"Green" Codes and Rating Systems: A Framework for Evaluating the Tools and the Measuring Sticks to Create Better Buildings

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ABSTRACT

The growth of the LEED Green Building Rating System has had an impact on standard design practice in commercial new construction by uncovering and road-testing strategies that have applicability to building codes. This progress has led to the development of comprehensive or "green" building codes now available and beginning to be adopted in jurisdictions across the country. As a result, understanding the implications of this evolving set of codes on beyond-code rating systems and vice-versa has become increasingly important, as has clear communication of the purposes of each. To illuminate these implications and differing uses, USGBC developed a framework and visualization tool for comparative analysis for individual measures of sustainability (siting, energy, water, air quality, and materials) between buildings constructed to CALGreen, the IgCC, Standard 189.1 and average LEED Certified, Silver, Gold, and Platinum buildings. A *breadth* and *depth* approach was taken; *breadth* where analysis of the scope of impacts within a category are assessed, and *depth* where a more detailed analysis can help to quantify the outcomes. The framework and visualization tool will enable comparisons of code compliant buildings on a variety of metrics to the average achievement of certified buildings at each level. The framework will also enable comparisons between "green" code compliant buildings on those same metrics.

Introduction

The continued market growth of green buildings and green building practice presents an overwhelmingly positive story of multiple building industries adopting best practices and evolving the design, construction and building management process. Better buildings are the result, predominantly assessed and verified by third party green building rating systems like the Leadership in Energy and Environmental Design (LEED) rating system, administered by the U.S. Green Building Council (USGBC). The more than twelve thousand LEED certified commercial projects and the growing community of professionals are changing the definition of standard practice for design and construction professionals. Further evolutions of green building rating systems will reward greater achievements as market leaders think beyond the codes to create healthier, more efficient, lower impact and productive places to work and live.

While continuously improving building practices among market leaders is crucial, best practice does not become standard practice until all buildings begin to incorporate more advanced designs. An effective way to achieve and accelerate this market transformation is through the development, adoption, and implementation of better building codes that require greener building strategies. Such codes have recently been developed for commercial buildings and, in some cases, states and localities have adopted them and begun implementation. These codes include the 2010 California Green Building Standards Code (CALGreen), the International Green Construction Code (IgCC), and ASHRAE Standard 189.1 (Standard 189.1). The development of these code products has provided a much-needed set of regulatory tools for states and localities that intend to require buildings in their jurisdictions take on greater responsibility for the human and environmental health issues to which buildings contribute.

For all their added worth, these new green building code products have caused unintended market confusion that has spurred perplexing policy discussions in states and localities around the best use of regulatory tools like codes and voluntary-based, beyond-code rating systems like LEED. Many of these discussions have led to unfounded claims about the stringency of these codes compared to rating systems – LEED in particular. Some in the building industry opportunistically claim an unverified compliance with a green code is equivalent to LEED certification in an attempt to avoid third party oversight. Well-intended comparisons have also arisen that make arbitrary assumptions about the credits attained (or not attained) by LEED buildings to compare certification levels to green code compliant buildings without the benefit of data on credit attainment. As a result, USGBC determined that only a rational framework for comparison would clarify this confusion and support the appropriate roles of these distinct and complementary policy tools. Beginning with commercial buildings, the assessment methodology and comparison tool intends to measure buildings built to any green code along the many green building achievement scales that are commonly understood within the LEED rating system.

Background on Codes and Rating Systems

The International Green Construction Code (IGCC). The International Green Construction Code (IgCC) is a wide-scoping code document that provides minimum code guidance for designers, builders and code officials to design, build and oversee the construction of greener commercial buildings. The code is published by the International Code Council (ICC) and was a joint initiative of the ICC, the American Institute of Architects (AIA), ASTM International, and in partnership with the American Society of Heating, Refrigerating, and Air-conditioning, Engineers (ASHRAE), the Illuminating Engineering Society (IES), and the U.S. Green Building Council (USGBC). The code is developed through the ICC code development process by and for code officials though a series of public submissions and review hearings. The code is written in mandatory language and intended to serve as an overlay to base building codes, and not as a stand-alone document (i.e. you still need a building code, a plumbing code, a fire code, an electrical code, etc.). The IgCC is applicable to the construction of new commercial buildings, structures and systems, as well as alterations and additions. Given the availability of versions at the time of this analysis, IgCC Public Version 2.0 was used for this analysis.

Standard 189.1. ASHRAE Standard 189.1 was developed with the intent of codifying the voluntary, aspirational LEED credits into a format that can be adopted and referenced alongside a minimum building code. Similar to the IgCC, Standard 189.1 provides guidance for designers, engineers, builders and code officials to design, build and oversee the construction of greener commercial buildings. The standard was written and is maintained by the ASHRAE community of building industry experts. The standard is applicable to the construction of new commercial buildings, structures and systems, as well as alterations and additions. The standard is referenced as an optional compliance pathway within the IgCC should the design professional prefer it (and should the jurisdiction allow it). Sponsors of the standard include ASHRAE, USGBC, and IES. Given the availability of versions at the time of this analysis, Standard 189.1-2009 was used for this analysis.

CALGreen. The California Green Building Standards Code, better known as CALGreen, adds Part 11 to the State's well-known code of building regulations, Title 24. The code was originally developed as a response to legislation in the 2007-2008 session that proposed green building regulations for commercial and residential buildings. The Governor's veto message set a course for the state's leading code development and implementation infrastructure to construct a set of mandatory, minimum guidelines for greener residential and commercial buildings. The first version of the code was made public in 2008 as a means to communicate where the state intended to take its newest set of regulations. The 2010 revisions then became mandatory statewide on January 1, 2011. Like similarly-intended green building codes and standards, CALGreen establishes minimum, mandatory measures in water efficiency, location and transportation planning, indoor environmental quality, and a building's impact on the environment and people through site development and materials selection. Energy efficiency continues to be regulated by Title 24 Part 6, the California Energy Code, although CALGreen's "voluntary tiers" provide additional code language for localities to go above and beyond.

LEED. The LEED Green Building Rating System defines pre-requisites (required minimum measures) and credits (voluntary measures) that projects can pursue in order to accrue the point values associated with the credits. Buildings are awarded LEED certifications at the Certified, Silver, Gold, and Platinum levels dependent upon how many points are successfully achieved from 100 possibilities, each describing a desirable green building outcome. Credits are divided into five core categories: Energy and Atmosphere, Sustainable Sites, Water Efficiency, Indoor Environmental Quality, and Materials and Resources. Each credit has requirements that must be satisfied to document achievement of the desired outcome. The Green Building Certification Institute (GBCI) acts as the certification body for each LEED project submittal. There are different versions of the rating system available for different applications, but for the purposes of comparing buildings at the levels of LEED certification to buildings built to a green code (which currently focus on commercial building construction), only those covered by the 2009 version of the Building Design and Construction (BD&C) rating systems are relevant here, which include New Construction, Commercial Interiors, Core and Shell, Retail, Schools, and Healthcare. LEED is the market leader in green building certifications worldwide, with over 60,000 projects in the system (registered and certified, commercial and residential), comprising more than 8 billion square feet across 120 countries as of February 2012.

Previous Comparisons

No studies have utilized a similar framework for comparing the outcomes of codes and rating systems on defined metrics, but many comparative analyses of the overlap between code provisions and LEED pre-requisites and credits have been conducted. These began with crosswalks of CALGreen and LEED 2009 done by implementers in California.

In 2010, Simon & Associates mapped LEED 2009 credits to CALGreen mandatory, Tier 1 and 2 provisions and vice versa on behalf of the AIA California, USGBC Northern California, the San Francisco Department of Environment, BuildItGreen and StopWaste.org. The exercise addresses areas of overlap between the two: where LEED pre-requisites or credits appear to satisfy CALGreen and where CALGreen compliance would contribute either partially or fully toward the attainment of LEED credits and point thresholds. Many code provisions were denoted as "maybe" contributing to credit attainment. The study concluded that 18 LEED credits or pre-requisites could satisfy the mandatory level of CALGreen, and that 23 total LEED credits could satisfy CALGreen Tier 1, and 27 total credits could satisfy CALGreen Tier 2. Conversely, 8 mandatory CALGreen provisions contribute towards attaining LEED points or pre-requisites, while 3 CALGreen Tier 1 and 4 CALGreen Tier 2 provisions also contribute.

Simon & Associates also separately reported in June 2010 that compliance with CALGreen mandatory would satisfy 7 LEED pre-requisites and 15 LEED credits; Tier 1 would satisfy 22 credits; and Tier 2 satisfied 34 credits. In April 2010, Global Green USA found that the mandatory provisions of CALGreen potentially satisfied 4 of LEED's 8 pre-requisites and could contribute about 15 points towards certification. The Global Green study further found that CALGreen Tier 1 (which includes CALGreen mandatory as a base) could contribute to achieving 5 pre-requisites and 30 points; and Tier 2 could contribute to achieving the same 5 pre-requisites and 40 points. In October 2010, Foctman and Shane found that CALGreen compliance does not meet the Energy and Atmosphere Pre-requisites in LEED 2009 and that mandatory CALGreen measures may enable to the attainment of 9 LEED points, while Tier 2 compliance could enable 27 points, less than the 40 points required for minimum certification.

Some additional mapping and comparison exercises have been done for 189.1 and LEED 2009, sometimes including IgCC. The U.S. Department of Energy mapped LEED 2009 credits to the June 2010 draft of 189.1 without evaluating stringency. The US Air Force Center for Engineering and the Environment studied the incremental cost of meeting 189.1 above other departmental requirements (including LEED certification) and created a side by side map of 189.1 to IgCC and the relevant LEED 2009 credits generally and in four specific projects, but did not compare the codes and LEED broadly.

Roberts, Lee, and Mehdizadeh compared CALGreen and 189.1 in "LEED Points Approximated" and visually showed increasing numbers of LEED points attained in increasing Tiers of CALGreen, but the totals are unclear. 189.1 buildings were shown to achieve somewhere between 40 and 50 LEED points, but the methodology is unclear. The authors also organized all code provisions, LEED pre-requisites, and LEED credits by category and assigned them darker shades of green based on "No Content", "Good", "Very Good" and "Leadership" to visually show the strengths of LEED and the codes. Visuals were developed for both maximum and minimum "Comparative Performance Intensity" that show breadth of coverage and simple stringency assessments on individual criteria, but broader conclusions are not clear beyond LEED and 189.1 having more green and darker green than mandatory CALGreen. Specific differences are also noted.

Similar to Roberts, Lee, and Mehdizadeh, the assessment methodology and visualization tool discussed in this paper intends to show the breadth of coverage and stringency (depth), but with a more transparent structure.

Framework

When confronted with the existence of green building codes and green building rating systems, the average policymaker or layperson will ask “which is more stringent?” in their desire to support the approach that achieves maximum impact. Unfortunately, the premise of this question is fundamentally flawed and places advocates of codes, rating systems, or both in the unenviable situation of explaining the nuances of the building process to a stakeholder for whom these details are complicated and confusing.

The inherently deterministic approach of a code, designed to be implemented as a regulation dictating mandatory minimum action, is fundamentally at odds with an aspirational green building rating system, in which only minimum prerequisites are mandatory while credits are voluntary and fluid, although achievement of a minimum number of credits is mandatory to earn certification. Certification confirms achievement of a minimum permutation of possible green building actions. Compliance with a code determines satisfaction of all mandatory actions.

To oversimplify, codes tell you what to do; rating systems tell the world how well you did. Since a building code instructs design teams on what to do when designing a new building, while a rating system evaluates the success of their design and construction against desired outcomes within a comprehensive framework, it is impossible to directly compare a code like Standard 189.1 to a rating system like LEED. The different pathways design teams can take to achieve their desired certification level in rating systems make direct comparison of a code and an entire rating system unachievable.

Flawed comparisons serve neither codes nor rating systems. Comparison of only mandatory requirements falsely implies that satisfying prerequisites is equivalent to certification. Comparison of actual buildings certified to a rating system will often reflect achievements beyond those required by a mandatory minimum code, implying a lack of stringency in the code. Out of context, neither tool will provide a proper vantage point.

The real questions that need answering are, “How should this (code or rating system) be implemented in policy?” and to follow, “Which (level of certification on a rating system) is best for this voluntary policy; which (code product) is best for this mandatory policy?”

USGBC determined that only an open “apples to apples” comparison of code provisions and the combinations of attained LEED credits – where possible (sourced from actual LEED achievement data) – would evolve this discussion. This would entail comparing the credit achievement of the average LEED Certified, Silver, Gold, and Platinum buildings to that of the buildings specified by the green codes on common, pre-defined metrics. Overall comparisons would arbitrarily combine sustainability metrics and add bias to the comparison by over- or under-weighting a category, like energy efficiency for example. On the contrary, comparing the modeled source energy use of the average LEED (Certified, Silver, Gold, or Platinum) building to the modeled source energy consumption of a building built to a green code provides useful information to policymakers, as well as code and rating system developers without conflating the roles of codes and rating systems.

This comparative exercise would demonstrate the effectiveness of both green codes and green building rating systems by documenting how building to a green code (or any code) achieves the outcomes that are evaluated, verified, and communicated by green building rating systems. Additional benefits include,

- Enabling a discussion about the co-evolution of codes and rating systems;
- Documenting the necessary information for additional codes or versions of codes for similar evaluation;
- Providing a venue for identifying ways to streamline documentation and compliance with both codes and rating systems;
- Engendering a discussion about the role of third party verification in achieving the desired outcomes shared across tools; and
- Showing the impact of removing critical code provisions before adoption.

Tool Development

To begin to make some of these comparisons on this framework, USGBC commissioned ICF International to build a comparison tool that would expand on this assessment methodology to enable a dynamic comparison – on specific, common metrics – between average LEED buildings at all certification levels and buildings constructed to green codes, and also visualize the results. Policymakers could utilize the conclusions drawn from this tool to understand how their mandatory policies with codes will map to their voluntary policies with rating systems.

The comparison tool is intended to be flexible and expandable to include new codes, updated rating systems, refined metrics and revised categorization. Eventually, this tool could be made public and utilize information developed by parties other than ICF and USGBC.

Breadth and Depth

For simplicity, the categories chosen for analysis were mapped to the five 2009 era LEED credit categories that are now part of the universal green building lexicon: Energy and Atmosphere, Sustainable Sites, Materials and Resources, Water Efficiency, and Indoor Environmental Quality. Within each category, two approaches for comparative analysis were possible: breadth and depth.

Most analyses preceding this effort appeared to focus far more on breadth than depth, unable to move to depth in the same framework or without access to data to enable the analysis. Depth analyses without fully incorporating the scope of unique green building ideas that are addressed in the various tools will lead to insufficient, inaccurate and misleading conclusions. While more remains to be built and explored, this comparative tool and assessment methodology would not be adequately robust without delving deep into each.

Breadth. An analysis based purely on breadth must be wide and detailed, even if only establishing basic connections between provisions. This analysis identifies the unique and shared content areas (or “bins”) of green building outcomes that code and rating system language intends to effect. In the breadth analysis, individual LEED credits are mapped to code provisions covering the same content and vice-versa. Areas covered by one and not another are equally identified and included. In several cases, an idea in one document was unique enough to stand alone, thus establishing the scope of addressed green building ideas (represented by these bins) that no code or rating system completely covers.

The breadth analysis defined the foundation for all comparisons in this study. IgCC, CALGreen, and Standard 189.1 provisions and all available LEED credits were mapped. Importantly, if a new code or rating system were to be introduced into the comparative tool, the assessment methodology requires first revisiting the breadth analysis to determine if the scope of green building ideas addressed by the set of codes and rating systems has grown. If so, additional bins may need to be added, or existing bins possibly modified.

Bins within the comparative tool were defined in columns and assigned weightings to account for the relative importance of each of the content areas that the bins represent. These weightings offer users the opportunity to prioritize the areas that are important to their community. The comparative tool allows for weighting along this scale, or endless variations based on areas of import.

The outputs of the weightings translate to the visualization tool, thus allowing the user a clearer view of the coverage of these green building content areas within the codes or rating systems. Conversely, users can also visualize the amount that may be left unaddressed if certain provisions are struck from an adopted version of the code, or if relevant LEED credits are not attained.

Credit achievement data of LEED buildings built to LEED 2009 were used to determine the profile of the LEED certified buildings. Green code compliant buildings were assumed to satisfy all the code provisions (i.e. 100% enforcement and compliance), but this assumption could be modified in future iterations of the tool based on further research.

Once the bins were set, the breadth exercise is essentially binary. Rating systems or codes either did or did not cover green building content areas. This coverage – or in LEED's case, attainment within the average LEED 2009 project profile – was represented by 100% or 0% values for the buildings compared. The only exception to the binary inputs in breadth analysis is in the Materials and Resources section, where the amount of materials, by percentage, of recycled, reused, recyclable, and local is easily determined from the provisions.

Comparison within each of these bins (rather than across the bins in the scope of the breadth analysis) falls within the scope of the depth analysis. For example, there are several ways to define access to thermal comfort controls or methods for determining what qualifies as a view to the exterior. Quantifying the differences in the effectiveness of these methods, while difficult in categories like this one, allows for further refining the comparison between the codes and rating systems. Similar to other comparisons done previously, only conclusions about the scope of coverage should be made from the breadth analysis.

Depth. A depth analysis is deep and detailed, but necessarily narrow. This analysis qualifies (and ultimately quantifies) nuances between the codes and rating systems being compared within a single content area (or "bin") that defines a green building outcome that code and rating system language intends to effect. The depth analysis therefore builds upon the breadth foundation, ensuring that only similarly intended code and rating system language is compared.

At this time, the depth approach has only been performed for the Energy and Atmosphere (EA) category. The depth approach involves identifying a metric (or metrics) within a category and conducting an analysis to determine each of the buildings' performance on that metric. In the case of EA, the buildings were modeled using ICF's Beacon Commercial™ with EnergyPlus Version 6. For simplicity, buildings were modeled in three 2009 IECC Climate Zones: CZ 3 – Los Angeles, CZ 4 – Sterling, VA, CZ 5 – Chicago, IL. These locations were selected as they provide a cross section of the moderate to cold climates in the United States.

In selecting the building types to model for this study, quantities and building types reported for buildings obtaining LEED certification compiled by USGBC were used to create overall weightings between building types that reflect the mix of buildings obtaining LEED certification. Using this mixture, building types in the LEED certification dataset were classified into the sixteen building types found in the Department of Energy's (DOE) Commercial Reference Buildings. During this process, the top six building types that comprised approximately 80% of the market were selected. These include: Large Office, Warehouse, Midrise Apartment, Primary School, Hospital, and Stand-alone retail.

The whole building energy simulations modeled in Beacon Commercial™ provided the site energy consumption for each of the selected building types, by location. This depth analysis enables the user to view the energy consumption data in three ways: site energy, source energy, and source emissions. Source energy data was calculated using the national site to source ratios determined by the U.S. EPA's *ENERGY STAR Performance Ratings: Methodology for Incorporating Source Energy Use*. These values equate to 3.34 source kWh for every site kWh and 1.047 source therms for every site therm.

The final data type, source emissions, was determined using the site electric and natural gas usage, and applying source emission factors contained within the U.S. EPA's Emission & Generation Resource Integrated Database (eGRID) database. For this study, national average greenhouse gas (GHG) emission factors were utilized due to the broad view of the study.

Visualized Output

The following figures and charts represent the conclusions of the breadth and depth analyses for all categories. In breadth, the percentages noted in the graphic describe the overall percentage of available bins covered by a product within the category. In depth, the Energy and Atmosphere category visualization for source energy, site energy, and emissions follows.

Breadth. The breadth analysis is only meant to demonstrate the scope of the usability of the tool and is not meant the enable conclusions about stringency, only coverage.

Figure 1. IEQ Breadth

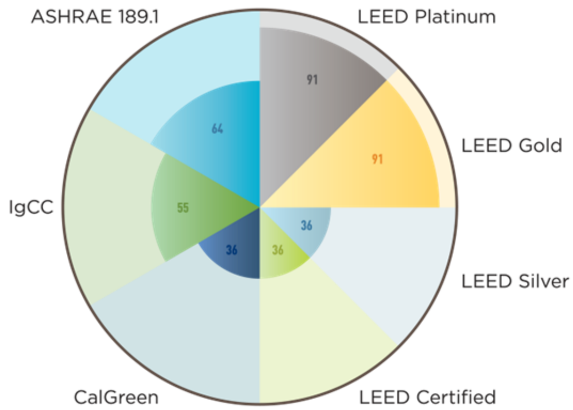
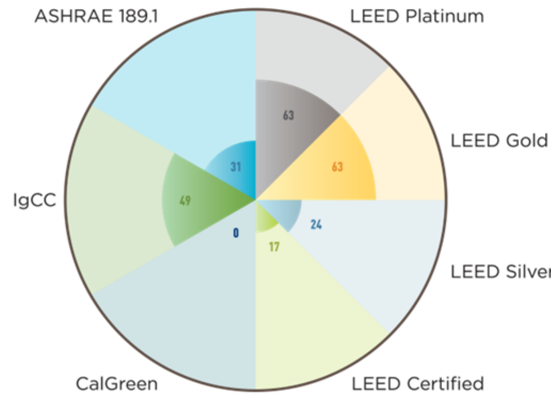


Figure 2. MR Breadth



Indoor environmental quality. The IEQ breadth analysis shows that LEED Gold and Platinum buildings generally show the most consideration for IEQ. Buildings built to both IgCC and standard 189.1 follow, with significant coverage of IEQ considerations. Only thermal and lighting control access separates the higher LEED tiers from 189.1, while IgCC has the only impact not accounted for in LEED or 189.1 with the "Lighting Comfort" provisions in section 808.3. LEED Certified and Silver buildings follow the national model green codes closely, while CALGreen shows the narrowest breadth of IEQ coverage.

Materials and resources. In MR breadth, LEED Gold and Platinum buildings perform the best due to high use of reused materials. IgCC buildings also are strong on MR with their focus on renewable materials and a unique provision on recyclable materials (Section 503.2.3). 189.1 followed by Silver and certified LEED buildings show some coverage of MR. CALGreen does not address the MR impacts attempted by the other products.

Figure 3. SS Breadth

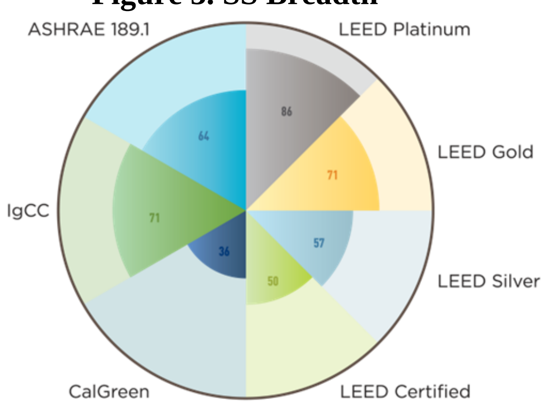
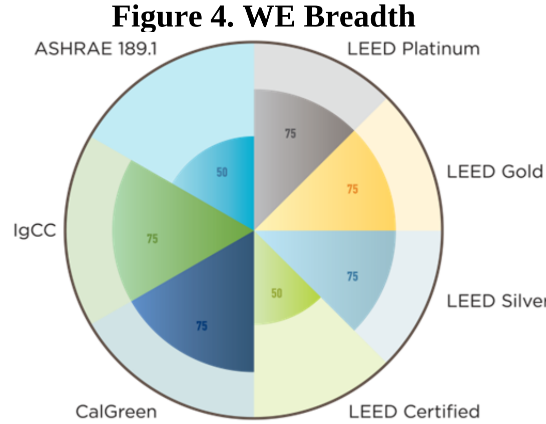


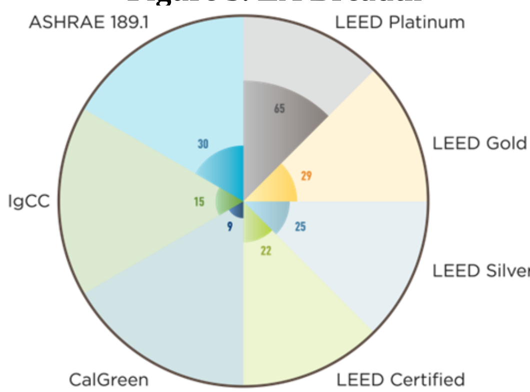
Figure 4. WE Breadth



Sustainable sites. All products pay significant attention to location and transportation. LEED Gold, Platinum, and IgCC buildings all show significant coverage. Platinum buildings generally address stormwater management, while lower levels of certification generally do not, while all the code products address the issue. Only LEED buildings address construction pollution prevention. IgCC shows the broadest coverage of all code products, matching Gold buildings. Certified, Silver and 189.1 buildings are all similar in coverage, though 189.1 does not address parking reduction. CALGreen shows the narrowest scope in SS.

Water efficiency. All the products address similar WE considerations. Certified buildings address the issue the least, though still significantly. Unlike other levels of LEED (and all the codes), Certified buildings do not generally pursue wastewater reduction. All other levels of LEED and all the green codes exhibit similar breadth. IgCC does not address landscaping water reductions but does include a unique consideration of water distribution.

Figure 5. EA Breadth



Energy and atmosphere. In EA, Platinum buildings again stand out for scope of coverage. Standard 189.1, Gold, Silver, and Certified are closely grouped, with IgCC and CALGreen following, respectively. Because so much of the emphasis in each of the products is energy use reduction, and all buildings do address it in some form, the depth analysis is far more important for this category and has been prioritized.

Depth: Energy and atmosphere. Depending on the metric chosen, the tool tells different stories about the effectiveness of the green codes and LEED certification levels. The most consistent is exceptionally high performance shown by LEED Platinum buildings, owing entirely to the combination of high attainment of energy efficiency and the development of on-site renewable energy.

Figure 6. EA Depth – Site Energy

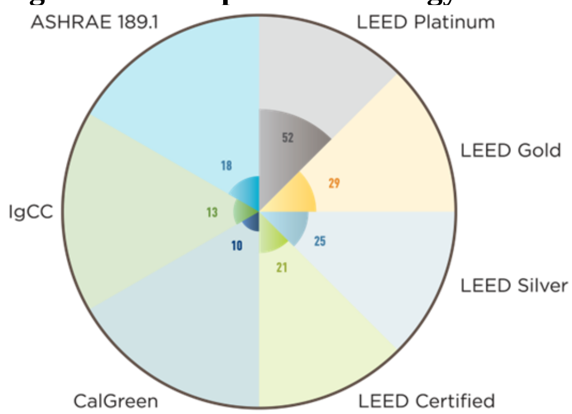


Figure 7. EA Depth – Source Energy

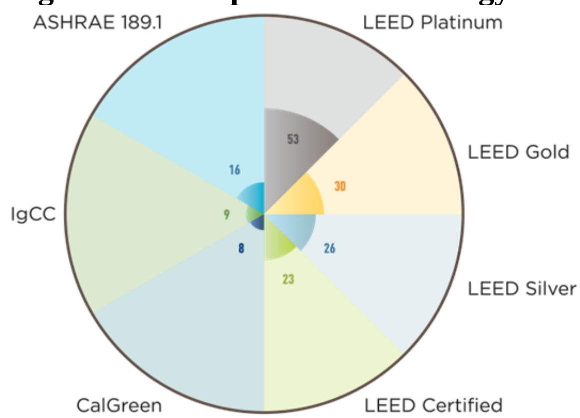
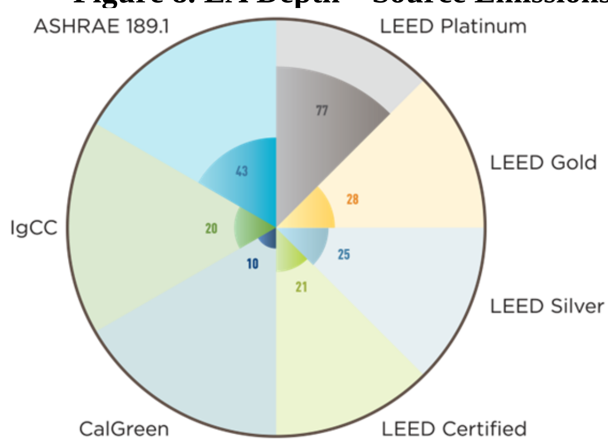


Figure 8. EA Depth – Source Emissions



Site energy. When modeled site energy consumption is chosen as the metric, Platinum buildings show a 52% reduction over the ASHRAE 90.1 2007 baseline, followed most closely by Gold buildings at 29%, Silver at 25% and Certified at 21%. Amongst the codes, 189.1 shows the most site energy reductions. Standard 189.1 includes a sizable requirement for on-site renewable energy systems, which contributes greatly to pulling its performance ahead of the other codes.

Source energy. When the tool is re-weighted to assess source energy, the order remains the same. Platinum building still excel, while the other certification levels demonstrate greater reductions and the green codes prescribe lower reductions.

Source emissions. In source emissions, a similar story is told, with the exception of a large increase in reductions shown by standard 189.1, outpacing all but Platinum buildings. Emissions savings are highly impacted by the use of on-site renewable energy systems – when the avoided grid-purchased electricity is taken into account, large emissions savings occur. In the case of 189.1, the renewable energy requirements are quantified on a per square foot basis rather than as a percent of total consumption. IgCC buildings also show improvement on source emissions, pulling roughly equivalent with Certified buildings.

Conclusions

The tool is able to apply a framework to compare the scope and outcomes produced through the appropriate use of codes and rating systems, where those comparisons are possible. Using this framework, the tool is then able to visualize the scope of coverage of the codes and rating systems while more clearly showing the impacts that can be expected to result from buildings built to comply with a green code. Similarly the tool illustrates the range of outcomes that can be expected should incentives be established for certification levels.

Now that the tool has provided a framework for discussion, it enables several areas for development and expansion. This could begin with an expansion of the Energy and Atmosphere depth analysis to include all IECC Climate Zones and all 16 DOE Commercial Reference Buildings. Additionally, because only the energy impacts were assessed in the depth framework, more research would be needed to include a depth analysis of the other four categories. Additional code products (CALGreen Tiers 1 and 2 for example) could be added to the comparison, as could the "as-adopted" versions of the national model codes.

The ability to individually weight green building outcomes adds a third dimension that complements the depth and breadth methodology. This is an area in which additional research is required and would allow for a more fine-tuned comparison. Currently, the breadth metrics are evenly weighted and the incorporation of informed statistical data would lead to a higher resolution comparison. One could use the weightings that determine the point distributions in the LEED rating system or data found in other independent studies to form the rationale for placing value on the weightings for each category.

Because of the framework, there is also the potential to move the analysis into other areas of building impacts. In this study, a 100% compliant green code building was considered, but field implementation and enforcement is far from perfect. Working another filter into the tool, similar to the weightings control, could lead to more accurate conclusions.

Ideally, the tool will continue to be built out by many parties and allow mutually beneficial identification of opportunities to streamline compliance with both green codes and rating systems where there are similar requirements and impacts. Similarly, the use of this tool to evaluate draft versions of future codes and rating systems could illuminate areas where requirements should be strengthened as a result of changes in market practice.

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Appendix

Example tables of inputs to visualization tool. Provided here are EA depth and MR breadth. All matrixes will be available online.

Table 1. Depth Table for Energy and Atmosphere

Standards	Code Reference Baseline Consumption	Energy Efficiency Savings	Renewable Energy Savings	Savings Total	Improvement over ASHRAE 90.1-2007
Energy Units	Site kBtu/ft^2	Site kBtu/ft^2	Site kBtu/ft^2	Site kBtu/ft^2	%
ASHRAE 90.1-2007	48.5	0.0	0.0	0.0	0%
ASHRAE 189-2009	48.5	4.9	4.0	8.9	18%
IgCC Public Version 2	51.4	7.4	2.1	9.4	13%
CalGreen	49.9	5.9	0.4	6.3	10%
LEED Certified	48.5	10.1	0.0	10.1	21%
LEED Silver	48.5	11.9	0.0	11.9	25%
LEED Gold	48.5	14.0	0.0	14.0	29%
LEED Platinum	48.5	22.3	2.9	25.2	52%
LEED 2009 Max	48.5	23.3	2.8	26.1	54%

Table 2. Breadth Table for Water Efficiency

Standards	WE Combined	Metrics			
		Water Use Reduction - Fixture	Water Use Reduction - Hot Water Distribution	Water Use Reduction - Landscaping	Wastewater Reduction
Tags		Water	Water	Water	Water
Weighting	100%	25.0%	25.0%	25.0%	25.0%
ASHRAE 189.1	50%	100%		100%	0%
IgCC	75%	100%	100%		100%
CalGreen	75%	100%		100%	100%
LEED Certified	50%	100%	0%	100%	0%
LEED Silver	75%	100%	0%	100%	100%
LEED Gold	75%	100%	0%	100%	100%
LEED Platinum	75%	100%	0%	100%	100%
-	0%				
-	0%				
LEED 2009 Max	75%	100%	0%	100%	100%