# High-Performance Building Certification System Review

## Findings Report

Anna E. Bower

Keith E. Bryan

Kelli J. Canada

Kaitlyn A. Carter

Lisa M. Watts

Prepared for the U.S. General Services Administration by LMI.

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# Acknowledgements

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The following building certification system owners responded to the request for information regarding their systems:

- Elizabeth Beardsley, Leadership in Energy & Environmental Design (LEED®)
- Alison Capen, Living Building Challenge™
- John Smiciklas, BOMA BEST® Sustainable Buildings
- Micah Thomas, Green Globes®
- Breana Wheeler, Building Research Establishment's Environmental Assessment Method (BREEAM®) USA.

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# Executive Summary

Section 436(h) of the Energy Independence and Security Act of 2007 (EISA) (42 U.S.C. 17092) requires the General Services Administration's (GSA's) Office of Federal High-Performance Buildings to complete a review of high-performance building certification systems (building certification systems) every 5 years. After the review, GSA recommends to the Secretary of Energy the building certification systems most likely to encourage a comprehensive approach to certification of high-performance buildings.

GSA researched the U.S. market for whole-building certification systems. This screening identified six systems (one system, Earth Advantage, declined to participate):

1. BOMA BEST® Sustainable Buildings, version 3.0
2. Building Research Establishment's Environmental Assessment Method (BREEAM®) In-Use USA, version 2016
3. Green Globes®, version 2013
4. Leadership in Energy & Environmental Design (LEED®), version 4.0
5. Living Building Challenge (LBC™), version 3.1

GSA invited system owners to complete a survey, which asked for information on the technical components of the certification system that address federal high-performance building requirements and industry best practice (effectiveness criteria, Table 2-1) as well as the processes by which the system was created and awards certification (development and conformance criteria, Table 2-2). GSA developed the list of effectiveness criteria and development and conformance criteria based on specific building requirements found in:

- The Green Building Certification Systems Requirement for New Federal Buildings and Major Renovations of Federal Buildings Final Rule,[1] Department of Energy (DOE) Rule.
- EISA.

[1] [6450-01-P] Department of Energy 10 Code of Federal Regulations Parts 433, 435 and 436 [Docket No. EE RM/STD-02-112] RIN 1904-AC13. Available at https://www.energy.gov/eere/femp/downloads/green-building-certification-systems-requirement-new-federal-buildings-and-major.

- The 2016 Guiding Principles for Sustainable Federal Buildings (Guiding Principles).[2]

Using the results of an independent verification and evaluation of the survey responses, GSA determined whether the building certification systems demonstrate alignment with the effectiveness criteria and development and conformance criteria. Table ES-1 summarizes the findings of this review related to the effectiveness criteria. GSA evaluated 39 sub-criteria for new construction and building interior systems and 36 sub-criteria for existing buildings systems.

***Table ES-1. Summary of Review Findings, Effectiveness Criteria***

| *Effectiveness Criteria Findings* | | | |
|---|---|---|---|
| | The number of federal sub-criteria met by system | The number of federal sub-criteria partially met by system | The number of federal sub-criteria not met by system |
| | ✔ | ! | ✖ |
| **New Construction and Major Renovation Building Certification Systems** | | | |
| LEED BD+C | 29 | 8 | 2 |
| Green Globes NC | 29 | 8 | 2 |
| LBC NC | 22 | 12 | 5 |
| **Existing Building Certification Systems** | | | |
| LEED O&M | 24 | 8 | 4 |
| Green Globes EB | 14 | 16 | 6 |
| LBC EB | 22 | 9 | 5 |
| BREEAM | 16 | 14 | 6 |
| BOMA | 18 | 14 | 4 |
| **Building Interior Certification Systems** | | | |
| LEED ID+C | 22 | 9 | 8 |
| Green Globes Interiors | 12 | 9 | 18 |
| LBC Interiors | 22 | 12 | 5 |

Note: The number of effectiveness sub-criteria met by system (✔), partially met by system (!), or not met by system (✖). Acronyms: Building Design and Construction (BD+C), New Construction (NC), Operations and Maintenance (O+M), Existing Buildings (EB), and Interior Design and Construction (ID+C).

Table ES-2 summarizes alignment with the seven development and conformance sub-criteria selected to assess how the process for developing the building certification system and awarding certification aligns with requirements in EISA and the DOE Rule. Appendix A includes results on usability in narrative form, as well as general system overview information.

[2] Available at: https://www4.eere.energy.gov/femp/requirements/guidelines_filtering.

***Table ES-2. Summary of Review Findings, Development and Conformance Criteria***

| *Development and Conformance Criteria Findings* | | | | | | |
|---|---|---|---|---|---|---|
| Criteria | Sub-criteria | LEED | Green Globes | LBC | BREEAM[c] | BOMA[c] |
| Process for Developing and Administering the Certification System | Consensus-based approach | ✓ | ✓ | ✗ | ✗ | ✓ |
| | Transparency | ✓ | ✓ | ! | ✓ | ✓ |
| | Usability[a] | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Maturity | ✓ | ✓ | ✓ | ✓ | ✓ |
| Conformity Assessment | Independence | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Verification[b] | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Post Occupancy evaluation | ✓ | ! | ✓ | ✓ | ✓ |

[a] See Appendix A for more information about the cost of each system.

[b] Not included in DOE rule.

[c] The DOE rule does not apply to systems certifying existing buildings. The rule does apply to new construction and major renovations of projects that are above the prospectus threshold; however, these major renovations are captured in the new contruction systems.

While each system addresses the primary criteria which define high-performance buildings, no single system fully ensures compliance with all the federal building requirements. Although each building certification system offers a unique framework and approach to achieving building certification, they all generally agree on the aspects of building design, construction, operation, and maintenance that lead to high-performing commercial office buildings.

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# Chapter 1
# Purpose of Review

Section 436(h) of the Energy Independence and Security Act of 2007 (EISA) (42 U.S.C. 17092) requires the General Services Administration's (GSA's) Office of Federal High-Performance Buildings to evaluate and compare high-performance building certification systems (building certification systems) every 5 years. After the review, GSA recommends to the Secretary of Energy the building certification systems most likely to encourage a comprehensive approach to certification of high-performance buildings. This review examines detailed information about how the requirements of each building certification system align with high-performance building requirements used by the federal government. Appendix A includes additional background information, including the statutory drivers that establish the federal building requirements.

This report objectively summarizes the findings of GSA's building certification system review. The information from this report will inform the development of a recommendation from the GSA Administrator to the Secretary of Energy.

## Building Certification Systems

Building certification systems focus on an integrated design approach to building projects in order to both reduce impacts on the environment and improve efficient use of resources throughout a building's lifecycle. They offer both design and operational guidance to achieve a set of specified criteria and reward relative levels of achievement for meeting environmental goals and requirements.[3] They evaluate buildings' conformance to the system standards. This review does not include building certification systems that focus on building attributes (e.g., single sustainable product certifications or single aspects of building performance such as energy efficiency) or a limited scope of building attributes, even if they have a similar purpose of improving building performance (see Appendix A).

## Federal Use of Building Certification Systems

EISA does not require federal agencies to use building certification systems, although agencies may choose to do so to support conformance with federal high-performance building requirements in statutes and executive orders, as well as the Guiding Principles for Sustainable Federal Buildings (Guiding Principles). While the achievement of a building certification does not guarantee compliance with all federal requirements for new and existing buildings, the use of building certification systems has advantages for federal agencies.[4]

[3] For an expanded definition, see the Whole Building Design Guide: https://www.wbdg.org/resources/green-building-standards-and-certification-systems.

[4] List of advantages adapted from GAO-15-667 Report: "Federal Efforts and Third-Party Certification Help Agencies Implement Key Requirements, but Challenges Remain," https://www.gao.gov/assets/680/671618.pdf and feedback from past GSA reviews.

Certification systems:

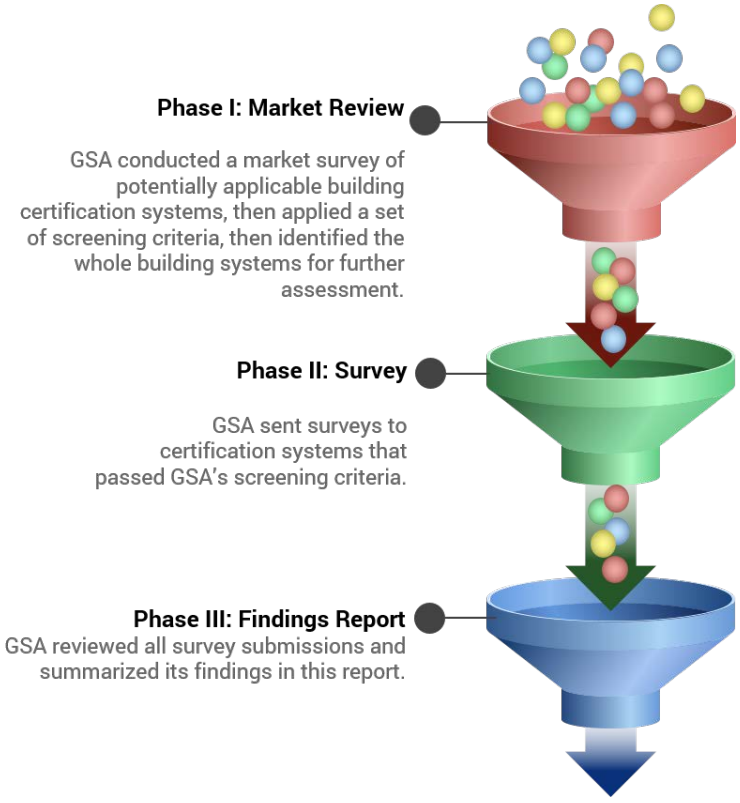
- Provide a well-established framework for documenting and ensuring compliance with energy, water, materials, and indoor environmental quality requirements
- Open up additional strategies and opportunities for building efficiency improvements by encouraging a holistic, integrated approach to building performance
- Are useful in connecting the federal sector with the current, commercially available private sector standards
- Serve as a tool to communicate with contractors and the public
- Reduce the need for additional staff to verify that a building meets requirements
- Are cheaper and preferable to developing an internal, proprietary, and/or non-consensus certification system (at the federal and/or agency level). The National Technology Transfer and Advancement Act directs federal agencies to use existing consensus-based certification systems or standards in the private sector where available.

# Chapter 2
# Review Method

## Review Approach

Figure 2-1 depicts the three phases of GSA's review of building certification systems. In Phase I, GSA identified applicable building certification systems based on four screening criteria that align with EISA requirements and The Green Building Certification Systems Requirement for New Federal Buildings and Major Renovations of Federal Buildings Final Rule, Department of Energy (DOE) Rule.[5,6] In Phase II, system owners completed a survey to demonstrate alignment with GSA's effectiveness criteria and development and conformance criteria.[7] In Phase III, GSA verified and evaluated the survey responses and system alignment with the effectiveness criteria and development and conformance criteria. This report summarizes the methods and results of each phase.

***Figure 2-1. GSA's Building Certification System Review Process***




[5] https://www.energy.gov/eere/femp/downloads/green-building-certification-systems-requirement-new-federal-buildings-and-major.

[6] Phase I completed in August 2017.

[7] Phase II completed in February 2018.

# Phase I: Market Review

To identify systems that fall within the scope of this review, GSA screened the market for all commercially available building certification systems as of the end of calendar year 2017. GSA applied the following four screening criteria, which are aligned with EISA requirements and the DOE Rule, to select building certification systems that qualified for further review. Qualified systems:

1. Are currently available for use in the U.S. commercial buildings market and not limited to one climate zone or geographic region
2. Address buildings (rather than individual products) with multiple performance and sustainable design attributes from EISA, including energy, water, materials, and indoor environmental quality
3. Award certification based on validation by an independent, third-party assessor
4. Incorporate, where feasible, measurable or calculated metrics to assess building performance.[8]

GSA found over 100 building certification systems[9] available in the market. The following six systems met the initial screening criteria for further assessment:

1. BOMA BEST® Sustainable Buildings, version 3.0 (http://www.bomabest.org), developed by the Building Owners and Managers Association (BOMA) of Canada
2. Building Research Establishment's Environmental Assessment Method (BREEAM®) In-Use USA, version 2016 (http://www.breeamusa.com), developed by BREEAM USA
3. Earth Advantage Commercial (EAC) Program, version 2.1 (https://www.earthadvantage.org), developed by Earth Advantage
4. Green Globes®, version 2013 (http://www.thegbi.org), developed by the Green Building Initiative
5. Leadership in Energy & Environmental Design (LEED®), version 4.0 (https://new.usgbc.org/leed), developed by the U.S. Green Building Council (USGBC)
6. Living Building Challenge (LBC™), version 3.1 (https://living-future.org/lbc), developed by the International Living Future Institute).

GSA notified these six building certification system owners in December 2017 of its intent to review their building certification system. The six system owners expressed interest in participating, but EAC notified GSA that lack of third-party assessors with current credentials to review and certify buildings made the system unavailable throughout the United States. Therefore, GSA removed EAC from further review.[10]

[8] For example, the criteria prefer directly measuring a building's generated waste (quantitative) to baseline and reduce over time rather than simply developing a waste management plan (qualitative, suggesting only evidence of intent to reduce building waste).

[9] See Appendix B for full list of systems.

[10] The market review relied only on publically available information, and the Earth Advantage website stated that the certification system could be used anywhere in the United States.

GSA identified specific criteria and sub-criteria to evaluate system development, how projects achieve certification, and how effectively the systems align with specific federal building requirements. GSA based these criteria on EISA Section 436(h), the DOE Rule, the Guiding Principles, and other federal drivers (listed in Appendix A). The criteria are divided into two broad categories:

1. Effectiveness Criteria
2. Development and Conformance Criteria.

## Effectiveness Criteria

These criteria evaluate the technical components of the certification system that align with federal high-performance building requirements in the Guiding Principles (for both new construction and existing buildings), EISA, and industry best practices. Table 2-1 lists each criteria and sub-criteria and includes the requirements and/or compliance metrics language from the Guiding Principles.

***Table 2-1. Effectiveness Criteria and Sub-Criteria Descriptions***

| Effectiveness criteria | Sub-criteria | Guiding Principles language |
|---|---|---|
| Healthy, Effective Environments | Ventilation and thermal control | Meet current American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standards 55 and either 62.1 or 62.2 for ventilation and thermal comfort. [Compliance metric] |
| | Daylighting and lighting controls | Maximize opportunities for daylighting in regularly occupied space, automatic dimming controls or accessible manual controls, task lighting, and shade and glare control. [Compliance metric] |
| | Indoor air quality (IAQ) plans | Develop and implement an IAQ policy that considers the following: moisture control, use of low emitting materials and products with low pollutant emissions, necessary protocols to protect IAQ during construction and in the finished building, prohibition of smoking in any form inside and within 25 feet of all building entrances, operable windows, and building ventilation intakes, and use of integrated pest management techniques. [Compliance metric] |
| | Radon detection | Test for radon in buildings and mitigate high levels. |
| | Moisture control | Establish policy and implement a moisture control strategy to prevent building materials damage, minimize mold growth, and reduce associated health risks. |
| | Low-emitting materials | Use low emitting materials for building construction, modifications, maintenance, and operations. In particular, specify the following materials and products to have low pollutant emissions: composite wood products, adhesives, sealants, interior paints and finishes, solvents, carpet systems, janitorial supplies, and furnishings. |
| | Protecting IAQ during construction | Establish a policy and implement necessary protocols to protect IAQ during construction and in the finished building. |
| | Environmental smoking control | Prohibit smoking in any form within the building and within 25 feet of all building entrances, operable windows, and building ventilation intakes. |
| | Integrated pest management | Use integrated pest management techniques as appropriate to minimize pesticide usage. |
| | Occupant health and wellness | Promote opportunities for voluntary increased physical movement of building occupants such as making stairwells an option for circulation, active workstations, fitness centers, and bicycle commuter facilities; and support convenient access to healthy dining options, potable water, daylight, plants, and exterior views. [Compliance metric] |

### *Table 2-1. Effectiveness Criteria and Sub-Criteria Descriptions*

| Effectiveness criteria | Sub-criteria | Guiding Principles language |
|---|---|---|
| Energy Efficiency | Predicted or modeled energy use reduction | Employ strategies that minimize energy usage. Focus on reducing energy loads before considering renewable or clean and alternative energy sources.[a] |
| | Actual energy use reduction | For new construction, ensure energy efficiency is 30% better than the current ASHRAE Standard 90.1, OR<br>For modernization, ensure:<br>1) Energy use is 20% below the fiscal year (FY) 2015 energy use baseline, OR<br>2) Energy use is 30% below the FY 2003 energy use baseline, OR<br>3) The building has an ENERGY STAR® rating of 75 or higher, OR<br>4) For building types not in ENERGY STAR Portfolio Manager, where adequate benchmarking data exists, the building is in the top quartile of energy performance for its building type.<br>[Compliance metric] |
| | ENERGY STAR® products | For new construction and modernization, use energy efficient products, as required by statute. [Compliance metric]<br>Buy either ENERGY STAR products or products designated as energy efficient by the Federal Energy Management Program (FEMP) [Energy Policy Act of 2005 Section 131]. |
| | Renewable energy | Evaluate and implement, where appropriate, lifecycle cost-effective renewable energy projects onsite; consider long-term offsite renewable sources and Renewable Energy Certificates (RECs). [Compliance metric] |
| | Clean and alternative energy | Utilize clean and alternative energy where possible. |
| | Metering | Install building level meters for electricity, natural gas, and steam; install advanced or standard meters as appropriate. [Compliance metric] |
| | Benchmarking | Benchmark building performance at least annually, preferably using ENERGY STAR Portfolio Manager; regularly monitor building energy performance against historic performance data and peer buildings. [Compliance metric] |
| Water Use Efficiency and Management | Predicted or modeled water use reduction | Employ strategies that minimize water use and waste.[a] |
| | Actual indoor water use reduction | Employ strategies that minimize water use and waste. |
| | Actual outdoor water use reduction | Employ strategies that minimize water use and waste. |
| | Water conserving products | Purchase water conserving products, including WaterSense and FEMP-designated products, as required by statute. |
| | Meters | Install building level water meters to allow for the management of water use during occupancy, including detection of leaks.<br>Install water meters for irrigation systems serving more than 25,000 square feet of landscaping. |
| | Cooling towers | Optimize cooling tower operations; and eliminate single pass cooling. |

### *Table 2-1. Effectiveness Criteria and Sub-Criteria Descriptions*

| Effectiveness criteria | Sub-criteria | Guiding Principles language |
|---|---|---|
| | Water-efficient landscapes | Use water efficient landscapes, AND limit potable water use for irrigation to 50% or more below conventional practices using methodologies from (but not the numeric requirements contained in) ASHRAE standard 189.1 2014 section 6.5.1, or current comparable ASHRAE standards, to calculate water use of conventional practices. [Compliance metric] |
| | Alternative sources of water | Implement cost effective methods to utilize alternative sources of water such as harvested rainwater, treated wastewater, air handler condensate capture, grey water, and reclaimed water, to the extent permitted under local laws and regulations. |
| | Stormwater management | For new construction, meet or exceed EISA section 438 stormwater management requirements [Compliance metric].<br>Employ strategies that reduce stormwater runoff and discharges of polluted water offsite to protect the natural hydrology and watershed health. |
| Solid Waste Diversion | Space for collection and storage of recyclables | Incorporate appropriate space, equipment, and transport accommodations for collection, storage, and staging of recyclable and, as appropriate, compostable materials in building design, construction, renovation, and operation. Provide reuse and recycling services, including composting, for building occupants, where markets or onsite recycling exist. |
| | Construction waste management | Where markets exist, divert at least 50% of construction and demolition materials from landfills. [Compliance metric] |
| | Waste diversion for occupants | Where markets exist, provide reuse and recycling services for building occupants and divert at least 50% of non-hazardous, non-construction related materials from landfills. [Compliance metric] |
| Sustainable Procurement | Recycled content | Use Resource Conservation and Recovery Act (RCRA) section 6002 compliant products that meet or exceed the Environmental Protection Agency's (EPA's) recycled content recommendations for building construction, modifications, operations, and maintenance. |
| | Biobased content | Per section 9002 of the Farm Security and Rural Investment Act (FSRIA), for U.S. Department of Agriculture (USDA)-designated products, use products with the highest content level per USDA's biobased content recommendations. |
| | Environmentally preferable products | Purchase products that meet Federally Recommended Specifications, Standards, and Ecolabels or are on the Federal Green Procurement Compilation. |
| | Ozone depleting compounds | Avoid ozone depleting compounds and high global warming potential (GWP) chemicals. [Compliance metric] |
| Siting | Access to public transportation | Prioritize sites that offer robust transportation options, including walking, biking, and transit, and minimize the combined greenhouse gas emissions of the building and associated commuter and visitor transportation emissions over the project's life. |
| | Access to public amenities and neighborhood assets | Leverage existing infrastructure, and align, where possible, with local and regional planning goals; protect natural, historic, and cultural resources. |
| | Floodplain avoidance | For new construction, avoid, to the extent possible, the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and avoid floodplain development whenever there is a practicable alternative. |

***Table 2-1. Effectiveness Criteria and Sub-Criteria Descriptions***

| Effectiveness criteria | Sub-criteria | Guiding Principles language |
|---|---|---|
| | Occupant transportation emissions | Prioritize sites that offer robust transportation options, including walking, biking, and transit, and minimize the combined greenhouse gas emissions of the building and associated commuter and visitor transportation emissions over the project's life. |
| | Protection of historic resources | Leverage existing infrastructure, and align, where possible, with local and regional planning goals; protect natural, historic, and cultural resources.[a] |
| | Bicycling options | Where feasible, promote opportunities for voluntary increased physical movement of building occupants such as making stairwells an option for circulation, active workstations, fitness centers, and bicycle commuter facilities; and support convenient access to healthy dining options, potable water, daylight, plants, and exterior views. [Compliance metric] |

[a] Applicable to new construction and major renovation building certification systems. Not used to assess existing building certification systems in this review.

## Development and Conformance Criteria

GSA created the development and conformance criteria (Table 2-2) to assess the processes by which the system was created and awards certification. These criteria are based on requirements from EISA and the DOE Rule. GSA also worked with the EPA to align methods and terminology with the EPA Guidelines for the Assessment of Environmental Performance Standards and Ecolabels for Federal Procurement for consistency with a related federal effort to recognize systems and standards that certify products.[11] GSA added one additional sub-criterion, "usability," to evaluate the cost for completing the certification process and describe any project support offered to achieve certification.

***Table 2-2. Development and Conformance Criteria and Sub-Criteria Descriptions***

| Development and conformance criteria | Sub-criteria | EISA/DOE Rule language |
|---|---|---|
| Process for Developing and Administering the Building Certification System | Consensus-based approach | 42 U.S.C. 17092(h)(2)(D): the ability of the standard to be developed and revised through a consensus-based process. |
| | Transparency | 42 U.S.C. 17092(h)(2)(C): the ability of the applicable standard-setting organization to collect and reflect public comment. |
| | Usability | 42 U.S.C. 17092(h)(2)(E): affordable cost of use; the building certification system organization offers product support. |
| | Maturity | DOE Rule 10 Code of Federal Regulations (CFR) Parts 433, 435, and 436, Green Building Certification Systems for Federal Buildings: the system under which the building is certified must be subject to periodic evaluation and assessment of the environmental and energy benefits that result under the rating system (part 433.33(b)(4)). |

[11] https://www.epa.gov/greenerproducts/guidelines-assessment-environmental-performance-standards-and-ecolabels-federal.

***Table 2-2. Development and Conformance Criteria and Sub-Criteria Descriptions***

| Development and conformance criteria | Sub-criteria | EISA/DOE Rule language |
|---|---|---|
| Conformity Assessment | Independence | 42 U.S.C. 17092(h)(2)(B): the ability and availability of assessors and auditors to independently verify the criteria and measurement of metrics. |
| | Verification | 42 U.S.C. 17092(h)(2)(B): the ability and availability of assessors and auditors to independently verify the criteria and measurement of metrics. |
| | Post-occupancy evaluation | DOE Rule 10 CFR Parts 433, 435 and 436: Green Building Certification Systems for Federal Buildings: The system under which the building is certified must include a verification system for post occupancy assessment of the rated buildings to demonstrate continued energy and water savings at least every four years after initial occupancy (part 433.300(b)(5)). |

# Phase II Survey

Certification system owners are most knowledgeable about how their system was developed, which technical components of building performance are assessed, and how projects achieve certification; therefore, GSA asked the system owners to complete an information survey to inform GSA's review (Appendix C).

GSA designed the survey to collect information to determine system alignment with the effectiveness criteria (Table 2-1) and development and conformance criteria (Table 2-2). GSA distributed the survey via an electronic form that consisted of a combination of multiple choice and free-form responses with options to attach supporting documentation as necessary (Appendix C). The survey contains three major components:

1. Part I. General information, such as the name of system, contact information for the representative completing the survey, and the system's public website. Each system owner completed this section only once.
2. Part II. Information on how the system supports the effectiveness criteria and sub-criteria, with supporting justification. System owners completed this part for each applicable certification system, e.g., new construction and existing buildings.
3. Part III. System development and conformity assessment. Each system owner completed this section only once.

GSA sent out the system owner survey in December 2017 indicating which rating systems to include (e.g., new construction, existing buildings) and requested the surveys be completed within 60 days. GSA recorded an informational webinar and provided additional background to the system owners to further clarify the intent and scope of the certification system review. GSA invited system owners to submit clarifying questions after reviewing the survey templates and shared all questions and responses with the system owners to aid in survey completion (see Appendix C). GSA received all completed surveys and supporting documentation by February 2018. Appendix C includes a sample of the system owner survey while Appendix D contains the completed surveys as submitted to GSA.

## Phase III: Findings Report

GSA conducted an independent verification and evaluation of the submitted survey responses. The independent review process verified the following:

1. Completeness of the answers
2. Accuracy of the answers
3. Alignment of the building certification system with the effectiveness criteria and development and conformance criteria.

GSA commissioned the Rocky Mountain Institute (RMI) to review all submitted survey responses. GSA supplied RMI with a template to ensure a consistent process and documentation across their review. RMI first confirmed the completeness and accuracy of the survey responses by analyzing the system owner's documentation and publicly available information. RMI reviewers noted all unanswered, incomplete, factually incorrect, and unclear responses. RMI reviewers then assessed the alignment of the building certification system with the effectiveness criteria and development and conformance criteria. GSA corresponded directly with system owners to request clarifying information.

After the completion of RMI's review, GSA used RMI's templates as the basis for forming this report's findings (see Chapter 3). Appendix E details each survey response and GSA's findings.

# Chapter 3
# Findings

GSA evaluated the following systems and organized findings based on building certification system type:

- New construction and major renovations
  - LEED v4 for Building Design and Construction (LEED BD+C)
  - Green Globes for New Construction (Green Globes NC)
  - Living Building Challenge for New Construction (LBC NC)
- Existing buildings
  - LEED v4 for Building Operations and Maintenance (LEED O+M)
  - Green Globes for Existing Buildings (Green Globes EB)
  - Living Building Challenge for Existing Buildings (LBC EB)
  - BREEAM USA In-Use (BREEAM)
  - BOMA BEST Sustainable Buildings (BOMA)
- Building interiors
  - LEED v4 for Interior Design and Construction (LEED ID+C)
  - Green Globes for Sustainable Interiors (Green Globes Interiors)
  - Living Building Challenge for Building Interiors (LBC Interiors).

## Effectiveness Criteria Review Findings

GSA based Tables 3-1, 3-2, and 3-3 on RMI's review of survey responses. Table 3-4 summarizes the information in these tables at a high level by adding up the results across all reviewed systems. GSA evaluated 39 sub-criteria for new construction and building interior systems and 36 sub-criteria for existing buildings systems.

Appendix E contains a detailed explanation of the scoring results in the tables below. For some of the sub-criteria, RMI evaluated the survey responses against multiple levels of questions related to federal requirements. Although a building certification system may address a specific sub-criterion used in GSA's review, it may not align with the prescriptive federal requirement for that sub-criterion. For example, a building certification system may not fully align with the specific Guiding Principles metric for energy use reduction to achieve energy efficiency 30 percent better than ASHRAE Standard 90.1 or one of the other compliance options to meet that specific federal requirement.[12] In this case, GSA would consider this as partial alignment with the federal

[12] Other Guiding Principles compliance paths for energy use reduction include energy use 20 percent below the FY 2015 energy use baseline; energy use 30 percent below the FY 2003 energy use baseline; an ENERGY STAR® rating of 75 or higher; or for building types not in ENERGY STAR Portfolio Manager, where adequate benchmarking data exists, placement in the top quartile of energy performance for its building type.

requirement for energy use reduction. While the intent to reduce energy may be evident in the system requirements, the system does not assess compliance in the same way as the federal requirement. The following symbols depict degree of alignment with federal requirements:

- ✔ —Green check: system demonstrates alignment with prescriptive federal building requirements for the specific sub-criterion.
- ! —Yellow exclamation: system demonstrates partial alignment with prescriptive federal building requirements for the specific sub-criterion.
- ✖ —Red "X": system does not demonstrate alignment with prescriptive federal building requirements and/or is not addressed in the system for the specific sub-criterion.

Some certification systems contain prerequisites that must be met for a project to achieve certification while others do not. LEED has a different number of prerequisites for each building certification system type[13] while LBC requires all credits, called "imperatives," be met to achieve certification. Green Globes, BREEAM, and BOMA do not have prerequisites as part of their building certification systems. The notes in the findings tables indicate when building certification systems require a prerequisite related to that sub-criterion.

[13] LEED. BD+C (New Construction and Major Renovation) includes 12 prerequisites, O+M (Existing Buildings) includes 12 prerequisites, ID+C (Interiors) includes 8 prerequisites.

### *Table 3-1. Effectiveness Criteria Findings for New Construction and Major Renovation Building Certification Systems*

| *Effectiveness Criteria Summary of Findings for New Construction and Major Renovation Building Certification Systems* | | | | |
|---|---|---|---|---|
| **Criteria** | **Sub-criteria** | **LEED BD+C** | **Green Globes NC** | **LBC NC** |
| Healthy, Effective Environments | Ventilation and thermal control[c] | ✓ | ✓ | ! |
| | Daylighting and lighting controls[b] | ✓ | ✓ | ! |
| | Indoor air quality plans[b] | ! | ! | ✓ |
| | Radon detection | ✗ | ✓ | ✗ |
| | Moisture control[b] | ! | ✗ | ✓ |
| | Low-emitting materials[b] | ✓ | ✓ | ✓ |
| | Protecting IAQ during construction[b] | ✓ | ! | ! |
| | Environmental smoking control[c] | ✓ | ✓ | ✓ |
| | Integrated pest management | ! | ✓ | ✗ |
| | Occupant health and wellness[b] | ✓ | ✓ | ✓ |
| Energy Efficiency | Predicted/Modeled energy use reduction[c] | ✓ | ✓ | ! |
| | Actual energy use reduction[c] | ! | ! | ! |
| | ENERGY STAR® products[a] | ! | ✓ | ✗ |
| | Renewable energy[b] | ✓ | ✓ | ✓ |
| | Clean and alternative energy[b] | ✓ | ✓ | ✓ |
| | Metering[c] | ✓ | ✓ | ✓ |
| | Benchmarking | ! | ! | ! |
| Water Use Efficiency and Management | Predicted/Modeled water use reduction[b] | ✓ | ✓ | ! |
| | Actual indoor water use reduction[c] | ✓ | ✓ | ! |
| | Actual outdoor water use reduction[c] | ✓ | ✓ | ! |
| | Water conserving products[a] | ✓ | ✓ | ✗ |
| | Meters[c] | ✓ | ✓ | ! |
| | Cooling towers | ✓ | ✓ | ! |
| | Water efficient landscapes[c] | ✓ | ! | ✓ |
| | Alternative sources of water[b] | ✓ | ✓ | ✓ |
| | Stormwater management[b] | ✓ | ✓ | ✓ |
| Solid Waste Diversion | Space for collection and storage of recyclables[c] | ✓ | ✓ | ✓ |
| | Construction waste management[c] | ✓ | ✓ | ✓ |
| | Waste diversion for occupants[c] | ✗ | ✗ | ✓ |
| Sustainable Procurement | Recycled content | ! | ! | ✗ |
| | Biobased content[b] | ! | ! | ✓ |
| | Environmentally preferable products[b] | ✓ | ✓ | ✓ |
| | Ozone depleting compounds[c] | ✓ | ✓ | ✓ |
| Siting | Access to public transportation[b] | ✓ | ✓ | ✓ |
| | Access to public amenities/neighborhood assets[b] | ✓ | ✓ | ✓ |
| | Floodplain avoidance[b] | ✓ | ✓ | ✓ |
| | Occupant transportation emissions[b] | ✓ | ✓ | ✓ |
| | Protection of historic resources[b] | ✓ | ! | ! |
| | Bicycling options[b] | ✓ | ✓ | ✓ |

[a] LEED has a prerequisite that is related to this sub-criteria. Green Globes, BREEM, and BOMA Best rating systems do not have prerequisites.

[b] Living Building Challenge has a prerequisite that is related to this sub-criteria. Green Globes, BREEM, and BOMA Best rating systems do not have prerequisites.

[c] Both LEED and Living Building Challenge have a prerequisite that is related to this sub-criteria. Green Globes, BREEAM, and BOMA Best rating systems do not have prerequisites.

## *Table 3-2. Effectiveness Criteria Review for Existing Building and Major Renovation Certification Systems*

| *Effectiveness Criteria Summary of Findings for Existing Building and Major Renovation Certification Systems* | | | | | | |
|---|---|---|---|---|---|---|
| **Criteria** | **Sub-criteria** | **LEED O+M** | **Green Globes EB** | **LBC EB** | **BREEAM** | **BOMA** |
| Healthy, Effective Environments | Ventilation and thermal control[c] | ✓ | ! | ! | ! | ! |
| | Daylighting and lighting controls[b] | ✓ | ✓ | ! | ✓ | ! |
| | Indoor air quality plans[b] | ! | ! | ✓ | ! | ✓ |
| | Radon detection | ✗ | ! | ✗ | ✗ | ✓ |
| | Moisture control[c] | ✓ | ✗ | ✓ | ✗ | ✓ |
| | Low-emitting materials[c] | ✓ | ✗ | ✓ | ✓ | ✓ |
| | Protecting IAQ during construction[c] | ✓ | ! | ! | ! | ! |
| | Environmental smoking control[c] | ✓ | ✗ | ✓ | ✗ | ✗ |
| | Integrated pest management | ✓ | ✓ | ✗ | ✓ | ! |
| | Occupant health and wellness[c] | ! | ✓ | ✓ | ✓ | ! |
| Energy Efficiency | Actual energy use reduction[c] | ! | ! | ! | ✗ | ! |
| | ENERGY STAR® products[a] | ! | ! | ✗ | ! | ! |
| | Renewable energy[b] | ✓ | ✓ | ✓ | ! | ✓ |
| | Clean and alternative energy[b] | ✓ | ✓ | ✓ | ! | ✓ |
| | Metering[c] | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Benchmarking[a] | ✓ | ! | ! | ✓ | ✓ |
| Water Use Efficiency and Management | Actual indoor water use reduction[c] | ✓ | ! | ! | ! | ! |
| | Actual outdoor water use reduction[c] | ✓ | ! | ! | ! | ! |
| | Water conserving products[a] | ✓ | ✓ | ✗ | ✓ | ✓ |
| | Meters[c] | ✓ | ! | ! | ! | ! |
| | Cooling towers | ✓ | ✗ | ! | ✗ | ✓ |
| | Water efficient landscapes[c] | ! | ! | ✓ | ! | ! |
| | Alternative sources of water[b] | ✗ | ✓ | ✓ | ✓ | ✓ |
| | Stormwater management[c] | ✓ | ✓ | ✓ | ✓ | ✓ |
| Solid Waste Diversion | Space for collection and storage of recyclables[c] | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Construction waste management[c] | ✓ | ! | ✓ | ✗ | ! |
| | Waste diversion for occupants[c] | ! | ! | ✓ | ! | ! |
| Sustainable Procurement | Recycled content | ! | ! | ✗ | ! | ✓ |
| | Biobased content[b] | ! | ! | ✓ | ! | ✗ |
| | Environmentally preferable products[c] | ✓ | ! | ✓ | ✓ | ✓ |
| | Ozone depleting compounds[c] | ✓ | ✓ | ✓ | ! | ✗ |
| Siting | Access to public transportation | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Access to public amenities/neighborhood assets | ✗ | ✗ | ✓ | ✓ | ! |
| | Floodplain avoidance[b] | ✗ | ✗ | ✓ | ✓ | ✗ |
| | Occupant transportation emissions | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Bicycling options | ✓ | ✓ | ✓ | ✓ | ✓ |

[a] LEED has a prerequisite that is related to this sub-criteria. Green Globes, BREEM, and BOMA Best rating systems do not have prerequisites.

[b] Living Building Challenge has a prerequisite that is related to this sub-criteria. Green Globes, BREEM, and BOMA Best rating systems do not have prerequisites.

[c] Both LEED and Living Building Challenge have a prerequisite that is related to this sub-criteria. Green Globes, BREEAM,

## *Table 3-3. Effectiveness Criteria Review for Building Interiors and Major Renovation Certification Systems*

| *Effectiveness Criteria Summary of Findings for Building Interiors and Major Renovation Certification Systems* | | | | |
|---|---|---|---|---|
| **Criteria** | **Sub-criteria** | **LEED ID+C** | **Green Globes Interiors** | **LBC Interiors** |
| Healthy, Effective Environments | Ventilation and thermal control[c] | ✓ | ✓ | ! |
| | Daylighting and lighting controls[b] | ✓ | ✓ | ! |
| | Indoor air quality plans[b] | ! | ! | ✓ |
| | Radon detection | ✗ | ✗ | ✗ |
| | Moisture control[b] | ! | ! | ✓ |
| | Low-emitting materials[b] | ✓ | ✓ | ✓ |
| | Protecting IAQ during construction[b] | ! | ! | ! |
| | Environmental smoking control[c] | ✓ | ✗ | ✓ |
| | Integrated pest management | ! | ✓ | ✗ |
| | Occupant health and wellness[b] | ✓ | ✗ | ✓ |
| Energy Efficiency | Predicted/Modeled energy use reduction[c] | ✓ | ✗ | ! |
| | Actual energy use reduction[c] | ! | ! | ! |
| | ENERGY STAR® products[a] | ✓ | ✓ | ✗ |
| | Renewable energy[b] | ✓ | ✗ | ✓ |
| | Clean and alternative energy[b] | ✓ | ✗ | ✓ |
| | Metering[b] | ✓ | ✓ | ✓ |
| | Benchmarking | ! | ✗ | ! |
| Water Use Efficiency and Management | Predicted/Modeled water use reduction[b] | ✓ | ✗ | ! |
| | Actual indoor water use reduction[c] | ✗ | ✓ | ! |
| | Actual outdoor water use reduction[b] | ✗ | ✗ | ! |
| | Water conserving products[a] | ✓ | ✓ | ✗ |
| | Meters[b] | ✗ | ! | ! |
| | Cooling towers[a] | ✓ | ! | ! |
| | Water efficient landscapes[b] | ✗ | ! | ✓ |
| | Alternative sources of water[b] | ✓ | ✓ | ✓ |
| | Stormwater management[b] | ! | ✗ | ✓ |
| Solid Waste Diversion | Space for collection and storage of recyclables[c] | ✓ | ✓ | ✓ |
| | Construction waste management[c] | ✓ | ✓ | ✓ |
| | Waste diversion for occupants[c] | ✗ | ✗ | ✓ |
| Sustainable Procurement | Recycled content | ! | ! | ✗ |
| | Biobased content[b] | ! | ! | ✓ |
| | Environmentally preferable products[b] | ✓ | ✓ | ✓ |
| | Ozone depleting compounds[c] | ✓ | ✗ | ✓ |
| Siting | Access to public transportation[b] | ✓ | ✗ | ✓ |
| | Access to public amenities/neighborhood assets[b] | ✓ | ✗ | ✓ |
| | Floodplain avoidance[b] | ✗ | ✗ | ✓ |
| | Occupant transportation emissions[b] | ✓ | ✗ | ✓ |
| | Protection of historic resources[b] | ✗ | ✗ | ! |
| | Bicycling options[b] | ✓ | ✗ | ✓ |

[a] LEED has a prerequisite that is related to this sub-criteria. Green Globes, BREEM, and BOMA Best rating systems do not have prerequisites.

[b] Living Building Challenge has a prerequisite that is related to this sub-criteria. Green Globes, BREEM, and BOMA Best rating systems do not have prerequisites.

[c] Both LEED and Living Building Challenge have a prerequisite that is related to this sub-criteria. Green Globes, BREEAM, and BOMA Best rating systems do not have prerequisites.

***Table 3-4. Summary of Review Findings, Effectiveness Criteria***

| *Effectiveness Criteria Findings* | | | |
|---|---|---|---|
| | The number of federal sub-criteria met by system | The number of federal sub-criteria partially met by system | The number of federal sub-criteria not met by system |
| | ✔ | ! | ✖ |
| **New Construction and Major Renovation Building Certification Systems** | | | |
| LEED BD+C | 29 | 8 | 2 |
| Green Globes NC | 29 | 8 | 2 |
| LBC NC | 22 | 12 | 5 |
| **Existing Building Certification Systems** | | | |
| LEED O&M | 24 | 8 | 4 |
| Green Globes EB | 14 | 16 | 6 |
| LBC EB | 22 | 9 | 5 |
| BREEAM | 16 | 14 | 6 |
| BOMA | 18 | 14 | 4 |
| **Building Interior Certification Systems** | | | |
| LEED ID+C | 22 | 9 | 8 |
| Green Globes Interiors | 12 | 9 | 18 |
| LBC Interiors | 22 | 12 | 5 |

Note: The number of effectiveness sub-criteria met by system (✔), partially met by system (!), or not met by system (✖).

# Development and Conformance Criteria Review Findings

Table 3-5 shows the alignment of all assessed certification systems against the seven development and conformance criteria described in Chapter 2. Each rating system's development and conformance assessment process is consistent across their products. The symbols in the table correspond to the following interpretations of how the system aligns with the development sub-criteria:

- ✔—Green check: Building certification system complies with the EISA or DOE Rule requirement.
- !—Yellow exclamation: Building certification system does not fully comply with the EISA or DOE Rule requirement but may align with the intent of the requirement.
- ✖—Red "X": Building certification system does not comply with the EISA or DOE Rule requirement.

### *Table 3-5. Findings, Development and Conformance Criteria*

| *Development and Conformance Criteria Findings* | | | | | | |
|---|---|---|---|---|---|---|
| Criteria | Sub-criteria | LEED | Green Globes | LBC | BREEAM[c] | BOMA[c] |
| Process for Developing and Administering the Certification System | Consensus-based approach | ✓ | ✓ | ✗ | ✗ | ✓ |
| | Transparency | ✓ | ✓ | ! | ✓ | ✓ |
| | Usability[a] | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Maturity | ✓ | ✓ | ✓ | ✓ | ✓ |
| Conformity Assessment | Independence | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Verification[b] | ✓ | ✓ | ✓ | ✓ | ✓ |
| | Post Occupancy evaluation | ✓ | ! | ✓ | ✓ | ✓ |

[a] See Appendix A for more information about the cost of each system.

[b] Not included in DOE rule.

[c] The DOE rule does not apply to systems certifying existing buildings. The rule does apply to new construction and major renovations of projects that are above the prospectus threshold; however, these major renovations are captured in the new contruction systems.

# Chapter 4
# Summary

This report provides an objective evaluation of the alignments of whole-building certification systems available for use in the United States with federal high-performance building criteria. Many factors influence the decision of an agency to pursue (or not pursue) certification, including the cost of the certification, agency-specific mission and policy, specialized building characteristics, and familiarity with a particular building certification system.

While each system reviewed for this report addresses the primary criteria that define high-performance buildings, no single system fully ensures conformance with all the federal requirements. Each system offers a unique framework and approach to achieving building certification, but all the systems generally agree on the aspects of building design, construction, operation, and maintenance that lead to high-performing commercial office buildings.