minimizes demand charges. For example, at Zion, a 73-kW PV system is needed for a site and source ZEB at current performance levels (about 65% energy savings without PV).

To be a cost ZEB, with the utility providing credit for net electricity generation at avoided generation costs, a 100-kW PV system would be needed. A cost ZEB may be technically possible in this case, but the following characteristics would all be required to achieve this ZEB definition:

- High energy savings (Zion's measured energy savings approach 65%).
- Aggressive demand management to allow PV to help offset demand. Without demand-responsive controls, PV systems cannot be relied upon to reduce peak demand charges (Torcellini et al. 2004). Additionally, the low peak demands enable the building to qualify for the small commercial rate structure.
- A favorable utility rate structure weighted toward energy use, not peak demand charges. Standard commercial rate structures often result in electricity charges that are typically split between peak demand and energy charges. The small building commercial rate structure for Zion, which has comparatively low peak demand rates and higher consumption rates, would not apply if the building used more than 35 kW for any 15-minute period over any time of the year. This small commercial rate includes a low demand charge of $6.30/kW for all usage that exceeds 15 kW, and an energy charge of $0.08/kWh for the first 1500 kWh and $0.045/kWh for all additional kilowatt-hours. A time-of-use rate would also be advantageous for a cost ZEB.
- A net-metering agreement that credits excess electricity generation at avoided generation costs ($0.027/kWh in this case), without capacity eligibility limits to PV system sizes. Avoided generation costs refer to how the utility credits the customer for net generation and is based on the costs associated with the utility not having to generate this energy. A far more favorable net-metering agreement would credit the net generation at the full retail rate. This is considered "true" net metering, and would be the favored net metering arrangement in a cost ZEB. The net-metering agreement also must allow the excess generation credit to be used for offsetting energy-related and nonenergy charges, such as monthly meter charges, demand charges, and taxes.

In the Zion net cost ZEB example, a PV system 30% larger than a site or source ZEB PV system would be required to reach the net cost ZEB goal. For utility rates that do not allow the net generation credit to be applied to nonenergy charges, a net cost ZEB would not be possible, irrespective of the size of the PV system, the energy or demand savings, or how the rates weight energy and nonenergy charges.

If demand charges account for a significant portion of the utility bills, a net cost ZEB becomes difficult. For example, Oberlin's rate structure is not weighted toward energy rates combined with minimal demand savings. A 430-kW PV system would be required for a cost ZEB at Oberlin at current levels of performance. This is 3.6 times the size of the PV system Oberlin would need to be a site or source ZEB. For this 13,600 ft^2 building to be a net cost ZEB, a PV system approaching 40,000 ft^2 would be required—much larger than the building footprint.

If two-way or net metering is not available, on-site energy storage and advanced demand-responsive controls to manage peak demand charges should be included in the design and operation of cost ZEBs. It may be more effective to store excess PV energy and use it at a later time to reduce demand charges rather than export the energy to the grid.

Net Zero Energy Emissions Building

An emissions-based ZEB produces at least as much emissions-free renewable energy as it uses from emissions-producing energy sources. An on-site emission ZEB offsets its emissions by using supply-side options 1 and 2 in Table 1. If an all-electric building obtains all its electricity from an off-site zero emissions source (such as hydro, nuclear, or large scale wind farms), it is already zero emissions and does not have to generate any on-site renewable energy to offset emissions. However, if the same building uses natural gas for heating, then it will need to generate and export enough emissions-free renewable energy to offset the emissions from the natural gas use. Purchasing emissions offsets from other sources would be considered an off-site zero emissions building.

Success in achieving an emissions ZEB depends on the generation source of the electricity used. Emissions vary greatly depending on the source of electricity, ranging from nuclear, coal, hydro, and other utility generation sources. One could argue that any building that is constructed in an area with a large hydro or nuclear contribution to the regional electricity generation mix would have fewer emissions than a similar building in a region with a predominantly coal-fired generation mix. Therefore, an emissions ZEB would need a smaller PV system in areas with a large hydro or nuclear contribution compared to a similar building supplied by a utility with a large coal-fired generation contribution.

The net zero emissions ZEB definition has similar calculation difficulties previously discussed with the source ZEB definition. Many of these difficulties are related to the uncertainty in determining the generation source of electricity. Like the source definition, one would need to understand the utility dispatch strategy and generation source ratio to determine emissions from each of these sources.

Conclusions

ZEB Definitions Applied to a Sample of Current Generation Low-Energy Buildings

Each of these leading-edge case study buildings demonstrates the progress toward achieving ZEB goals in real-world examples. Only the Science House has achieved the site and source ZEB goal because it is a small building with a relatively large PV system. The other one-story buildings—Zion, BigHorn, and TTF—could achieve ZEB within their roof areas for all the definitions except cost ZEB. ZEB is not feasible for the two-story buildings unless their loads are further reduced. For Oberlin (currently closest to meeting a ZEB goal in a two-story building), the annual PV production is still less than the best-case energy consumption scenario. Oberlin is currently installing another 100-kW PV system in the parking lot (total installed DC capacity will be 160 kW), which will be tied into the building's electrical system. We expect that the building will achieve a site, source, and emissions ZEB, but that a cost ZEB will be difficult to reach without further demand management controls. To accomplish a ZEB, the PV system has been extended past the building footprint.

None of our sample commercial buildings could clearly be cost ZEBs with the current rate structures. Zion could be the closest because of its aggressive demand management, favorable utility rate structure, and efficient use of energy. A cost ZEB is the most difficult ZEB goal to reach because typical commercial rate structures do not allow for net metering such that exported electricity can offset all other utility charges. To reach a cost ZEB goal, the credit received for exported electricity would have to offset energy, distribution, peak demand, taxes, and metering charges for both electricity and gas use.

The ZEB Definition Selected Can Have an Impact on Future ZEB Designs

The zero energy definition affects how buildings are designed to achieve the goal. It can emphasize energy efficiency, supply-side strategies, purchased energy sources, utility rate structures, or whether fuel-switching and conversion accounting can help meet the goal. Table 3 highlights key characteristics of each definition.

Table 3. ZEB Definitions Summary

Defini-tion	Pluses	Minuses	Other Issues
Site ZEB	• Easy to implement. • Verifiable through on-site measurements. • Conservative approach to achieving ZEB. • No externalities affect performance, can track success over time. • Easy for the building community to understand and communicate. • Encourages energy-efficient building designs.	• Requires more PV export to offset natural gas. • Does not consider all utility costs (can have a low load factor). • Not able to equate fuel types. • Does not account for nonenergy differences between fuel types (supply availability, pollution).	
Source ZEB	• Able to equate energy value of fuel types used at the site. • Better model for impact on national energy system. • Easier ZEB to reach.	• Does not account for nonenergy differences between fuel types (supply availability, pollution). • Source calculations too broad (do not account for regional or daily variations in electricity generation heat rates). • Source energy use accounting and fuel switching can have a larger impact than efficiency technologies. • Does not consider all energy costs (can have a low load factor).	• Need to develop site-to-source conversion factors, which require significant amounts of information to define.
Cost ZEB	• Easy to implement and measure. • Market forces result in a good balance between fuel types. • Allows for demand-responsive control. • Verifiable from utility bills.	• May not reflect impact to national grid for demand, as extra PV generation can be more valuable for reducing demand with on-site storage than exporting to the grid. • Requires net-metering agreements such that exported electricity can offset energy and nonenergy charges. • Highly volatile energy rates make for difficult tracking over time.	• Offsetting monthly service and infrastructure charges require going beyond ZEB. • Net metering is not well established, often with capacity limits and at buyback rates lower than retail rates.
Emis-sions ZEB	• Better model for green power. • Accounts for nonenergy differences between fuel types (pollution, greenhouse gases). • Easier ZEB to reach.		• Need appropriate emission factors.

A source ZEB definition can emphasize gas end uses over the electric counterparts to take advantage of fuel switching and source accounting to reach a source ZEB goal. Conversely, a site ZEB can emphasize electric heat pumps for heating end uses over the gas counterpart. For a cost ZEB, demand management and on-site energy storage are important design considerations, combined with selecting a favorable utility rate structure with net metering. An emissions ZEB is highly dependent on the utility electric generation source. Off-site ZEBs can be reached just by purchasing off-site renewable energy—no demand or energy savings are needed. Consistent ZEB definitions are needed for those who research, fund, design, and evaluate ZEBs.

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A net zero-energy building (ZEB) is a residential or commercial building with greatly reduced energy needs through efficiency gains such that the balance of energy needs can be supplied with renewable technologies. Despite the excitement over the phrase "zero energy," we lack a common definition, or even a common understanding, of what it means. In this paper, we use a sample of current generation low-energy buildings to explore the concept of zero energy: what it means, why a clear and measurable definition is needed, and how we have progressed toward the ZEB goal.

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zero energy building; zeb; commercial building; low-energy building

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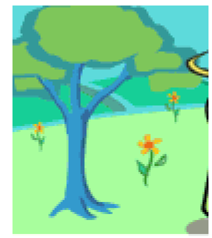
The Carbon Calculator Morass

Posted June 18, 2008 9:06 AM by Jennifer Atlee
Related Categories: Op-Ed, Science & Tech, Books & Media, Nature & Nurture



In the process of looking into carbon calculators for buildings as a behind-the-scenes assistant for the *EBN* feature article "Counting Carbon: Understanding Carbon Footprints of Buildings," I took a short detour into the wider carbon calculator world. While construction calculators may still be rare, the Web offers a multitude of general carbon calculators for businesses and households and also specialized calculators for everything from wineries to land remediation activities. It seems everyone is getting into the act — utilities, environmental groups, oil companies, government agencies, and offset providers (*especially* offset providers) are all offering up their own calculators. These vary widely in their approach, scope, level of complication, rigo transparency, visual appeal, and results — including what aspect of household or business ope is the greatest contributor to total emissions.

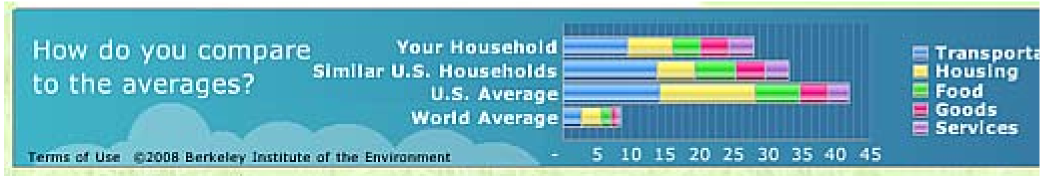
The primary value of these simple calculators is getting people thinking about the issue and pr some motivation for change, but the system should at least be accurate enough to help users a reasonable sense of priorities for action. The ideal calculator would provide default values usi average data while allowing users to improve the results by providing their own actual data on bills (including gallons, therms, kWh, not just dollars), vehicle fuel efficiency, miles driven, fligl taken, and other behavioral characteristics. The ideal calculator would also provide tips for nex and allow users to track efforts over time, as well as test the likely impact of different strategie better would be if you could dig behind the displayed answers and see what *all* the assumption underlying them — a major bonus for geeks like me.

EBN did not attempt a comprehensive review of lifestyle calculators, or comparison of results (especially once we realized what a rabbit hole we'd be entering). A little browsing on the web how many others have tried variations on that theme — and how hard it can be. Also, new calc pop up daily. The calculators below are just a few that we thought rose to the top while wande through the morass of options. For a more in depth review (though still by no means comprehe try Consumer Reports' review of travel results, the Home Energy Saver table outlining the scop covered by a range of calculators, or check out the Earth Charter Initiative's list of calculators available by country. We'd love to hear of any truly thorough reviews you know of, or what cal you think are best.

A few notable calculators in the mix are the following:

- Low Impact Living's **Environmental Impact Calculator**, which provides a comparative assessment of a range of impacts, not just carbon emissions; suggests actions; and lets save and update their profiles. (In contrast, the Ecological Footprint Calculator has an animated custom avatar, but I'm not convinced it provides much life-changing value.)

- The **CoolClimate Carbon Footprint Calculator**, which considers a wider range of acti at a detailed level. Inputs include what users eat and purchase as well as the more typi questions about the user's house, based on expenditures, and comparison with national "similar household" averages. The calculator was developed by the Berkeley Institute of Environment (BIE), at the University of California, Berkeley).



- **Safe Climate Calculator**, by World Resources Institute, which is short and asks only tl numbers: therms, kWh, fuel economy and miles traveled, and rewards you at the end v little animated guy who becomes a devil or angel depending on your emissions.

- **TerraPass**, like most if not all carbon offset providers, has a suite of calculators, includ personal and business calculators as well as specific calculators for driving, flying, etc. / typical, the only option to "take action" is to buy carbon offsets or other "green product None of these are designed to encourage behavioral change. Still, I liked that it allows u input specific flights taken, rather than number of "short" or "long" flights, or total miles hours traveled. This doesn't mean TerraPass's calculator is more accurate, while that is possible — all I know is it shows the lowest emissions on the Consumer Reports review, I'd lean towards using one in the middle of the range in the absence of better info on ac

- **EPA** provides a whole suite of calculators themselves (including ones for waste, recycle content and durable goods), and links to other's calculators — but what is especially use folks trying to get the word out is their GHG Equivalencies Calculator — which lets you i consumption unit and get out how that number compares to barrels of oil consumed, tr seedlings grown, passenger vehicles, etc, etc. With this you can put emissions into term anyone can understand.

What's next? Well, it looks like we'll be getting calculators like the "Carbon Hero" that calculate user's carbon footprint from transportation as you move around, carrying the tiny data-collecto you. While I'm not sure whether this is really any better a calculator, I'm pretty sure it'll appea gadget-geeks (but, we also need a hand-held one that calculates the embodied and operationa carbon of each gadget they purchase).

Unfortunately, the most noticeable thing about carbon calculators is still the plethora of options the lack of consistency amongst them and we will applaud all efforts to clarify the field. In the time we still think trying out some of these calculators is a worthwhile effort to get people thin but we suggest taking the results and recommendations with more than a grain of salt.

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Comments

The coolest calculator on the web is for air travel. At http://chooseclimate.org/flying, you can the cute cursor to plot your trip, enter your aircraft type, class of service, passenger load fact get the results in fuel and GHG emissions. You can also find out how your trip compares to ar annual budget for sustainable GHG emissions, that is, a global per capita average that is estir to produce a stable climate. You will find out that GHG emissions in aircraft are roughly 3x as climate forcing as ground level emissions, partly because of where they are injected and part because of the water vapor emitted.

ASHRAE is working on a project to develop a calculator for building designers and operators t
allows the use of simulation data or real monitored energy use to see the impact of design an
operational alternatives. Time of day, season, weather, and location make a lot of difference.
use has different GHG emission implications as a result. So evaluating trade-offs requires
understanding the total and marginal emissions on a time and weather dependent basis. We a
working to develop that tool and now have a description of the project that will result in the t
we are lacking is the funding. Checkbook handy, anyone?
Posted 6/18/08 9:28 PM by Hal Levin

A calculator that links energy to carbon that is not listed here, but should be(!) is
AMEE: a neutral aggregation platform to measure and track all the energy data in the world.
web-service (API) that combines measurement, CO2 conversion, profiling and transactional
systems. I don't work for the creators of it, just think its really well done, and definitely need
See: http://www.amee.cc
Posted 7/1/08 11:29 AM by Anastasia O'Rourke

Regarding carbon credits, what I am seeing is that people are now using them as an excuse t
continue living the way they have been, but feeling better about it because they can offset th
habits by purchasing credits. The awareness that has been raised since the Kyoto Protocol is
valuable, however; is it backfiring for the everyday consumer? Some of my clients tell me tha
are planning a holiday (as usual) and are flying (as usual), have booked a resort (as usual) a
have offset the trip by purchasing carbon credits, so they feel really green. I think the carbon
are great at creating the awareness, though a strong next step is needed. How does one polic
those purchasing credits randomly to absolve their sins? Is education an even better way to r
people aware that change is more important than offsets? This conundrum sits with me at thi
and I have no ideas for solutions. Do you?
Posted 7/5/08 6:21 PM by Eileen Wosnack

Eileen has posed the major moral dilemma of our time. I confess to being as guilty as the nex
person in spite of my "heightened awareness." I fear that short of regulations and taxation, r
carbon emissions is still a ways off. One hopeful sign is that most major corporations are awa
the issue and many are actually taking steps to identify and reduce their carbon footprint.
Governments are acting too, but perhaps too meekly and slowly. The presence of carbon labe
cars is about to happen in California, but when cars are carbon neutral, then consumers can r
the "right" choice. Now cars are promoted as "green" that are half as fuel efficient as the mor
efficient ones on the road. The awareness is rising, and that is the first step toward change. L
hope it doesn't take too long or it may not be enough.

A humorous rendition of Eileen's comment is Cheat Neutral, a clever spoof on carbon offsets c
about a year ago. It is very entertaining albeit terribly sad. You can see it at www.cheatneutr
They describe it thus:

What is Cheat Offsetting?
When you cheat on your partner you add to the heartbreak, pain and jealousy in the atmosph
Cheatneutral offsets your cheating by funding someone else to be faithful and NOT cheat. Thi
neutralises the pain and unhappy emotion and leaves you with a clear conscience.

Can I offset all my cheating?
First you should look at ways of reducing your cheating. Once you've done this you can use
Cheatneutral to offset the remaining, unavoidable cheating
Posted 7/6/08 1:37 AM by Hal Levin

We already have a building carbon calculator that is very transparent, can list the assumption
make and spits out consistent tonnage based on some general building data. I think it is the c
one currently written. Unfortunately, it was funded and therefore written for the UK building t
and climate. I am working on a US model at this point in time, but am in the early stages. Th
version on the web is very basic, entering three building parameters; you can also download a
protected copy that gives many other opportunities to modify input assumptions. Any comme
appreciated. http://www.fgould.com/uk
Posted 8/13/08 3:19 PM by Dave

After you have read the EBN article on buildings' carbon emissions, you will want to stay tune

Francisco for the California Energy Commission -- "Developing a Greenhouse Gas Tool for Bui in California: Methodology and Use." It is a carbon emissions calculator based on California da (only) and using dispatch software rather than historical data. But it will show the users how difference alternative design and operational strategies make in terms of carbon emissions th don't always map one-to-one with energy consumption due to the different sources of energy different times of the day, week, and year in California. It provides both marginal and total ca emissions results. It is not tuned to the weather conditions that give rise to different energy consumption in buildings and, at least in the case of hydro, different sources of energy with d carbon emissions implications. There are plans to post the spreadsheet on the E3 web site so anyone can use it or at least play around to get a feel for what it is like to use electric energy different times of the year or to make trade-offs between on-site combustion and electricity generation or to substitute conservation or energy efficiency measures for supply options.

Another project completed by Synapse Energy Economics in Cambridge, MA, -- ANALYSIS OF INDIRECT EMISSIONS BENEFITS OF WIND, LANDFILL GAS, AND MUNICIPAL SOLID WASTE GENERATION. It is based on historical data for 2005 for the entire country and gives hourly emissions for all regions of the country. Again, it is only for that one year and is not necessar applicable to any other weather year. It shows that for some regions of the country, using an average value can distort the annual total carbon emissions by as much as ~60% while in oth regions, there is little difference between an annual average value and an annual total based 8760 hourly values. You can download a copy of the report from http://www.synapse-energy.com/Downloads/SynapseRep...

We (at ASHRAE) continue to work on developing a tool that will combine the best features of these projects in the ASHRAE project committee, and hope to issue an RFP to address some c unanswered questions about the uncertainties associated with the alternative approaches to developing the emissions database that would be necessary for the ultimate tool we want to c for use with popular building energy simulation software. Our present task is to revise it into a Statement for funding by ASHRAE. We are awaiting news on a possible project to be funded b to develop data for use in a building carbon emission calculator before finalizing our Work Statement. We hope to submit the project for approval by ASHRAE's Research Advisory Comr at the Winter Meeting in Chicago in January.

Posted 9/5/08 10:13 PM by Hal Levin

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LABS FOR THE 21ST CENTURY

Labs for the 21st Century

Become a Labs21 Partner

What Is the Laboratories for the 21st Century Partnership Program?

The Laboratories for the 21st Century (Labs21) Partnership Program encourages the development of sustainable, high-performance, and low-energy laboratories. Developed by the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE), this voluntary program is open to all public and private sector organizations in the United States interested in improving their laboratories' energy- and water-efficiency, encouraging the use of renewable energy sources, and promoting environmental stewardship. By setting goals to reduce energy and water use in defined projects, Labs21 Partners demonstrate the potential for improved laboratory design, construction, and management worldwide.

The goal of Labs21 is to create environmental showcase laboratories that take a "whole-building" approach to laboratory design. This goal involves focusing on all of a laboratory's energy systems and wastes rather than on specific building components. As Labs21 Partners are demonstrating, this holistic approach can result in significantly higher efficiencies and cost savings, as well as reduced emissions and improved health and safety conditions.

What Are the Benefits of Becoming a Labs21 Partner?

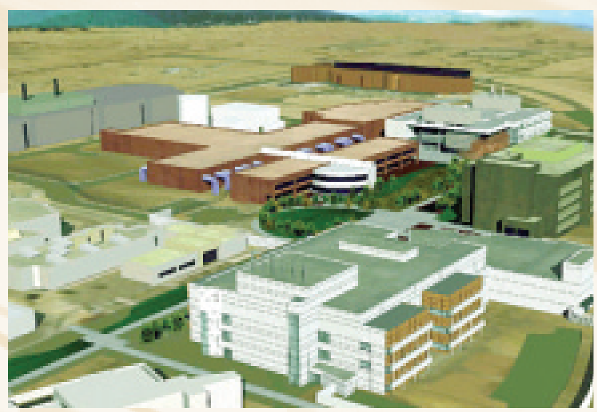
Labs21 Partners enjoy a long list of benefits, including:

- National recognition through Labs21 events, awards, and promotional materials.
- Opportunities for technical assistance from nationally recognized experts.
- Access to tools and resources to enhance project design and help establish performance goals.
- Opportunities to network and share project results with peers from around the globe.
- Lower laboratory utility and operating costs through improved design strategies, equipment, and facility management.
- Reduced health and safety risks through system upgrades and improved operations.
- Reduced pollution and greenhouse gas emissions.

How Are Labs21 Partners Achieving Success?

Labs21 Partners are at the forefront of sustainable laboratory design, setting the standard for laboratories in the 21st century. Here are just a few examples:

- Totaling 377,000 square feet, **Sandia National Laboratories'** state-of-the-art Microsystems and Engineering Sciences Applications Complex in Albuquerque, New Mexico, will be 30 percent less energy intensive than similar buildings at Sandia, and will reclaim and recycle its process water. Construction began in mid-2003, and the first phase—the most energy intensive of the three buildings—is scheduled for completion in early 2005.



Aerial depiction of Sandia National Laboratories' new research complex in Albuquerque, New Mexico.

EPA United States Environmental Protection Agency

FEMP Federal Energy Management Program United States Department of Energy

www.epa.gov/labs21century

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- To achieve a number of aggressive energy efficiency goals for its new Science and Engineering Building, the **University of California-Merced** is using efficient lighting, solar control through shading and high-performance glazing, low pressure-drop air systems, variable air volume fume hood systems, and other measures.

Rendering of the University of California-Merced's Science and Engineering Building.

- Through commissioning and retro-commissioning, **Raytheon Integrated Defense Systems and Network Centric Systems** is identifying strategies to reduce energy consumption and increase overall environmental performance at its Satellite Communications Building and other facilities.

- To improve energy efficiency at its 300,000 square-foot Levine Science Research Center, **Duke University** is measuring the impact of various exhaust hood management practices and strategies on energy utilization. The university is also applying a "whole building" design to other laboratories on campus.

How Can I Become a Labs21 Partner?

All public and private sector laboratories in the United States are invited to join the program as Partners. To become a Partner, you agree to set voluntary energy- and water-efficiency goals for a specific laboratory and to measure and report your results. The specific criteria for joining include:

- Identifying a central point of contact.
- Identifying a specific laboratory site (new construction or retrofit) as your Labs21 project, and setting measurable energy and environmental performance goals for this facility.
- Agreeing to benchmark the energy and environmental performance of your facility and share these results with the larger Labs21 community.
- Reporting your project results to EPA annually.

If you're willing to adopt the principles of sustainable design and management, but do not yet have a specific laboratory project, you may join the program as a Labs21 Prospect.

If you are interested in becoming a Partner or Prospect, or would simply like to learn more about the program, visit the Labs21 Partnership Web site at **www.epa.gov/labs21century/partnership.**

Duke University's Levine Science Research Center in Durham, North Carolina.

LEED 2009 Vision & Executive Summary

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LEED V3
USGBC's evolution of the LEED Green Building Rating System is a multi-faceted initiative to streamline and create capacity for LEED project execution, documentation and certification. This initiative is referred to as LEED Version 3 (commonly referred to as LEED v3). In the spirit of the most successful LEED projects, this initiative has been undertaken in an integrated fashion made up of 3 key pieces:

- LEED 2009 – LEED Rating System updates/revisions
- Revision and evolution of the LEED certification process
- LEED Online v3

LEED 2009
In order to remain relevant in a rapidly changing market, technology must evolve; LEED, as a market transformation instrument, is no different. The suite of LEED Green Building Rating Systems has enjoyed remarkable and unprecedented growth as the building industry has sought to engage with its concepts and technical criteria. LEED has been an incontrovertible success as a tool to promote market transformation and recognize buildings with exemplary green pedigrees. As of May 1, 2008, 3.5+ billion square feet of building projects (10,000+ individual projects) have registered intent to seek LEED certification with dozens more signing up every day. LEED's rapid success presents its stewards, the USGBC membership, with an opportunity to advance the system to ensure that future buildings certified under its criteria are even greener than the stock in the pipeline to date.

LEED has always existed and enjoyed unparalleled success, in part, due to its ability to operate in the dynamic tension between the pursuit of environmental excellence and the business realities of buildings industry. While the urgency of pending environmental crises that face the coming generations weighs heavily on all of us, there is recognition that LEED cannot completely forsake market uptake for environmental priorities. Issues like global climate change may be the most urgent and dire social equity issues that we have ever faced, and they demand immediate, effective action. In spite of this knowledge, we also acknowledge that no transformation is catalyzed if the bar set by LEED is unachievable in the context of existing technological and economic boundaries.

Continuing to strike the optimal balance between market uptake and technical advancement is one of the driving forces behind the LEED 2009 work. Additionally, much has been invested in the current LEED system and, as a direct result, a concerted effort has been made to ensure that LEED 2009 capitalizes on the existing market momentum. Consequently, the LEED Steering Committee[1] has created a

[1] The LEED Steering Committee is comprised of Scot Horst (Chair), Joel Ann Todd (Vice-Chair), Neal Billetdeaux, John Boecker, Stu Carron, Bryna Dunn, Doug Farr, Holley Henderson, Greg Kats, Malcolm Lewis, Christine Magar, Nadav Malin, Muscoe Martin, Sara O'Mara, Kristin Shewfelt, Bob Thompson, and Lauren Yarmuth (Board Liaison).

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LEED structure that will be familiar to those versed in the current LEED Rating Systems. Most of the structural and technical changes incorporated into LEED 2009 were designed to create a LEED Rating System that can be part of a continuous improvement cycle.
LEED 2009 is not a "tear down and rebuild" of the LEED that exists in the market but rather a reorganization of the existing LEED Rating Systems along with several key advancements. LEED 2009 is the sum of several parts:

- LEED Prerequisite/Credit Alignment and Harmonization
- Predictable Development Cycle
- Transparent Environmental/Human Impact Credit Weighting
- Regionalization

LEED Prerequisite/Credit Alignment and Harmonization – the LEED Bookshelf
In a concerted and organized effort to provide a rapidly evolving green building market with tools that support a variety of building projects, USGBC has, over the past 6 years, created numerous market-specific LEED Rating Systems. While the deployment of these LEED Rating Systems has met, and in most instances continues to meet, the market demand, LEED version deployment has some undesirable side effects. Under the previous development paradigm, USGBC has been obligated to internalize 100% of the necessary rating system support infrastructure (rating system, LEED Online, submittal documents, reference guide, educational curriculum, case studies, marketing material, etc.) even when the new version of LEED is only marginally different than an existing version. Additionally, the rapidly ongoing transformation of the building industry has produced, at times, individual LEED rating systems that capture the latest industry advances but contain credits and prerequisites and may conflict with credits and prerequisites in other LEED versions.

In an effort to synchronize the development and deployment of LEED rating systems while creating capacity to respond to previously underserved markets, the LEED Steering Committee[1], in collaboration with LEED committee/TAG volunteers and USGBC staff, undertook a reorganization of the existing LEED Rating Systems. The resultant prerequisite/credit structure is a consolidation, alignment and updating of all existing LEED Rating Systems into their "most effective common denominator". Prerequisite/credit alignment across applicable rating systems now provides a pool of prerequisites/credits for all LEED Rating Systems, and multiple versions of prerequisites/credits have been retained were needed to address different market situations. In this process, credit "fixes" were introduced. In addition, a scrub of the existing Credit Interpretation Rulings (CIRs) was conducted and necessary precedent-setting and clarifying language has been incorporated into the prerequisites/credits.

Predictable Development Cycle
LEED alignment provides a continuous improvement structure that will enable USGBC to develop LEED in a predictable way. Using a cycle that is principally

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based on the familiar method by which building codes are developed, LEED will evolve on a set schedule. However, LEED is not a building code, and in so, policy mechanisms will be retained to allow for LEED to react to the rapidly changing green building industry including, but not limited to, administrative credit interpretations and the establishment of performance/intent equivalent alternative compliance paths to existing LEED prerequisites/credits.

Transparent Environmental/Human Impact Credit Weighting

Arguably the biggest change to LEED 2009 proposed in this public comment is the re-weighting/point re-allocation of LEED credits. The process used to evaluate the environmental and human benefit of each LEED credit is complex due to the sophisticated level of research and analysis involved, but the general philosophy, explained below, is relatively simple.

The term ‘weightings,’ as it is used herein, refers to the process of redistributing the available points in LEED so that a given credit’s point value more accurately reflects its potential to either mitigate the negative or promote positive environmental impacts of a building. Until now, the LEED Green Building Rating System has not used an overarching, consistent framework for allotting point values to credits. Though ample anecdotal explanation for those choices is available – i.e., consensus of a large pool of talented and experienced individuals in the buildings industry – LEED 2009 goes a step further by weighting LEED according to a logical, transparent framework that incorporates the best available science.

The explicit weightings in the revised LEED Rating System scorecards represent the culmination of a weightings exercise that utilized two existing tools (modified for use by USGBC) in conjunction with exhaustive research, policy guidance from the LEED Steering Committee, and a new tool developed to synthesize large quantities of relevant information.

Regionalization

The ability to recognize regional environmental priorities in LEED has been a clear priority of LEED users. In response to this market desire, the LEED Steering Committee created a structure that allows for regional bonus credits in LEED.

As a first step, incentives will be provided through LEED Innovation & Design style bonus points that will add value to those credits that are considered most important for defined regions. These points will be counted in the same way as LEED ID points and are not included in the certification threshold calculations (ID and regional points count towards a project’s certification tally but they are not ‘base’ points on which certified, silver, gold and platinum thresholds are established).

Project teams may select bonus points from a list of eligible credits based on the project’s location. The LEED Steering Committee is currently collaborating

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with Regional Councils and Chapters to create the list of eligible credits. As defined by these Regional Councils and Chapters, select credits from the available list will be eligible for bonus points in appropriate sub-regions.

Exemplary Performance

Currently in LEED, projects can earn up to 4 points for exemplary performance under IDc1: Innovation in Design. Exemplary Performance points are granted to projects that can demonstrate a doubling and/or attainment of the next incremental percentage threshold beyond the requirements of a LEED credit. Credit can also be earned under IDc1 for employing innovative strategies in building design, construction or operation. In an effort to encourage more innovation in LEED projects, the LEED Steering Committee voted to grant a maximum of 3 points for exemplary performance. This step was taken in order to return to the original intent of the credit, to encourage projects to pursue innovation in green building.

Beyond LEED 2009

As mentioned previously, one of the goals of the LEED 2009 update is to move LEED in to a continuous improvement cycle. With this goal in mind, framework and organizational changes were made to LEED for the 2009 update. Planning steps are underway to create a process that yields a predictable development cycle for LEED. Although USGBC has no intention of treating LEED as a building code, in the past, market feedback argues that LEED move in to a development cycle that more closely mirrors that of the traditional building code's continuous improvement cycle.

In addition to the creation of a continuous improvement cycle, individual elements of LEED (credits, prerequisites, calculation methodologies, etc) as well as macro level issues (weightings, market sectors served, etc.) will be scrutinized to ensure that LEED maintains its leadership position in the market. The LEED Steering Committee has already planned to revisit the issues surrounding the, only recently completed, weightings exercise. The proposed changes to LEED set the stage for comprehensive but incremental evolution and advancement. Through this structure, USGBC is committed to using LEED as a tool to promote and steward market transformation towards sustainability in the built environment.

LEED 2009 Documents to Review

Documents up for public review include overviews and supporting tools for credit & CIR alignment, regionalization and weightings. Additionally, the scorecards and redlined rating systems for New Construction, Core and Shell, Commercial Interiors, Existing Buildings: O&M and Schools are available and have all proposed changes incorporated. These documents can be found under each rating system link of the LEED 2009 section of the Public Drafts Page.

LEED for New Construction and Major Renovation 2009
Project Scorecard

Project Name:
Project Address:

Yes	?	No			Points
			Sustainable Sites		**26 Points**
Y			Prereq 1	**Construction Activity Pollution Prevention**	Required
			Credit 1	**Site Selection**	1
			Credit 2	**Development Density & Community Connectivity**	5
			Credit 3	**Brownfield Redevelopment**	1
			Credit 4.1	**Alternative Transportation,** Public Transportation Access	6
			Credit 4.2	**Alternative Transportation,** Bicycle Storage & Changing Rooms	1
			Credit 4.3	**Alternative Transportation,** Low-Emitting & Fuel-Efficient Vehicles	3
			Credit 4.4	**Alternative Transportation,** Parking Capacity	2
			Credit 5.1	**Site Development,** Protect or Restore Habitat	1
			Credit 5.2	**Site Development,** Maximize Open Space	1
			Credit 6.1	**Stormwater Design,** Quantity Control	1
			Credit 6.2	**Stormwater Design,** Quality Control	1
			Credit 7.1	**Heat Island Effect,** Non-Roof	1
			Credit 7.2	**Heat Island Effect,** Roof	1
			Credit 8	**Light Pollution Reduction**	1

Yes	?	No			Points
			Water Efficiency		**10 Points**
Y			Prereq 1	**Water Use Reduction,** 20% Reduction	Required
			Credit 1.1	**Water Efficient Landscaping,** Reduce by 50%	2
			Credit 1.2	**Water Efficient Landscaping,** No Potable Use or No Irrigation	2
			Credit 2	**Innovative Wastewater Technologies**	2
			Credit 3	**Water Use Reduction**	2 to 4
				30% Reduction	2
				35% Reduction	3
				40% Reduction	4

					Points
			Energy & Atmosphere		**35 Points**
Y			Prereq 1	**Fundamental Commissioning of the Building Energy Systems**	Required
Y			Prereq 2	**Minimum Energy Performance:** 10% New Bldgs or 5% Existing Bldg Renovations	Required
Y			Prereq 3	**Fundamental Refrigerant Management**	Required
			Credit 1	**Optimize Energy Performance**	1 to 19
				12% New Buildings or 8% Existing Building Renovations	1
				14% New Buildings or 10% Existing Building Renovations	2
				16% New Buildings or 12% Existing Building Renovations	3
				18% New Buildings or 14% Existing Building Renovations	4
				20% New Buildings or 16% Existing Building Renovations	5
				22% New Buildings or 18% Existing Building Renovations	6
				24% New Buildings or 20% Existing Building Renovations	7
				26% New Buildings or 22% Existing Building Renovations	8
				28% New Buildings or 24% Existing Building Renovations	9
				30% New Buildings or 26% Existing Building Renovations	10
				32% New Buildings or 28% Existing Building Renovations	11
				34% New Buildings or 30% Existing Building Renovations	12
				36% New Buildings or 32% Existing Building Renovations	13
				38% New Buildings or 34% Existing Building Renovations	14
				40% New Buildings or 36% Existing Building Renovations	15
				42% New Buildings or 38% Existing Building Renovations	16
				44% New Buildings or 40% Existing Building Renovations	17
				46% New Buildings or 42% Existing Building Renovations	18
				48% New Buildings or 44% Existing Building Renovations	19
			Credit 2	**On-Site Renewable Energy**	1 to 7
				1% Renewable Energy	1
				3% Renewable Energy	2
				5% Renewable Energy	3
				7% Renewable Energy	4
				9% Renewable Energy	5
				11% Renewable Energy	6
				13% Renewable Energy	7
			Credit 3	**Enhanced Commissioning**	2
			Credit 4	**Enhanced Refrigerant Management**	2
			Credit 5	**Measurement & Verification**	3
			Credit 6	**Green Power**	2

Yes ? No

LEED for New Construction and Major Renovation 2009 Project Scorecard

Project Name:
Project Address:

Yes	?	No			Points
			Materials & Resources		**14 Points**
Y			Prereq 1	**Storage & Collection of Recyclables**	Required
			Credit 1	**Building Reuse**	1 to 3
			Credit 1.1	Maintain 55% of Existing Walls, Floors & Roof	1
			Credit 1.2	Maintain 75% of Existing Walls, Floors & Roof	2
			Credit 1.3	Maintain 95% of Existing Walls, Floors & Roof	3
			Credit 1.4	**Building Reuse,** Maintain 50% of Interior Non-Structural Elements	1
			Credit 2.1	**Construction Waste Management**, Divert 50% from Disposal	1
			Credit 2.2	**Construction Waste Management**, Divert 75% from Disposal	1
			Credit 3.1	**Materials Reuse,** 5%	1
			Credit 3.2	**Materials Reuse,** 10%	1
			Credit 4.1	**Recycled Content,** 10% (post-consumer + ½ pre-consumer)	1
			Credit 4.2	**Recycled Content,** 20% (post-consumer + ½ pre-consumer)	1
			Credit 5.1	**Regional Materials,** 10% Extracted, Processed & Manufactured Regionally	1
			Credit 5.2	**Regional Materials,** 20% Extracted, Processed & Manufactured Regionally	1
			Credit 6	**Rapidly Renewable Materials**	1
			Credit 7	**Certified Wood**	1

Yes	?	No			Points
			Indoor Environmental Quality		**15 Points**
Y			Prereq 1	**Minimum IAQ Performance**	Required
Y			Prereq 2	**Environmental Tobacco Smoke (ETS) Control**	Required
			Credit 1	**Outdoor Air Delivery Monitoring**	1
			Credit 2	**Increased Ventilation**	1
			Credit 3.1	**Construction IAQ Management Plan,** During Construction	1
			Credit 3.2	**Construction IAQ Management Plan,** Before Occupancy	1
			Credit 4.1	**Low-Emitting Materials,** Adhesives & Sealants	1
			Credit 4.2	**Low-Emitting Materials,** Paints & Coatings	1
			Credit 4.3	**Low-Emitting Materials,** Flooring Systems	1
			Credit 4.4	**Low-Emitting Materials,** Composite Wood & Agrifiber Products	1
			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
			Credit 6.1	**Controllability of Systems,** Lighting	1
			Credit 6.2	**Controllability of Systems,** Thermal Comfort	1
			Credit 7.1	**Thermal Comfort,** Design	1
			Credit 7.2	**Thermal Comfort,** Verification	1
			Credit 8.1	**Daylight & Views,** Daylight 75% of Spaces	1
			Credit 8.2	**Daylight & Views,** Views for 90% of Spaces	1

Yes	?	No			Points
			Innovation & Design Process		**6 Points**
			Credit 1.1	**Innovation in Design:** Provide Specific Title	1
			Credit 1.2	**Innovation in Design:** Provide Specific Title	1
			Credit 1.3	**Innovation in Design:** Provide Specific Title	1
			Credit 1.4	**Innovation in Design:** Provide Specific Title	1
			Credit 1.5	**Innovation in Design:** Provide Specific Title	1
			Credit 2	**LEED® Accredited Professional**	1

Yes	?	No			Points
			Regional Priority Credits		**4 Points**
			Credit 1.1	**Regional Priority Credit:** Region Defined	1
			Credit 1.2	**Regional Priority Credit:** Region Defined	1
			Credit 1.3	**Regional Priority Credit:** Region Defined	1
			Credit 1.4	**Regional Priority Credit:** Region Defined	1

Yes	?	No		Points
			Project Totals (Certification Estimates)	**110 Points**

Not Certified

Certified: 40-49 points **Silver:** 50-59 points **Gold:** 60-79 points **Platinum:** 80+ points

SEED Frequently Asked Questions

How does SEED work?

Under SEED, state agencies are required to notify Energy of any new construction or renovation projects.

Depending upon the size and complexity of the project, Energy staff provide technical consulting services to state agencies and/or their authorized contractors throughout the course of a project. State agencies reimburse Energy for services rendered. Fees are capped at 0.2 percent of capital construction costs (but are usually less).

These services ensure that all cost-effective energy conservation measures (ECMs) are included in a building and that the building exceeds the energy conservation provisions of the Oregon State building code by 20 percent or more. In many cases, Energy involvement has also enabled the agency to save capital costs.

Click here for a more detailed description of the SEED process and program requirements.

Who is required to follow SEED?

SEED applies to all state agencies and state higher education institutions that are authorized to finance the construction, purchase or renovation of buildings or other structures to be used by the State of Oregon. It is not optional.

The only instance where SEED does not apply is when the facility has absolutely no energy using systems.

Who pays for SEED?

The state agency or higher education institution doing the construction or renovation pays for SEED. In order to meet the requirements of SEED, state agencies may incur higher design or construction costs. Early involvement by Energy can help minimize these costs.

State agencies reimburse Energy for services provided based on an hourly rate ($95 /hour) for the actual hours worked on a project. Invoices are issued quarterly. As established by ORS 276.900-915, total charges cannot exceed 0.2 percent of a project´s capital construction costs.

The goal of SEED is to ensure that all cost-effective energy conservation measures (ECMs) are included in state buildings and that the building meets the 20 percent better than code provision. The more work the owner/agency does towards this goal, the less work Energy must do and the less the agency must pay for SEED assistance.

Why do SEED?

1. By constructing and renovating buildings with energy efficiency in mind, state agencies can significantly reduce long-term operating costs. In some cases, initial capital costs may also be reduced. Those savings can be redirected to fund essential services. Additional benefits of energy efficiency are reducing environmental impacts and improving comfort for building occupants.

2. It´s the law.

What is EnergyÂ´s role in SEED?

Energy´s role is to help the agency/owner. We act as the owner´s representative to guide the SEED process and make sure that the design team´s work meets all SEED legislative requirements. We also act as the owner´s expert on energy efficient building design practices and provide an additional level of project quality control.

Working with Energy early in a project helps ensure that all parties are on the same page from the beginning and limits the possibility of future surprises.

History of SEED

1991	ORS 276.900-915 adopted by Oregon State Legislature.
	OAR 330-130 written. Officially establishes SEED program.
1998	OAR 330-130 amended. Major changes included adopting a two-path approach to SEED (Design Review Method or Design Assistance Method), establishing an hourly fee for services, and setting a cap on service changes of 0.2 percent of the first $3 million and 0.05 percent of costs over $3 million.
2001	House Bill 3788 passed by Oregon Legislature. Amended ORS 276.900-915 to include "20 percent better than code" and renewable energy provisions.
November 2001	OAR 330-130 amended. Major changes included eliminating the Design Assistance Method and establishing the Metering Plan, Verification Plan, and Post-Occupancy Monitoring.
May 2002	OAR 330-130 amended. Changed self-imposed cap of 0.05 percent of construction costs to 0.20 percent of construction costs and raised the hourly fee from $65 / hr to $75 / hr to fully recover program costs.
January 2003	OAR 330-130 amended. Major changes included changing wording to more accurately reflect current practices.
May 2007	Raised the hourly fee from $75/hr to $95/hr to fully cover program costs.

SEED legislation, rules, guidelines

ORS 276.900-915
Section of the Oregon Revised Statute that provides legislative authority for SEED.

OAR 330-130
Section of the Oregon Administrative Rules, written by Energy, which implements the SEED program.

SEED Guidelines

Guidelines, written by Energy, that describes the SEED program and requirements in detail.

SEED Contact Information

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