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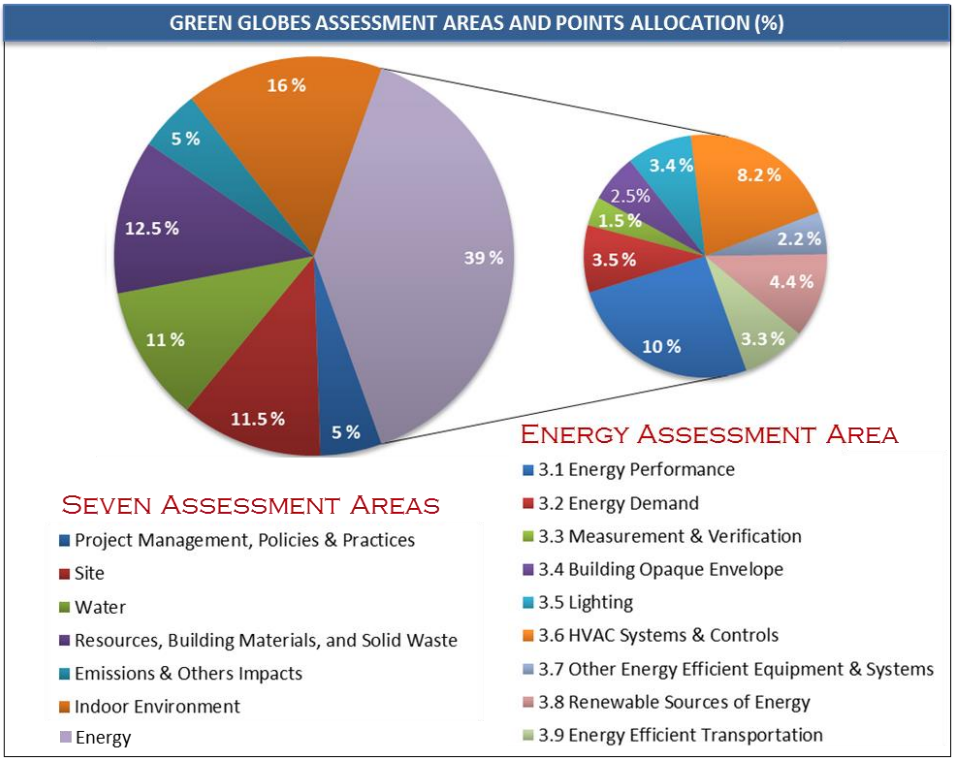
ENERGY ASSESSMENT & BUILDING ENERGY PERFORMANCE OPTIONS OF GREEN GLOBES FOR NEW CONSTRUCTION

Including an Overview of ENERGY STAR® Target Finder™, ASHRAE Std 90.1, ANSI/GBI 01-2010 and ASHRAE bEQ

Green Globes for New Construction (NC) advances the environmental performance and sustainability of buildings using seven assessment areas, namely Project Management, Site, Energy, Water, Resources & Materials, Emissions, and Indoor Environment. Out of the seven assessment areas, Energy is perhaps most significant, owing to the benefits of energy use reduction and direct cost savings to the owner. This assessment area is worth up to 39% of the maximum total points and has the greatest impact on the final Green Globes rating. It comprises nine sections for in-depth assessment of the various energy aspects and components.



The nine sections of the Energy assessment area employ both a performance and prescriptive approach and provide the flexibility and rigor necessary to achieve greater energy efficiency.

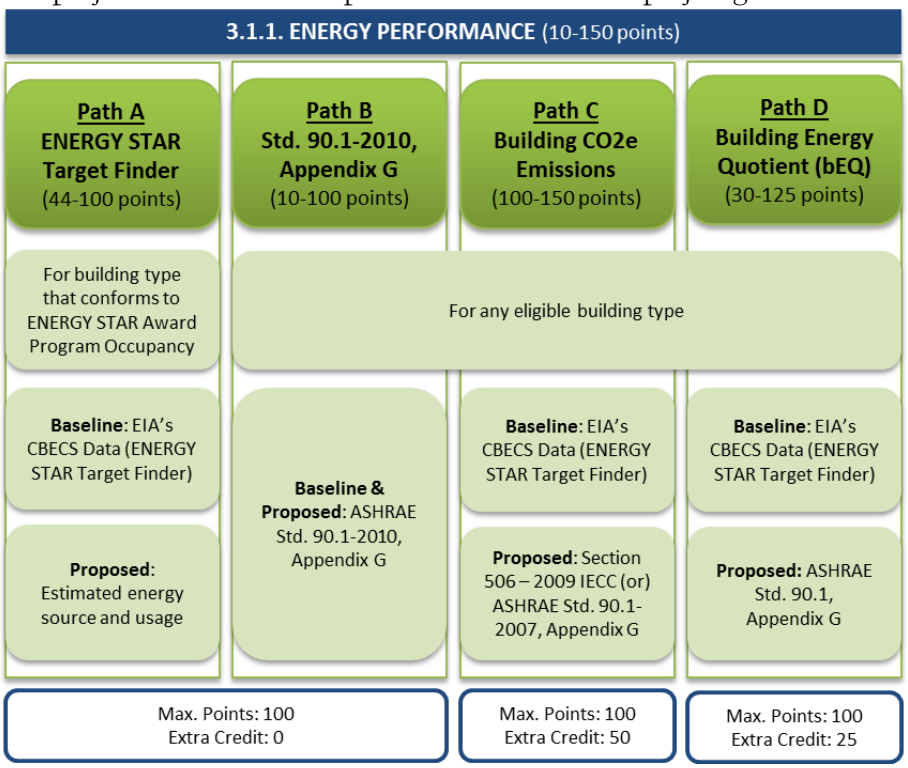
- The Energy Performance section provides four paths for evaluating the energy performance of new buildings and major renovations.
- The Energy Demand section includes four subsections to evaluate demand reduction.
- The Metering, Measurement, and Verification section allocates points based on energy demand and consumption metering of building components as well as program implementation based on the International Performance Measurement & Verification Protocol, Volume III, Option D.
- The Building Opaque Envelope section rewards strong thermal performance of envelope systems and optimal building orientation.

- The Lighting section offers points for lower lighting power density, lighting controls—namely automatic lighting shutoff and light reduction—and integrated daylighting for indoor spaces. In the same spirit, this section encourages energy reduction for exterior lighting systems through better lighting controls and energy efficient luminaires and lamps.
- The HVAC Systems and Controls section is composed of thirteen subsections that provide necessary rigor for designing high performance buildings. The subsections include building automation systems, cooling equipment and towers, heat pumps and equipment, condensate recovery, steam traps, domestic hot water heaters, variable speed control of pumps, reheat and re-cool systems, air economizers, fans and ductwork, and demand control ventilation systems.
- The Other Energy Efficient Equipment and Measures section offers points for variable refrigerant flow systems, regenerative brakes for elevators, and controls for escalators during low traffic hours.
- The Renewable Energy section focuses on both on-site and off-site renewable energy systems.
- The Energy Efficient Transportation section provides points for access to public transportation and cycling facilities at the project site.

Of the nine sections, Energy Performance is worth the most points at 100, which is 25.6% of the Energy assessment area and 10% of the maximum total points in Green Globes NC.

Building Energy Performance Paths

The latest version of Green Globes for New Construction offers four paths for evaluating energy performance. These paths were built on established standards or measures and are suited for the broadest range of users, some of whom might otherwise be discouraged by cost or difficulty of a single, prescriptive approach. Below is an overview of these four paths and their modeling methodology, evaluation, and points allotment criteria. In essence, the Energy Performance Paths of the newly enhanced version of Green Globes for New Construction provide flexibility for project teams to select a path that best suits their project goals.



The four paths for Energy Performance credit in Green Globes NC are as follows: Path A: ENERGY STAR Target Finder; Path B: ASHRAE Std. 90.1-2010 Appendix G; Path C: Building Carbon Dioxide Equivalent (CO_2e) Emissions (ANSI/GBI 01-2010); and Path D: ASHRAE Building Energy Quotient (bEQ). By using one of these paths, the project can achieve points toward the Energy assessment area and final Green Globes score if the associated thresholds are met. Each path has specific requirements as well as maximum points allowed, and some paths provide the opportunity to earn extra points for exemplary performance. To design buildings that minimize climate change, it is expected that the building stakeholders identify the most suitable path for achieving superior energy performance and Green Globes credit.

Each of the four Energy Performance Paths of Green Globes NC supports reduction in building energy use, but not all paths yield the same maximum point totals. The maximum total points possible in Path A is 100 compared to 150 in Path C. Tables I and II compare the energy performance paths for modeling methodology and evaluation criteria.

TABLE I. ENERGY PERFORMANCE PATHS – POINTS ALLOTMENT CRITERIA

ENERGY PERFORMANCE PATHS	POINTS			POINTS ALLOTMENT CRITERIA
	MAXIMUM (WITHOUT EXTRA POINTS)	EXTRA POINTS	MAXIMUM TOTAL POINTS	
Path A: ENERGY STAR Target Finder	100	0	**100**	1-74% Rating: 0 point 75% Rating: 44 points 76-78% Rating: 52 points 79-81% Rating: 60 points 82-84% Rating: 68 points 85-87% Rating: 76 points 88-90% Rating: 84 points 91-93% Rating: 92 points 94-100% Rating: 100 points
Path B: ASHRAE Std. 90.1-2010, Appendix G		0	**100**	1-4% Improvement: 0 point 5% Improvement: 10 points 6-50% Improvement: 12-100 points (2 points for each 1% improvement past 5%)
Path C: CO_2e Emissions		50	**150**	1-49% Reduction: 0 point 50% Reduction: 100 points 51-100% Reduction: 101-150 points (1 point for each 1% reduction past 50%)
Path D: bEQ Method		25	**125**	A+ Rating: 125 points A Rating: 100 points A- Rating: 60 points B Rating: 30 points

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TABLE II. ENERGY PERFORMANCE PATHS – MODELING METHODOLOGY			
ENERGY PERFORMANCE PATHS	**MODELING METHODOLOGY**		**EVALUATION CRITERIA**
	BASELINE	**PROPOSED**	
Path A: ENERGY STAR Target Finder	Energy Information Agency's CBECS (2003) data	Estimated energy sources and annual energy usage	Site Energy Use Intensity Unit: kBtu/sq.ft./yr.
Path B: ASHRAE Std. 90.1-2010, Appendix G	ASHRAE Std. 90.1-2010, Appendix G		Energy Cost Unit: $
Path C: CO_2e Emissions	ENERGY STAR Target Finder (Site EUI is 50% better than 50% Rating)	Section 506, 2009 IECC (or) ASHRAE Std. 90.1-2007, App G (Section G2.2 & Table G3.1)	CO_2e Emissions Unit: kg
Path D: bEQ Method	Energy Information Agency's CBECS (2003) data	Estimated energy sources and annual energy usage (ASHRAE Std. 90.1-2007) with normalized operational variables	Site Energy Use Intensity Unit: kBtu/sq.ft./yr.

Path A: ENERGY STAR Target Finder

The US Environmental Protection Agency's ENERGY STAR program offers a performance rating system through identifying Energy Use Intensities (EUIs). ENERGY STAR Target Finder uses the US Energy Information Agency's Commercial Building Energy Consumption Survey (CBECS) data to benchmark proposed building energy use. In other words, the actual data obtained from a national survey of energy-related building characteristics and energy consumption is used to determine an energy performance score for the estimated whole building energy use. Commercial buildings are rated on a scale of 1-100 based on Energy Use Intensity (EUI). With inputs such as building occupancy type, area, and fuel source and usage (derived from energy simulations), ENERGY STAR Target Finder compares the estimated EUI with actual EUI (derived from CBECS data) to calculate the energy performance score. For Path A, a 75% rating secures 44 points, 76-78% secures 52 points, and higher ratings secure an additional 8 points for every additional 3% increase (see Table III). The maximum points possible in this path are 100, and there are no extra points available. One shortcoming of ENERGY STAR Target Finder is that not all building occupancy types can be input for evaluation. For buildings that do not conform to ENERGY STAR occupancy types, other Green Globes Energy Performance Paths are available to pursue.

TABLE III. ENERGY PERFORMANCE PATH A – SCORING METHODOLOGY																
ENERGY STAR %:	100	99	98	97	96	95	94	93	92	91	90	89	88	87	86	85
Points:	100	100	100	100	100	100	100	92	92	92	84	84	84	76	76	76
ENERGY STAR %:	84	83	82	81	80	79	78	77	76	75	74 - 0					
Points:	68	68	68	60	60	60	52	52	52	44	0					

Path B: ASHRAE Std. 90.1-2010, Appendix G

ASHRAE Std. 90.1-2010 Appendix G, also referred to as the Performance Rating Method provides a procedure for evaluating the performance of all proposed designs, including alterations to existing buildings but excluding designs with no mechanical systems. ASHRAE Std. 90.1-2010 is a substantially improved standard compared to its 2007 version. Per this Standard, building energy models are prepared for both baseline and proposed cases. Several building components are modeled, including but not limited to the building envelope, HVAC, service water heating, power, lighting, equipment and renewable energy systems. The main purpose of the models is to compare their energy costs (using utility rate structure) and not their energy use or emissions. This approach, although successful in locations where peak shifting (i.e., utilities penalizing energy use during daytime peaks) is encouraged by using thermal energy storage systems, it may not necessarily reduce energy or emissions. There are limitations inherent to the modeling program and the models it generates. Furthermore, assumptions made about several factors affecting energy usage such as the occupancy, building operation and maintenance, weather, changes in energy rates, etc., will result in differences from the model to actual experience. Although models are meant to approximate the actual operation of the systems, it is difficult to predict unusual events. Also, the program assumes that the conditioning equipment works under ideal conditions for the entire year.

One important characteristic of complying with Appendix G protocol is the modeling of a hypothetical building as a baseline for comparison. While there are no published references, anecdotal evidence shows that energy modelers spend an overwhelming amount of time and effort developing a baseline model that complies with ASHRAE Std. 90.1-2010 Appendix G that could otherwise be spent on improving the proposed building model. For Path B, 10 points are awarded for a 5% improvement and 2 additional points can be achieved for every additional 1% improvement past 5% for a maximum total of 100 points. No extra points are available.

Path C: Building CO_2e Emissions (ANSI/GBI 01-2010)

In its broadest scope, sustainability seeks to offer a solution to the destruction of ecosystems through balanced development and promotion of environmental health and social equity. Building sustainability is no different, as environmental considerations have gained significant importance, particularly the emission of Green House Gases (GHGs). GHGs trap heat in the atmosphere and, similar to a glass roof of a greenhouse, make the earth warmer than it would otherwise be and cause lasting changes in the climate[1]. To address this issue, an ideal path to energy performance is required that uses an internationally accepted measure for highly effective assessment of building energy. The Green Globes Energy Performance Path C: ANSI/GBI 01-2010 Energy Performance Building Carbon Dioxide Equivalent Emissions is the perfect approach to building energy performance. This path addresses energy performance using Carbon Dioxide Equivalent emissions quantity as its measurement index and, consequently, gets to the bottom of the problem: emissions. In this path, Baseline and Proposed Equivalent Emission Rates (PER) are calculated to determine the percentage reduction in CO_2e emissions.

With a 50% reduction in CO_2e emissions over the Baseline Equivalent Emission Rate (BER), the proposed building will receive 100 points. For each reduction percentage above 50%, the proposed building can receive one bonus point, with a maximum of 50 bonus points (150 points total) for a 100% reduction. While BER is determined by ENERGY STAR Target Finder, PER is calculated using a building energy model that conforms

[1] Unlike other GHGs (Methane, Nitrous Oxide, Hydrofluorocarbons, Perfluorocarbons and Sulfur Hexafluoride), Carbon Dioxide make up the majority of human-generated GHG emissions. GHGs primarily enter the atmosphere through the burning of coal, oil, natural gas, solid waste, trees, and wood products.

to the requirements outlined in Section 506, 2009 International Energy Conservation Code or ANSI/ASHRAE/IESNA Standard 90.1-2007, Appendix G, Section G2.2 and Table G3.1. Although compliance with Standard 90.1 seems similar to Path B, there is one notable difference: BER calculations do not require a model of the hypothetical base building which, as previously discussed, is time-consuming. By using Path C, building stakeholders can focus on improving a proposed building's energy source and usage and compare them with actual building data rather than laboring over base building model protocols.

For building stakeholders, using Path C is a monumental opportunity to reduce operational energy use in buildings tracking CO_2e emissions. Moreover, this energy performance path is in line with the American Institute of Architects (AIA) "Architecture 2030 Challenge" in which new buildings and major renovations are designed to standards so that, by 2030, they will not operate on fossil fuel GHG-emitting energy. Both the Architecture 2030 Challenge and Path C observe similar protocols for baseline calculation, so architects using this approach can stay focused on the priority of designing carbon neutral buildings and communities by 2030.

Path D: ASHRAE bEQ As-Designed Rating

ASHRAE's new tool-based rating methodology for building energy use is the Building Energy Quotient (bEQ) program. This program relies on several standards and measures buildings both As-Designed and In-Operation. This path uses ASHRAE's bEQ As-Designed rating, which is based on simulated energy usage that is independent of operational and occupancy variables. A letter grade is assigned based on the ratio of a proposed building's EUI to the 50th percentile EUI of a target (baseline) building type by location. For example, a Zero Net Energy building would receive an A+; a High Performance building would receive an A; etc. While the proposed building's estimated energy usage and intensity are determined using the ASHRAE Std. 90.1 performance method, the baseline energy usage and intensity for ENERGY STAR eligible buildings are derived from ENERGY STAR Target Finder, and other buildings types directly from Commercial Buildings Energy Consumption Survey (CBECS). Both use actual data of comparative buildings. For this path, ratings B, A-, and A receive 30, 60, and 100 points respectively. If the proposed building achieves Zero Net Energy status (i.e., an A+ rating), 25 extra credit points are available for a total of 125 points.

Conclusion

In summary, the Energy assessment area of the latest version of Green Globes for New Construction offers increased flexibility to achieve a higher standard of building energy efficiency. As a crucial factor in the success of a high performance building project, the Energy area comprises 39% of the total maximum points possible for a Green Globes rating. Each of the nine sections in the Energy area provides specific objectives for energy efficiency. Among these, the Energy Performance section, with its four paths, provides an array of options to benefit the broadest range of users and building types.

In addition, the four paths for evaluating building energy performance are based on building science and established standards. As opposed to using a single, prescriptive approach, this enhanced version of Green Globes for New Construction offers stakeholders the opportunity to select their preferred energy performance path based on its applicability to their project and requirements. Each of the four paths firmly supports reduction in building energy use. Furthermore, exemplary performance is rewarded with extra points through Paths C & D to encourage stakeholders to go above and beyond standard compliance.

Thus, the Green Globes Energy assessment area not only encourages better energy performance and reduced environmental impact but also rewards stakeholders with a considerable number of points towards a Green Globes rating.

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ABOUT THE AUTHOR

Ravi Srinivasan is Assistant Professor of Low / Net Zero Energy buildings at the M.E. Rinker, Sr. School of Building Construction, University of Florida. Prior to joining University of Florida, he was working as the Director of Technology and Innovation at the Green Roundtable in Boston. Dr. Srinivasan is a member of the National Fenestration Research Council (NFRC) ANS Standards Committee. He was one of the Subject Matter Experts for NREL's Commercial Workforce Development Team to create national guidelines for Building Energy Modeling. The Net Zero Energy training program he developed was awarded 2010's "Most Innovative Product" by the Massachusetts USGBC chapter. Dr. Srinivasan holds an M.S. in Civil Engineering from the University of Florida and an M.S. and Ph.D. in Architecture from the University of Pennsylvania. Dr. Srinivasan is a Certified Energy Manager.