

BEYOND

SMART CITIES

ENERGY AND ATMOSPHERE - GREEN

BUILDING TECHNOLOGY TRAINING PROGRAM

FOR ENERGY AND GREEN BUILDING SPECIALISTS

KRISHNAJI PAWAR, LEED AP BD+C, GSAS CGP, ISO 14001:2015, GCP

ENERGY SPECIALIST CURRICULUM

ENERGY EFFICIENCY SPECIALIST

BEYOND SMART CITIES

BEYOND

SMART CITIES

MINIMUM ENERGY PERFORMANCE -

PREREQUISITE

FOR ENERGY AND GREEN BUILDING PROFESSIONALS

KRISHNAJI PAWAR, LEED AP BD+C, GSAS CGP, ISO 14001:2015, GCP

ENERGY EFFICIENCY SPECIALIST CURRICULUM

ENERGY EFFICIENCY SPECIALIST

BEYOND SMART CITIES

LEARNING OBJECTIVES



Intent of Minimum Energy Performance - Prerequisite

Behind the intent

Step by Step Guidance

Requirements

Required Documentation

Referenced Standards

Connection to Ongoing Building Performance

Terms and definitions

EA - PR- DESIGN

INTENT

To promote resilience and reduce the environmental and economic harms of excessive energy use that disproportionately impact frontline communities by achieving a minimum level of energy efficiency for the building and its systems.

POTENTIAL TECHNOLOGIES & STRATEGIES

An optimized building design can substantially reduce energy use- often for a modest initial cost with a short payback period-when it includes load reduction, improved mechanical system efficiency, and smart operational strategies. An integrated building design can lower operating and maintenance costs and improve indoor air quality, thermal comfort, and access to daylight. Either a prescriptive or a performance approach may be used to attain such results.

MINIMUM ENERGY PERFORMANCE REQUIREMENTS

Comply with ANSI/ASHRAE/IESNA Standard 90.1-2016, with errata or a USGBC-approved equivalent standard. ASHRAE 90.1-2016 Compliance pathways in Section 4.2.1.1 include compliance with all mandatory provisions, and compliance with one of the following: Prescriptive provisions of Sections 5 through 10

Section 11 Energy Cost Budget Method

Alternative Appendix G Performance Rating Method. When using Appendix G, the Performance Cost Index (PCI) shall be less than or equal to the Performance Cost Index Target (PCIT) in accordance with the methodology provided in Section 4.2.1.1. Document the PCI, PCIT, and percentage improvement using metrics of cost or greenhouse gas (GHG) emissions.

IMPLEMENTATION

REQUIRED DOCUMENTATION

Requirement	Appendix G	Appendix G	Appendix G
Building configuration analysis			
Building load and mechanical system design capacity			
Energy conservation strategy			
Building envelope details			
Domestic hot water efficiency			
Simulation compliance for 100% carbonated performance strategies			
Low ESR			
ASHRAE 90.1-2016			
Energy conservation strategy			
Energy conservation strategy			
Energy conservation strategy			

BEHIND THE INTENT

An optimized building design can substantially reduce energy use—often for a modest initial cost with a short payback period—when it includes load reduction, improved mechanical system efficiency, and smart operational strategies. An integrated building design can lower operating and maintenance costs and improve indoor air quality, thermal comfort, and access to daylight. Either a prescriptive or a performance approach may be used to attain such results.

A simplified, prescriptive approach—applicable to smaller buildings and certain building types, such as offices, retail stores, and schools—presents a limited set of system choices with mandatory performance characteristics. Best suited to projects with smaller budgets, straightforward design, and packaged equipment, the prescriptive approach provides energy-saving guidance for many simple buildings with typical energy systems. Not all projects will be eligible for a prescriptive approach, which can be infeasible, given that all listed requirements must be achieved to attain the prerequisite. Two prescriptive options are available, depending on building size and other factors.

Alternatively, the performance path offers a more flexible, tailored way to evaluate the interactive effects of efficiency measures. This option uses energy modeling to simulate the energy performance of the building as a whole. Design teams can then assess complex systems and make efficiency trade-offs among systems and components that the prescriptive options do not allow.

Partnering with the design team, qualified energy modelers can interpret the results of these complicated analyses to maximize the benefits to the project. When initiated early in the design process, an energy simulation serves as a design tool instead of a compliance check. One of the greatest benefits of early energy modeling is better integration of interrelated design issues, which encourages dialogue about assumptions concerning building components and systems. Information on energy use and costs thereby plays a bigger role as design decisions are made.

ASHRAE 90.1-2010 was chosen as the standard on which to base the requirements because it continues to push building design toward greater energy efficiency. Specifically, a study by the U.S. Department of Energy showed an average improvement of 18% across all building types when ASHRAE 90.1-2010 was applied instead of ASHRAE 90.1-2007.



STEP-BY-STEP GUIDANCE

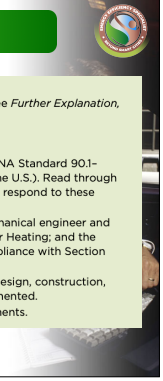
STEP 1. DETERMINE CLIMATE ZONE

Identify the project's climate zone according to ASHRAE 90.1-2010, Appendix B (see *Further Explanation, Climate Zone Determination*). 

STEP 2. REVIEW AND ADDRESS ASHRAE MANDATORY REQUIREMENTS

Early in the design process, review the mandatory provisions of ANSI/ASHRAE/IESNA Standard 90.1-2010, with errata (or a USGBC-approved equivalent standard for projects outside the U.S.). Read through Sections 5.4, 6.4, 7.4, 8.4, 9.4, and 10.4 to understand how the building design must respond to these requirements.

- Typically, the architect is responsible for Section 5.4, Building Envelope; the mechanical engineer and plumbing designer are responsible for Sections 6.4, HVAC, and 7.4, Service Water Heating; and the electrical engineer is responsible for Sections 8.4, Power, and 9.4, Lighting. Compliance with Section 10.4 requires coordination across multiple disciplines.
- Ensure that the project complies with the mandatory measures throughout the design, construction, and commissioning process, particularly when major design decisions are implemented.
- Confirm that compliant components are included in the final construction documents.



STEP-BY-STEP GUIDANCE +

STEP 1. DETERMINE CLIMATE ZONE

Identify the project's climate zone according to ASHRAE 90.1-2010, Appendix B (see *Further Explanation, Climate Zone Determination*). 

STEP 2. REVIEW AND ADDRESS ASHRAE MANDATORY REQUIREMENTS

Early in the design process, review the mandatory provisions of ANSI/ASHRAE/ESNA Standard 90.1-2010, with errata for a USGBC-approved equivalent standard for projects outside the U.S., (read through Sections 5.4, 6.4, 7.4, 8.4, 9.4, and 10.4 to understand how the building design must respond to these requirements).

- Typically, the architect is responsible for Section 5.4, Building Envelope; the mechanical engineer and plumbing designer are responsible for Sections 6.4, HVAC, and 7.4, Service Water Heating; and the electrical engineer is responsible for Sections 8.4, Power; and 9.4, Lighting. Compliance with Section 10.4 requires coordination across multiple disciplines.
- Ensure that the project complies with the mandatory measures throughout the design, construction, and commissioning process, particularly when major design decisions are implemented.
- Confirm that compliant components are included in the final construction documents.

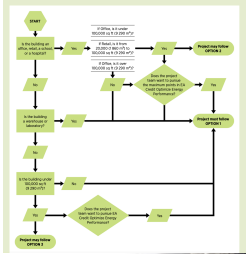
STEP 3. IDENTIFY ENERGY USE TARGET FOR BUILDING

Set an energy goal for the project early in the design process. Identifying an energy goal can help prioritize efficiency strategies, integrate systems, reduce first costs, and improve building performance.

- For EA Prerequisite Minimum Energy Performance, Option 3, the energy performance target must be established using ENERGY STAR's Target Finder and must be greater than a score of 90.
- For EA Credit Optimize Energy Performance, the target must be established as energy use intensity (EUI) in kBtu per square foot-year (kWh per square meter-year) of source energy use.
- Consider using ENERGY STAR's Target Finder to develop the EUI goal that will meet the credit requirements.

STEP 4. SELECT ONE OPTION

Select the appropriate option for the project (see *Further Explanation, Selecting an Option*). Review the requirements for EA Credit Optimize Energy Performance before making a selection, and consult Figure 1. 



STEP-BY-STEP GUIDANCE +

- Option 1 is available to all projects. Consider this option if the project team wants to continually review the energy effects of design decisions, or if the team is pursuing EA Credit Optimize Energy Performance, since energy modeling makes the project eligible to earn more points.
- Select Option 1 if the building or building systems are complex and cannot comply with standard prescriptive requirements.
- Select Option 1 if the project includes on-site renewable energy and intends to use the energy produced for additional points in EA Credit Optimize Energy Performance.

Option 2 is for projects that have limited opportunity or no need for unique design and systems, beyond the simple upgrades to mechanical, envelope, and lighting systems that are listed in the ASHRAE prescriptive components. Under this option, project teams will use ASHRAE 50% Advanced Energy Design Guide (AEDG) for HVAC and service water heating systems. Project teams may pursue a limited number of points under EA Credit Optimize Energy Performance. The eligible project types for Option 2 include the following:

- Small to medium office buildings, less than 100,000 square feet (9 290 meters)
- Medium to large box retail buildings, 20,000 to 100,000 square feet (8 600 to 9 290 square meters)
- School buildings, any size
- Large hospitals, more than 100,000 square feet (9 290 square meters)
- Option 2 uses the Advanced Buildings' Core Performance Guide and offers an alternative for projects that are less than 100,000 square feet (9 290 square meters) and not a school, healthcare, warehouse, or laboratory. The Core Performance Guide requires that the project comply with prescriptive criteria and also demonstrate that a process is in place for considering energy efficiency alternatives early in the design phase. Projects that use Option 2 cannot achieve points under EA Credit Optimize Energy Performance.

Option 1. Whole-Building Energy Simulation

STEP 1. REVIEW PREREQUISITE AND CREDIT REQUIREMENTS

Thoroughly review the criteria and informational details for both EA Prerequisite Minimum Energy Performance and EA Credit Optimize Energy Performance before beginning the simulation.

- The prerequisite and credit are integrated issues. Teams that intend to pursue the credit should focus on the expanded scope necessary for credit achievement.
- Buildings that meet the requirements for earning points under the credit, including mandatory requirements and excluding any credits from renewable energy, automatically achieve the prerequisite.
- Review the Integrative Process Credit to identify the requirements for concept-level energy modeling.

STEP 2. IDENTIFY ENERGY MODELER

Engage an energy modeler to perform the energy analysis.

- It is recommended that the qualifications of the energy modeler be carefully reviewed to ensure that the simulation will be performed accurately and according to the prerequisite requirements.
- Qualified energy modelers who have experience with numerous situations for a variety of building types can help the design team interpret the results to develop an efficient building design (see *Further Explanation, Energy Modeler Qualifications*). 

STEP 3. DEVELOP PRELIMINARY ENERGY MODEL

Consider creating preliminary energy models to analyze building design configuration and heating and cooling load reduction strategies. The preliminary model use information from the design to create a rough projection of energy usage in various scenarios (see *Further Explanation, Developing a Preliminary Energy Model*). 

- A preliminary energy model is not required; however, developing an early model of the proposed design will help the design team explore the energy consequences of design options and will provide an early estimate of energy performance.
- An analysis of various efficiency measures, which may take the form of a preliminary model, is necessary for the achievement of the related credit.

STEP-BY-STEP GUIDANCE +

- When evaluating energy usage in different scenarios, consider strategies for lighting and daylighting, envelope, orientation, and passive conditioning and ventilation systems, in terms of projected energy savings and market costs as they relate to all building systems. If pursuing the integrative process credit, consider energy performance as a concept level early in design.

STEP 4. MODEL POTENTIAL HVAC SYSTEM TYPES

After building design configuration and load reduction strategies have been assessed and implemented, use the energy model to analyze the performance of HVAC system alternatives for the project case. (*Further Explanation, Modeling HVAC Systems*). 

- For best HVAC system performance, ensure that the system is properly sized. Many effective system types, such as radiant heating and cooling or displacement ventilation, may be feasible when the loads are smaller, so begin the analysis by exploring ways to reduce the load.
- Analysis of HVAC systems in early design is optional for this prerequisite but is required for achievement of the related credit.

STEP 5. DEVELOP ENERGY MODEL FOR PROPOSED DESIGN

Once the HVAC system and other design parameters are established, build or update the proposed building energy model to reflect the anticipated design (see *Further Explanation, Building the Proposed Energy Model*). 

- Update the proposed model to reflect changes that occur throughout the design process to achieve energy performance and assist with design decisions.
- Ensure that all efficiency strategies are analyzed well before design documents are finalized.

STEP 6. CREATE BASELINE ENERGY MODEL

Build a baseline model that reflects the minimum requirements according to ASHRAE 90.1-2010, Appendix G (see *Further Explanation, Building the Baseline Energy Model*). 

- When modifications are made to the proposed energy model, update the baseline accordingly.
- Consider controlling the baseline model early in the design process so that the design team can see the effect of design changes on the percentage savings relative to ASHRAE 90.1. This will contribute toward achieving savings under the related credit.
- Use the energy modeling results and quality control checklist spreadsheet (Appendix Q) to help create the baseline model. This tool was designed to help project teams create a baseline model in alignment with Appendix G requirements.

STEP 7. UPDATE BASELINE AND PROPOSED MODELS BASED ON FINAL DESIGN

Update the proposed energy model to reflect final construction details and specifications and make any necessary corresponding updates to the baseline model (see *Further Explanation, Finalizing the Energy Models*). 

- For elements or systems that cannot be readily modeled by the software, use the exceptional calculation method or CORREL modeling guidelines for unrepresented loads (see *Further Explanation, Exceptional Calculation Method and Common Issues with Energy Modeling*). 

STEP 8. DETERMINE ENERGY COST SAVINGS

Compare the proposed model with the baseline model to determine the anticipated energy cost savings (see *Further Explanation, Energy Cost Savings*). 

- Ensure compliance with the prerequisite criteria for energy savings based on the building type (i.e., new construction, major renovation, or core and shell).
- Energy costs offset by on-site renewable energy systems do not count toward energy savings for compliance with the prerequisite. Renewable energy may be included in the model for achievement of points under the related credit.

Option 2. Prescriptive Compliance: ASHRAE 50% Advanced Energy Design Guide

STEP 1. SELECT APPROPRIATE GUIDE AND DRAINAGE AREA REQUIREMENTS ARE MET

Choose the appropriate building type (office, retail, school, or hospital) from the ASHRAE 50% Advanced Energy Design Guide (AEDG) and review the area requirements. If the project does not meet both building type and size criteria, the team must select Option 1 or Option 3.

STEP-BY-STEP GUIDANCE +

STEP 2. ASSESS ASHRAE PRESCRIPTIVE REQUIREMENTS

Work with the architect and engineers to assess the prescriptive requirements of ANSI/ASHRAE/IESNA Standard 90.1-2010, with areas (or a USGBC-approved equivalent standard for projects outside the U.S.) and ensure that the design will comply with envelope, HVAC, service water-heating, and lighting requirements, per Sections 5.5, 6.5, 7.5, and 9.2.2.

The ASHRAE 90.1-2010 prescriptive requirements should not be confused with the requirements of the AEDG. Although projects must meet only the HVAC and service water-heating prescriptive requirements of the applicable AEDG to earn this prerequisite, all the ASHRAE 90.1-2010 prescriptive requirements must be met, including building envelope, HVAC, service water heating, and lighting.

- Ensure that the lighting calculations include all task lighting except where specifically exempted by ASHRAE 90.1 and appropriately account for the total luminaire wattage for each fixture consistent with ASHRAE 90.1 requirements. Note that the luminaire wattage is not necessarily the sum of the lamp wattages but accounts for the ballast factor (standard luminaires) and the total circuit power or current-limited power (track lighting).

STEP 3. ASSESS HVAC AND SERVICE WATER HEATING EQUIPMENT PRESCRIPTIVE REQUIREMENTS

Work with the mechanical and plumbing engineer to ensure that the project's HVAC and service water-heating equipment will meet all the prescriptive requirements of the applicable AEDG. Specify qualifying equipment in the construction documents.

- The HVAC scope includes equipment efficiency, economizers, ventilation, and ducts and dampers as discussed in AEDG, Chapter 4, Design Strategies and Recommendations by Climate Zone.
- Consider the capacity needs for the project and identify potential equipment that will meet those requirements. AEDG does not address some types and sizes of equipment, and these constraints may mean certain equipment is inappropriate for the project.
- As a best practice, use the AEDG compliance checklists to track the requirements, review this list with the project team, and include these requirements in the CDP (see EA Prerequisite Fundamental Commissioning and Verification).
- Once the design is complete, a project that cannot meet all AEDG requirements will find it difficult to switch to Option 1 or Option 3. Therefore, these requirements should be established early in design.

STEP 4. CONFIRM THAT CREDIT CRITERIA WILL BE MET, IF APPLICABLE

If the project team is planning to achieve points under the related credit, consider the appropriate additional AEDG requirements. Points are available for complying with additional requirements not included in this prerequisite (see EA Credit Optimize Energy Performance, Option 2).

Option 3. Prescriptive Compliance: Advanced Buildings™ Core Performance™ Guide

STEP 1. ASSESS ASHRAE PRESCRIPTIVE REQUIREMENTS

Work with the design team to understand the prescriptive requirements of ANSI/ASHRAE/IESNA Standard 90.1-2010 to ensure that the design will comply. This also includes Sections 5.5 (envelope), 6.5 (HVAC), 7.5 (service water heating), and 9.2.2 (lighting).

STEP 2. REVIEW REQUIREMENTS IN SECTION 1, DESIGN PROCESS STRATEGIES

Develop an implementation strategy for achieving the requirements for Section 1, Design Process Strategies, as outlined in the Core Performance Guide (CPG).

- Consider the scheduling necessary to accommodate additional meetings and design time during the design process.
- Consider the scheduling and resource implications of prototyping activities, such as system verification, operator training and documentation, and ongoing measurement.
- Projects that select Option 3 must meet all criteria listed in Section 1 of the CPG. Many of these criteria are complementary to other credits and prerequisites. Sections 2.1, 2.3, 3.5, and 3.6, for example, are addressed elsewhere in the rating system and are therefore not described here.
- For Sections 1.3, 1.5, and 1.6, see EA Prerequisite Fundamental Commissioning and Verification.
- For Section 1.8, see the Integrative Process Credit.

STEP-BY-STEP GUIDANCE +

STEP 3. DISCUSS CPG REQUIREMENTS AND IMPLEMENTATION IN DESIGN TEAM MEETINGS

Engage the design team to discuss and detail meeting the requirements of all three sections of the CPG, implementing strategies for achieving the ENERGY STAR Target Finder goal, and documenting the process to ensure that the design team is clearly communicated.

STEP 4. REVIEW PRESCRIPTIVE REQUIREMENTS

Starting early in the design process, review the required prescriptive elements outlined in Section 3, Core Performance Requirements, and the three required elements from Section 5, Enhanced Performance Strategies. Consider alternatives for lighting, HVAC, envelope, and water-heating systems.

Engage appropriate design team members to confirm compliance with each prescriptive criterion. Projects that meet all prescriptive requirements:

- Consider the efficiency of components or barriers, low-voltage exterior illumination, and enhanced commissioning and start-up and commissioning, such as improved thermostat set points, and
- In addition to meeting the requirements of the CPG, projects must meet all local energy code requirements or the prescriptive requirements of ASHRAE 90.1-2010, whichever is more stringent.

STEP 5. ANALYZE PASSIVE AND ACTIVE ENERGY LOAD REDUCTION OPPORTUNITIES

At decision 1 (start) of the CPG, as part of design development, analyze at least three alternative building configurations to maximize passive reduction of building energy loads. When a preferred configuration has been selected, perform an analysis of the mechanical systems.

- Understand and document load calculations. Consider referencing ASHRAE 55 to identify thermal comfort design conditions.
- In the first iteration of load calculations, include heat-loss calculations based on zone-by-zone loads.
- Perform a second set of load calculations using peak-load conditions. Describe features of the design that will enable efficient operation at these conditions.
- Document the passive and active analyses and calculations according to Sections 1.3 and 1.4 of the CPG. Teams pursuing the Integrative Process Credits do not need to document Section 1.3 separately.

STEP 6. DESIGN TO MEET SECTION 2, CORE PERFORMANCE REQUIREMENTS

Select the optimal design indicated by the load calculations and confirm that each of the requirements listed in Section 2 of the CPG are met or exceeded. If any design revisions require upgrades to envelope or lighting components, note HVAC load calculations.

- Confirm with the architect that envelope-related efficiency measures included in the plans and specification meet or exceed the CPG requirements.
- Confirm with the mechanical engineer that the specifications of the mechanical system meet or exceed the CPG requirements.
- Confirm with the electrical engineer or lighting designer that lighting power densities calculations do not exceed the CPG requirements.
- Sections 2.3, 2.7, 2.8, and 2.9 are addressed elsewhere in the rating system and are therefore not covered here. However, teams must demonstrate compliance with each section and meet the LED requirements as well if they are more stringent than the CPG.
- For Sections 2.3 and 2.5, see EQ Prerequisite Minimum Indoor Air Quality Performance and EQ Credit Enhanced Indoor Air Quality Strategies.
- Sections 2.7 and 2.8 are already mandated through the prescriptive requirements of ASHRAE 90.1-2010, as indicated in the criteria for Option 3 of this prerequisite.

STEP 7. DESIGN FOR COMPLIANCE WITH SECTION 3, ENHANCED PERFORMANCE STRATEGIES

Work with the mechanical engineer to include the following three strategies from the CPG Section 3, Enhanced Performance Strategies, in the plans and specifications, as applicable.

- 3.5 Supply Air Temperature Reset (SAT): Confirm that the selected air-handling units can reset temperature and that the building automation system (BAS) can process inputs that allow proper reset operation, such as humidity, outdoor air temperature, and air carbon position.
- 3.9 Premium Economizer Performance: Confirm that the controls can accommodate a dedicated thermal mass, that economizer controls are installed in the correct location within the air stream, and that the BAS can adequately implement the requirements.
- 3.10 Variable Speed Control: Confirm that zones serving variable flow systems and VAV fans having a motor of 5 horsepower (3.73 kW) or larger can be upgraded to VFD with performance characteristics meeting those listed in the standard.

STEP 8. INCLUDE DESIGN CRITERIA IN OWNER'S PROJECT REQUIREMENTS

Develop a checklist of all the requirements needed to comply with the CPG, review this list with the project team, and include these requirements in the CDP (see EA Prerequisite Fundamental Commissioning and Verification).

BEYOND SMART CITIES

THANK YOU

THE WORLD'S 1ST GREEN TECHNOLOGY MARKETPLACE