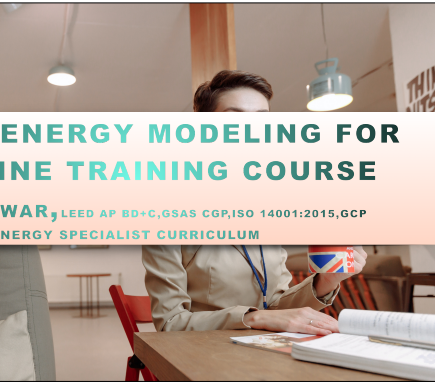




**ADVANCED ENERGY MODELING FOR
LEED ONLINE TRAINING COURSE**

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

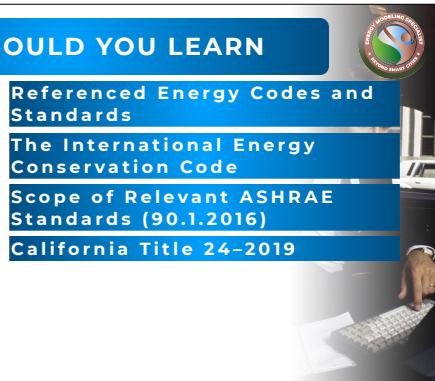




**ENERGY CODES AND STANDARDS
FOR ENERGY PROFESSIONALS**

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WHAT SHOULD YOU LEARN

Referenced Energy Codes and Standards

The International Energy Conservation Code

Scope of Relevant ASHRAE Standards (90.1.2016)

California Title 24-2019



ENERGY CODES AND STANDARDS

✓ Energy codes – specify how buildings must be constructed or perform, and are written in mandatory, enforceable language. Regional or local governments adopt and enforce energy codes for their jurisdictions.

✓ Energy standards – describe how buildings should be constructed to save energy cost-effectively. They are published by professional organizations such as the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). They are not mandatory, but serve as national recommendations, with some variation for regional climate.



ENERGY CODES AND STANDARDS +

✓ ASHRAE 90.1-2016 is the technical standard referenced as a basis for the energy performance credits in LEED BD+C: New Construction v4.1 - LEED v4.1, LEED for Core & Shell (CS) v4.1, and LEED for Schools. LEED v4.1 is the next generation standard for green building design, construction, operations and performance.

✓ Projects following the whole building energy simulation compliance path can demonstrate improvement in energy performance using the building performance rating method detailed in Appendix G of this standard. Projects in California that elect to conduct a whole building energy simulation for EA Credit 1 may use Title 24-2016 OR Title 24-2019 to determine the energy savings.



ENERGY CODES AND STANDARDS +

✓ Regional and local governments frequently use energy standards as the technical basis for developing their energy codes.

✓ Some energy standards are written in mandatory, enforceable language, making it easy for jurisdictions to incorporate the provisions of the energy standards directly into their laws or regulations.



INTERNATIONAL ENERGY CONSERVATION CODE



✓ The International Code Council (ICC) publishes and maintains the International Energy Conservation Code (IECC), which is a model energy code that makes allowances for different climate zones.

✓ Because it is written in mandatory, enforceable language, state and local jurisdictions can easily adopt the model as their energy code.

✓ Before adopting the IECC, state and local governments often make changes to reflect regional building practices.



STANDARDS ORGANIZATIONS AND CODE ORGANIZATIONS



✓ American Society of Heating and Air-Conditioning Engineers (ASHAE)

✓ 180 Technology Parkway NW Peachtree Corners, GA 30092

<https://www.ashrae.org>

✓ ICC - International Code Council - ICC

✓ 500 New Jersey Avenue, NW 6th Floor, Washington, DC 20001.

✓ <https://www.iccsafe.org>



BUILDING CODES - ENERGY COMPONENT



✓ Most states in the US use the ASHRAE 90 standard as the basis for the energy component of their building codes.

ASHRAE = American Society of Heating, Refrigerating, and Air Conditioning Engineer

✓ ASHRAE 90.1 for commercial buildings

✓ ASHRAE 90.2 for residential buildings
Some states have quite comprehensive building codes (e.g. Building Energy Efficiency Standards - Title 24)



ABOUT STANDARD 90.1-2016

- ✓ ASHRAE Standard 90.1-2016 is an industry standard that provides minimum requirements for the energy-efficient design of commercial buildings and criteria for determining compliance with these requirements. The performance rating method in Appendix G is “provided for those wishing to use the methodology to quantify performance that substantially exceeds the requirements of Standard 90.1” (ASHRAE 2016). This manual is written for users with intermediate or advanced understanding of ASHRAE 90.1-2016, Appendix G, and will therefore not address every detail.
- ✓ Projects using Appendix G also need to comply with all the minimum requirements noted in the ASHRAE 90.1-2016 standard. All LEED projects must comply with mandatory provisions listed in Sections 5.4, 6.4, 7.4, 8.4, 9.4, and 10.4. The interior lighting power allowance can be determined using either Tables G3.7 or G3.8 and the methodology described in Sections 9.5.1 and 9.6.1.

ABOUT STANDARD 90.1-2016 +

- ✓ The mandatory provisions point to minimum efficiency tables (e.g. Table 6.8.1-) within the Standard. Appendix G allows the baseline efficiency to be taken from Appendix Table G3.5.1, which is much less stringent than Table 6.8.1-.
- ✓ The protocol for building each of these models is detailed in ASHRAE 90.1-2016, Appendix G, Table G3.1. Appendix G also defines the requirements for the modeling software used to simulate energy use, the climate zones and weather data, the necessary energy simulation runs, and the energy savings calculation protocol. Most projects attempting EA Credit 1 adopt the performance compliance path and use Appendix G.
- ✓ LEED points are calculated based on the project percent improvement PCI below the PCI using metrics of cost and GHG emissions. Total points have been divided equally between the metrics of energy cost and greenhouse gas emissions. Points are awarded according to Table 1 and Table 2.
- ✓ For project percent improvement for the cost metric, on-site renewable energy may be subtracted from proposed energy cost prior to calculating proposed building performance per ASHRAE Standard 90.1-2016 Section G 2.4.1.

ABOUT STANDARD 90.1-2016 +

- ✓ LEED v4.1 splits the energy modeling points into two point thresholds - Performance Cost Index (PCI) & greenhouse gas (GHG) emissions. Up to 9 points for reducing energy cost and up to 9 points for reducing GHG.
- ✓ This standard provides the minimum requirements for energy-efficient design of most buildings, except low-rise residential buildings. It offers, in detail, the minimum energy-efficient requirements for design and construction of new buildings and their systems, new portions of buildings and their systems, and new systems and equipment in existing buildings, as well as criteria for determining compliance with these requirements. It is an indispensable reference for engineers and other professionals involved in design of buildings and building systems.
- ✓ Standard 90.1 has been a benchmark for commercial building energy codes in the United States and a key basis for codes and standards around the world for more than 35 years.

ANSI/ASHRAE/IES STANDARD 90.1-2019

- ✓ Requires minimum performance measures for energy efficiency of equipment.
- ✓ New commissioning requirements in accordance with ASHRAE/IES Standard 202
- ✓ Requires minimum lighting levels in Lux; and in W per square metre. Co-sponsor of 90.1 is IESNA – the lighting professionals.
- ✓ Requires lighting performance measures and operation. Requires lighting controls.
- ✓ Prescriptive thermal requirements.
- ✓ Energy Cost Budget (ECB) Method (Section 11)
- ✓ New simplified method for lighting for contractors and designers of renovated office buildings and retail buildings up to 25,000 ft² (2300 m²).



CALIFORNIA TITLE 24

- ✓ The Building Energy Efficiency Standards were first adopted in 1976 and have been updated periodically since then as directed by statute. In 1975 the Department of Housing and Community Development adopted rudimentary energy conservation standards under their State Housing Law authority that were a precursor to the first generation of the Standards
- ✓ The 2019 update to the Building Energy Efficiency Standards focuses on several key areas to improve the energy efficiency of newly constructed buildings and additions and alterations to existing buildings. The most significant efficiency improvements to the residential Standards include the introduction of photovoltaic into the prescriptive package, improvements for attics, walls, water heating, and lighting. The most significant efficiency improvements to the nonresidential Standards include alignment with the ASHRAE 90.1 2017 national standards. The 2019 Standards also include changes made throughout all of its sections to improve the clarity, consistency, and readability of the regulatory language.



CALIFORNIA TITLE 24 -2019

- ✓ The Standards are conceptually divided into three basic sets. First, there is a basic set of mandatory requirements that apply to all buildings. Second, there is a set of performance standards – the energy budgets – that vary by climate zone (of which there are 16 in California) and building type; thus the Standards are tailored to local conditions, and provide flexibility in how energy efficiency in buildings can be achieved. Finally, the third set constitutes an alternative to the performance standards, which is a set of prescriptive packages that provide a recipe or a checklist compliance approach.
- ✓ Public Resources Code Section 25402.1 also requires the Energy Commission to support the performance standards with compliance tools for builders and building designers. The Alternative Calculation Method (ACM) Approval Manual adopted by regulation as an appendix of the Standards establishes requirements for input, output and calculational uniformity in the computer programs used to demonstrate compliance with the Standards. From this, the Energy Commission develops and makes publicly available free, public domain building modeling software in order to enable compliance based on modeling of building efficiency and performance. The ACM Approval Manual also includes provisions for private firms seeking to develop compliance software for approval by the Energy Commission, which further encourages flexibility and innovation.



EQUIVALENCY TO ASHRAE 90.1-2017

✓ Title 24-2019 is deemed to be directly equivalent to ASHRAE 90.1-2017 by USGBC for projects in California for the purpose of certification of EA Prerequisite 2 and EA Credits 1, 2, and 6. Projects in California may still elect to use ASHRAE 90.1-2017 instead of Title 24-2019.

✓ However, once the Title 24 or ASHRAE path is chosen, it must be used consistently for the prerequisite and credits listed above. Projects do not need to provide justification or support of Title 24-2019 equivalence when applying for LEED BD+C: New Construction v4.1 - LEED v4.1, LEED for Core & Shell (CS) v4.1, and LEED for Schools.

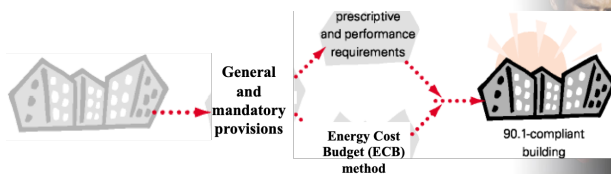
ENERGY COST BUDGET METHOD

✓ The ECB method permits tradeoffs between building systems (lighting and fenestration, for example) if the annual energy cost estimated for the proposed design does not exceed the annual energy cost of a base design that fulfills the prescriptive requirements.

✓ Using the ECB approach requires simulation software that can analyze energy consumption in buildings and model the energy features in the proposed design.

✓ Standard 90.1 sets minimum requirements for the simulation software; suitable programs include Energy Plus, Equest, DOE-2, and TRACE.

ASHRAE 90.1 COMPLIANCE



ANSI/ASHRAE STANDARD 62.1-2019



Standard 62.1 has been fully revised for the first time since 2004 to include three procedures for ventilation design: the IAQ Procedure, the Ventilation Rate Procedure, and the Natural Ventilation Procedure. 62.2 New technology and the latest research ensure that the information in the standard is means of achieving this goal have evolved.

Example for offices in a commercial office building (VRP) Prescriptive -- 10 LPS outside air per person Performance -- Measure CO₂ in return ducts of zone and keep CO₂ less than 1000 PPM. This is also called Demand Control Ventilation, or DCV. Requires sensors, control system, and active damper. Actually 700 ppm above ambient (300 – 350 ppm)

SIGNIFICANT PARTS OF ASHRAE.62.1



- ✓ Ventilation for Acceptable Indoor Air Quality
- ✓ The scope is changed to remove commentary and to more specifically identify occupancies previously not covered.
- ✓ The Ventilation Rate Procedure is modified with a new simplified version for determining E_v and a more robust option for determining values of E_z .
- ✓ The Natural Ventilation Procedure is significantly modified to provide a more accurate calculation methodology and also define the process for designing an engineered system.
- ✓ Natural ventilation now requires considering the quality of the outdoor air and interaction of the outdoor air with mechanically cooled spaces.
- ✓ Example for offices in a commercial office building (VRP) Prescriptive 10 LPS outside air per person Performance Measure CO₂ in return ducts of zone and keep CO₂ less than 1000 PPM. This is also called Demand Control Ventilation, or DCV. Requires sensors, control system, and active damper. Actually 700 ppm above ambient (300 – 350 ppm)



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