



BUILDING ENERGY MODELING PROFESSIONAL - BEMP EXAM PREP

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Air- conditioning

the process of treating air to meet the requirements of a conditioned space by controlling its temperature, humidity, cleanliness, and distribution

Air economizer

a duct and damper arrangement and automatic control system that together allow a cooling system to supply outdoor air to reduce or eliminate the need for mechanical cooling during mild or cold weather

Air temperature

the temperature of the air
measured at a test point

Baseline model

the set of arithmetic factors,
equations, or data used to describe
the relationship between energy
use or demand
and other baseline data. A model
may also be a simulation process
involving a specified simulation
engine and set of input data

Boundary conditions

physical conditions (values of physical quantities, conditions of energy interchange, etc.) imposed upon a system at the start or end of a process (temporal boundary conditions) and/or at the boundaries separating the system from its surroundings (local boundary conditions)

Building automation system (BAS)

an energy management system, usually with additional capabilities, relating to the overall operation of the building in which it is installed, such as equipment monitoring, protection of equipment against power failure, and building security; compare to building management system

Building envelope

(1) outer elements of a building, including walls, windows, doors, roofs, and floors, including those in contact with earth. (2) the exterior plus the semi-exterior portions of a building.

Building information model(BIM)

a data specification for representing building information for the purposes of interoperable data exchanged. Also, a data model of a specific building or its systems, components, or other information elements based on that specification

Capacity

measure of the maximum amount of energy or material that may be stored in a given system

Coefficient of performance (COP)

(1) the rate of net heat output to the total energy input, given in standard units and under certain rating conditions; (2) the ratio of the compressor's cooling capacity to the work it does per unit of time.

Cogeneration

sequential production of either electrical or mechanical power and useful thermal energy (heating or cooling) from a single energy form

Cooling load

the difference in temperature between the outdoor mean temperature over a 24-hour period and a given base temperature, used in estimating heating and cooling energy use. For any one day, there are as many degree days (Kelvin-days) as there are degrees Fahrenheit (degrees Celsius) departure of the mean temperature for the day from the base temperature

Density

mass per unit of volume

Dew-point temperature

temperature of moist air
saturated at pressure p , with the
same humidity ratio W as that of
the given sample of moist air. It is
defined as the solution $td(p, W)$
of the equation: $Ws(p, td) = W$

Distribution system

(1) conveying means, such as ducts, pipes, and wires, to bring substances or energy from a source to the point of use. The distribution system includes auxiliary equipment such as fans, pumps, and transformers. (2) parts of a cooling tower, beginning with the inlet connection, that distribute the hot, circulating water within the tower to the points where it contacts the air

Dry-bulb temperature (DBT)

1) temperature of air indicated by an ordinary thermometer shielded from solar and long wave radiation. (2) in general, any thermometer that indicates the temperature of air (or other fluids); distinguished from a wet-bulb thermometer

Economizer

(1) a process employing heat recovery equipment or heat exchangers. (2) device that, on proper variable sensing, initiates control signals or actions to conserve energy. A control system that reduces the mechanical heating and cooling requirement

Energy efficiency ratio (EER)

(1) ratio of net cooling capacity in Btu/h to total rate of electric input in watts under designated operating conditions; (2) ratio of the net total cooling capacity to the effective power input at any given set of rating conditions, in watts per watt

Energy use intensity (EUI)

an expression of the annual energy used or calculated to be used by a building or building space per unit of gross floor area. Expressed in MBtu/ft²·yr (watts-hours/m²·yr)

Enthalpy

(also known as heat content), a thermodynamic quantity equal to the sum of the internal energy of a system plus the product of the pressure volume work done on the system. $H = E + pv$, where H = enthalpy or total heat content, E = internal energy of the system, p = pressure, and v = volume. (Compare to specific enthalpy)

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Fenestration

(1) commonly used to refer to any opening, usually glazed, in a building envelope; windows Examples include windows, plastic panels, clerestories, skylights, glass doors that are more than one-half glass, and glass block walls. (2) in an external wall of a building, any area that allows light to pass

Gross floor area

the sum of the floor areas of all the spaces within the building, with no deductions for floor penetrations other than atria. The exterior faces of exterior walls or the centerline of walls separating buildings are used to measure gross floor area. However, covered walkways, open roofed areas, porches, and similar spaces are not included. Neither are pipe trenches, exterior terraces or steps, roof overhangs, parking garages, surface parking, and other similar features.

Heat capacity

1) the amount of heat necessary to raise the temperature of a given mass by one degree; numerically, the mass multiplied by the specific heat. (2) the capacity of a body to store heat

Heat gain (heat uptake)

quantity of heat a system or enclosed space absorbs

Heat loss

(1) (also known as infiltration losses) energy required to warm outdoor air leaking in through cracks and crevices around doors and windows, through open doors and windows, and through porous building materials (2) (also known as transmission losses) heat transferred through confining walls, glass, ceilings, floors, or other surfaces (3) See also heat gain (heat uptake).

Heat pump

thermodynamic heating and refrigerating system to transfer heat. The condenser and evaporator may change roles to transfer heat in either direction. By receiving the flow of air or other fluid, a heat pump is used to cool or heat. Heat pumps may be the air source with heat transfer between the indoor air stream and outdoor air or the water source with heat transfer between the indoor air stream and a hydronic source (ground loop, evaporative cooler, cooling tower, or domestic water).

Heating degree day

For any one day, when the mean (HDD) temperature is less than the local or country-specific common temperature base, Annual HDDs are the sum of the HDDs over a calendar year.

Heating load

heating load required to replace heat loss from the space being controlled

Illuminance

luminous (or photometric)
irradiance

Indoor air

air inside the building envelope

Indoor air quality

attributes of the respirable air inside a building (indoor (IAQ) climate), including gaseous composition, humidity, temperature, and contaminants. See also indoor environmental quality (IEQ). See also sick building syndrome.

Infiltration

uncontrolled air leakage into conditioned spaces from outside or unconditioned spaces through ceiling, floor, and wall openings that weren't meant to be there. This is caused by the same pressure differences that cause air to leave.

Latent heat

the change in enthalpy brought about by a change in humidity ratio due to the addition or removal of moisture

Life-cycle assessment

the process of evaluating a component, product, assembly, building, etc. and its development from the moment of extraction of raw materials, transportation, processing, manufacturing, use, recyclability, and disposal and assigning a value or assessment of its cumulative and ultimate social, environmental, and economic costs, benefits, and impacts. This is often referred to as a cradle-to-grave or cradle-to-cradle assessment.

Life-cycle cost

cost of equipment over its entire life, including operating, maintenance, and repair/replacement costs. May also include decommissioning costs.

Load profile

summary of thermal or other energy loads in a system over a period of time.
Note: For example, a common load profile on a peak design day for thermal storage designs would show hourly system load requirements for 24 hours.

Metabolic rate

1) rate of energy production in the body.
The rate varies with the type of activity.
(2) the rate of transformation of chemical energy into heat and mechanical work by metabolic activities within an organism, usually expressed in terms of the unit area of the total body surface. Metabolic rate is expressed in met units.

Microclimate

conditions such as temperature, humidity, and motion of air within an enclosure or limited outdoor area

Natural ventilation

movement of air into and out of a space primarily through intentionally provided openings (such as windows and doors), through nonpowered ventilators, or by infiltration

Operative temperature

the uniform temperature of an enclosure in which an occupant would exchange the same amount of heat by radiation plus convection as in the actual nonuniform environment. Compare it to the mean radiant temperature.

Optimization

(1) collection of data in a control system in order to produce the best possible output, usually in accordance with what is most economical. (2) procedures used in the design of a system to maximize or minimize some performance index. May entail the selection of a component, a principle of operation, or a technique. (3) refinement of a system to reduce its energy requirements

Outdoor air

1) air outside a building or taken from the external atmosphere and, therefore, not previously circulated through the system. (2) ambient air that enters a building through a mechanical ventilation system, through intentional openings for natural ventilation, or by infiltration. (3) compare to outside air

Outside air

Air external to a defined zone
(e.g., corridors)

Owner's project requirements (OPR)

a written document that details the functional requirements of a project and the expectations of how it will be used and operated. These include project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information. (The term project intent is used by some owners for their commissioning process, Owner's Project Requirements.)

Performance factor

the ratio of capacity to power input at specified operating conditions.

Using consistent units, the performance factor may be expressed in dimensionless form as a coefficient of performance (COP) or as the energy efficiency ratio (EER).

Plenum

Plenum box or chamber (1) a compartment or chamber with one or more ducts that is part of the air-distribution system and not used for occupancy or storage. Building parts often form a plenum. (2) an air compartment attached to or integral to a forced-air furnace that distributes heated air after it leaves the heat exchanger in a supply plenum or collects air that enters the return inlet in a return plenum. (3) component that interfaces ductwork and one or more air terminal devices; can equalize pressure or velocity across the device by design or accessories.

Pressure independent

The flow rate through a flow control device is not affected by changes in system pressure.

Primary air

(1) any air that is mixed with fuel at or in a burner prior to burning. (2) in a clean room, air that recirculates through the work space (3) treated supply air that enters the space through any supply air device, such as an air outlet, or through any air supply terminal, such as a VAV unit or fan terminal unit. The air is not mixed with space air before entering the space.

Psychrometric

relating to the measurement or determination of atmospheric conditions, particularly regarding moisture mixed with air

Range

(1) difference between the highest and lowest operational values, such as pressure, temperature, rate of flow, or computer values. (2) region between limits within which a quantity is measured, transmitted, or received, expressed by stating the lower and upper range values

Return air

air removed from a space to be recirculated or exhausted. Air extracted from a space and totally or partially returned to an air conditioner, furnace, or other heating, cooling, or ventilating system

Sensible heat

the energy exchanged by a thermodynamic system that relates to a change in temperature

Sensible heat ratio (SHR)

[also known as sensible heat factor (SHF)] is the ratio of sensible heat transfer to total (sensible and latent) heat transfer for a process. Also, see sensible heat and latent heat.

Sensitivity

a measure of the smallest incremental change to which an instrument can respond

Setback

Reduction of heating (by reducing the setpoint) or cooling (by increasing the setpoint) during hours when a building is unoccupied or during periods when lesser demand is acceptable

Setpoint

Reduction of heating (by reducing the setpoint) or cooling (by increasing the setpoint) during hours when a building is unoccupied or during periods when lesser demand is acceptable

Solar heat gain (SHGC)

The ratio of the solar heat gain entering the space through the fenestration area to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted, or convected into space.

Specific heat (CP)

A standard substance is usually water at 59°F (15°C). The ratio of the amount of heat needed to raise the temperature of a given mass of any substance by one degree to the amount of heat needed to raise the temperature of an equal mass of water at the same temperature. The units are expressed in Btu/lb·°F [J/(kg·K)].

Static pressure

the actual pressure of the fluid, which is associated not with its motion but with its state. The pressure is exerted uniformly throughout the entire fluid. The portion of the fluid pressure that exists by virtue of the degree of compression only If expressed as gage pressure, it may be negative or positive. In a dynamic system, static pressure is the difference between total and velocity pressures. in. H₂O (kPa)

Stratification

division into a series of layers, as with thermal gradients across a fluid in motion or at rest.

Supply air

(1) Air delivered to a space through mechanical or natural ventilation, which may include any combination of outside air, recirculated air, or transfer air. (2) air entering a space from an air-conditioning, heating, or ventilating apparatus for the purpose of comfort conditioning. Supply air is generally filtered, fan-forced, and either heated, cooled, humidified, or dehumidified as necessary to maintain specified conditions. Only the quantity of outdoor air within the supply airflow may be used as replacement air.

Thermal energy storage (TES)

(1) Several technologies store energy in a thermal reservoir for later use. Their use can balance daytime and nighttime energy demand. The thermal reservoir can be hotter or colder than ambient. Today, the main use is making ice, chilled water, or eutectic solution at night to cool environments during the day. (2) Thermal energy storage technologies store heat from active solar collectors in an insulated repository for space heating, domestic or processed hot water, or electricity. Most practical active solar heating systems store heat for a few hours to a day. Few seasonal thermal stores store summer heat for winter space heating, but their number is growing.

Thermal comfort

the condition of mind that expresses satisfaction with the surrounding thermal environment and is assessed by subjective evaluation. Thermal comfort is affected by heat conduction, convection, radiation, evaporative heat loss, and relative air motion.

Thermal resistance

(R-value), the reciprocal of the time rate of heat flow through a unit area induced by a unit temperature difference between two defined surfaces of material or construction under steady-state conditions; units of thermal resistance are $\text{h}\cdot\text{ft}^2\cdot^\circ\text{F}/\text{Btu}$ ($\text{m}^2\cdot^\circ\text{K}/\text{W}$); thermal resistance is the reciprocal of the thermal conductance.

Thermostat

an automatic control device used to maintain temperature at a fixed or adjustable setpoint

Ventilation

(1) the process of supplying air to or removing air from a space for the purpose of controlling air contaminant levels, humidity, or temperature within the space. (2) the process of supplying or removing air by natural or mechanical means to or from any space. Such air is not required to have been conditioned.

Wet-bulb temperature

the temperature indicated when a thermometer bulb is covered with a water-saturated wick over which air is caused to flow at approximately 4.5 m/s (900 ft/min) to reach the equilibrium temperature of water evaporating into the air when the heat of vaporization is supplied by the sensible heat of the air.

Zoning

division of a building or group of buildings into separately controlled spaces (zones), where different conditions can be maintained simultaneously.

Basis of design (BOD)

the information necessary to accomplish the owner's project requirements, including system descriptions, indoor environmental quality criteria, design assumptions, and references to applicable codes, standards, regulations, and guidelines.

Commissioning (Cx)

the process of verifying and documenting that a building and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the owner's project requirements.

Commissioning authority (CxA)

the individual designated to organize, lead, and review the completion of commissioning process activities. The CxA facilitates communication among the owner, designer, and contractor to ensure that complex systems are installed and function in accordance with the owner's project requirements.

District energy system (DES)

a central energy conversion plant and transmission and distribution system that provide thermal energy to a group of buildings (e.g., a central cooling plant on a university campus). It does not include central energy systems that provide only electricity.

Downstream equipment

the heating and cooling systems, equipment, and controls located in the project building or on the project site and associated with transporting the thermal energy of the district energy system (DES) into heated and cooled spaces. Downstream equipment includes the thermal connection or interface with the DES, secondary distribution systems in the building, and terminal units.

Operations and maintenance (O&M) plan

a plan that specifies major system operating parameters and limits, maintenance procedures and schedules, and documentation methods necessary to demonstrate proper operation and maintenance of an approved emissions control device or system

Systems manual

provides the information needed to understand, operate, and maintain the systems and assemblies within a building. It expands the scope of the traditional operating and maintenance documentation and is composed of multiple documents developed during the commissioning process, such as the owner's project requirements, operation and maintenance manuals, and sequences of operation.

Upstream equipment

a heating or cooling system or control associated with the district energy system (DES) but not part of the thermal connection or interface with the DES. Upstream equipment includes the thermal energy conversion plant and all the transmission and distribution equipment associated with transporting the thermal energy to the project building or site.

IT annual energy

electricity consumption by information technology and telecom equipment, which includes servers, networking, and storage equipment, over the course of a year

Plug load or receptacle load

the electrical current drawn by all equipment that is connected to the electrical system via a wall outlet.

Plug load or receptacle load

the power from an IT equipment powering device. The output of a power distribution unit (PDU) does not include efficiency losses from internal transformations, but it may include downstream non-IT ancillary devices like fans in IT racks. Non-IT equipment (e.g., computer room air-conditioning units, air handlers, in-row coolers) must be metered and subtracted from the PDU output reading. Metering should match power usage efficiency requirements.

Power utilization effectiveness (PUE)

a measure of how effectively a data center uses its power; specifically, how much power is used by computing equipment rather than for cooling and other overhead.

Process energy

power resources consumed in support of a manufacturing, industrial, or commercial process other than conditioning spaces and maintaining comfort and amenities for building occupants. It may include refrigeration equipment, cooking and food preparation, clothes washing, and other major support appliances. (ASHRAE)

Process load or unregulated load

the load on a building resulting from the consumption or release of process energy (ASHRAE)

Regulated load

any building end use that has either a mandatory or a prescriptive requirement in ANSI/ASHRAE/IES Standard 90.1–2010

Server input

the information technology (IT) load as measured at the point of connection (e.g., power receptacle) of the IT device to the electrical power system. Server input captures the actual power load of the IT device, exclusive of any power distribution losses and non-IT loads (e.g., rack-mounted fans).

Uninterruptible power supply (UPS)

output the electricity a unit supplies to run IT equipment during a power outage. UPS output includes losses from downstream electrical distribution components like power distribution units and IT rack-mounted non-IT ancillary devices like fans, but not system efficiency losses. Metered usage of non-IT equipment (e.g., computer room air-conditioning units, air handlers, in-row coolers) must be subtracted from UPS output. For power usage efficiency (PUE) categories 1, 2, and 3, continuous consumption metering is required.

Demand response (DR)

a change in electricity use by demand-side resources from their normal consumption patterns in response to changes in the price of electricity or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized.

Demand response (DR)

event a specific period of time when the utility or independent service operator calls for a change in the pattern or level of use of grid-based electricity from its program participants. Also known as a curtailment event.

Load shedding

an intentional action by a utility to reduce the load on the system. Load shedding is usually conducted during emergency periods, such as capacity shortages, system instability, or voltage control.

Peak demand

the maximum electricity load at a specific point in time or over a period of time

Permanent peak load shifting

the transfer of energy consumption to off-peak hours, when demand for power is lower and energy is therefore less expensive.

Solar garden

a shared solar array or other renewable energy system with grid-connected subscribers who receive credit for the use of renewables using virtual net metering. Also known as a community renewable energy system. (Adapted from solargardens.org)

Natural refrigerant

a compound that is not manmade and is used for cooling. Such substances generally have a much lower potential for atmospheric damage than manufactured chemical refrigerants. Examples include water, carbon dioxide, and ammonia.

Carbon offset

a unit of carbon dioxide equivalent that is reduced, avoided, or sequestered to compensate for emissions occurring elsewhere (World Resources Institute)

District energy system (DES)

a central energy conversion plant and transmission and distribution system that provide thermal energy to a group of buildings (e.g., a central cooling plant on a university campus). It does not include central energy systems that provide only electricity.

Green power

a subset of renewable energy composed of grid-based electricity produced from renewable energy sources

Scope 1 emissions

direct greenhouse gas emissions from sources owned or controlled by the entity, such as emissions from fossil fuels burned on site. Electricity produced on site through the burning of fossil fuels is measured by the Scope 1 emissions associated with that fossil fuel.

Scope 2 emissions

indirect greenhouse gas emissions associated with the generation of purchased electricity, heating, cooling, or steam on site through a utility provider for the entity's consumption. Transmission and distribution losses related to hot water, chilled water, and steam are included in Scope 2 emissions, but transmission and distribution losses associated with electricity are not included.

Chlorofluorocar bon (CFC)-based refrigerant

A chlorofluorocarbon (CFC)-based refrigerant is a fluid containing hydrocarbons that absorbs heat from a reservoir at low temperatures and rejects heat at higher temperatures. When emitted into the atmosphere, CFCs cause the depletion of the stratospheric ozone layer.

Energy modeling

Energy modeling or energy system modeling is the process of building computer models of energy systems in order to analyze them. Such models often employ scenario analysis to investigate different assumptions about the technical and economic conditions at play.

Agent-based models

Agent-based models are a specific case of models where actors participating in, e.g., the electricity market are modeled explicitly as agents with distinct strategies and behaviors.

The bottom-up approach

The bottom-up approach follows a techno-economic philosophy that leads to disaggregated models representing the energy sector with great details. Bottom-up models are appropriate for the assessment of new technologies and marginal cost analysis.

Capacity expansion models

Capacity expansion models simulate generation and transmission capacity investment, given assumptions about future electricity demand, fuel prices, technology cost and performance, and policy and regulation.

Computable General Equilibrium (CGE)

Computable General Equilibrium (CGE) models are large numerical models that combine economic theory with real economic data in order to derive computationally the impacts of policies or shocks in the economy.

Demand dispatch

Demand dispatch is the capability to aggregate and precisely control (or dispatch) individual loads on command.

Demand response

Demand response refers to the ability to curtail some electrical loads at peak times to alleviate the need for peaking generation sources. Basically, it means being able to turn loads off on command.

Econometric method

The econometric method uses economic models found through statistical methods to make predictions about the future by extrapolating from what has been seen in the past.

Partial equilibrium models

Partial equilibrium models are concerned with computing economic equilibria, in particular for the energy sector. Partial equilibrium models deal only with equilibrium in the energy sector without taking into account possible adjustments in the rest of the economy. They focus on medium- to long-range analyses. General equilibrium models are concerned with the conditions that apply when simultaneous equilibrium in all markets is imposed.

The integrated modeling framework method

The integrated modeling framework method uses interdisciplinary approaches (including natural and social sciences) combined with transdisciplinary research methods to enable the study of complex questions about the impact of technical, socio-economic, and political decisions on the performance of the future energy system.

IoT (Internet of Things)

IoT (Internet of Things) employs sensors and communication technologies for sensing and transmitting real-time data, which enables fast computations and optimal decision-making. Moreover, IoT can help the energy sector transform from a centralized to a distributed, smart, and integrated energy system.

Life-cycle assessment

Life-cycle assessment is a method to assess environmental impacts associated with all the stages of a product's life from cradle to grave (i.e., from raw material extraction through material processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling).

Optimization models

Optimization models generate outcomes that represent the best solution for given variables while meeting the given constraints. Optimization models look for 'ideal' outcomes (e.g., best technologies and energy forms satisfying exogenous constraints).

Simulation models

Simulation models simulate an energy system based on specified equations and characteristics. They are often bottom-up models with a detailed technological description of the energy system. Simulation models allow the testing of various system topologies as well as the impacts and developments of various scenarios.

The top-down approach

The top-down approach follows a macro-economic philosophy that leads to aggregate models in the sense that they use aggregate economic variables. Top-down models are adapted to the analysis of the macro-economic impacts of energy policies.

Unit commitment problem

The unit commitment problem figures out how committed generating units should be in order to meet demand, keep costs low, and make sure safety and technical requirements are met.



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