

BUSINESS ENERGY PROFESSIONAL - BEP

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Domain 1: Codes and Standards and Green Buildings**ASHRAE 90.1**

Energy standard for buildings other than low-rise residential

ASHRAE 90.2

Energy standard for low-rise residential buildings

ASHRAE 62.1

Ventilation standard for acceptable indoor air quality

Energy code

Minimum legal energy-efficiency rules for building design and construction

Code compliance paths

Prescriptive, trade-off or performance methods of showing a design meets code

Minimum outdoor air

Ventilation airflow set by ASHRAE 62.1 from occupancy and floor area

Domain 1: Codes and Standards and Green Buildings**Green building**

Building designed to cut energy, water and environmental impact over its life

LEED

Green building rating system with Certified, Silver, Gold and Platinum levels

LEED-NC Gold

At least 60 points

LEED energy points

Awarded for reducing energy costs against a baseline

ENERGY STAR

US programme that labels energy-efficient products and buildings

Portfolio Manager

Free ENERGY STAR tool for benchmarking building energy use

Domain 1: Codes and Standards and Green Buildings

IECC

International Energy Conservation Code: model energy code adopted by many US states

Prescriptive path

Meets code by following specific requirements for each component, such as R-values

Performance path

Meets code by modelling total building energy use against a baseline

Trade-off path

Lets a weak component be offset by a stronger one

LEED Platinum

Highest level: 80 or more points

Indoor air quality

Needs humidity control, good filtration, moisture control and ventilation

Domain 2: Energy Fundamentals**Energy vs power**

Energy is the capacity to do work (kWh); power is the rate of use (kW)

Energy conservation

Using less energy by cutting demand or waste

Energy efficiency

Getting the same output from less energy

Site energy

Energy consumed at the facility, as shown on the bills

Source energy

Primary energy used to generate and deliver site energy, including losses

kWh

Unit of energy: 1 kWh = 3,412 Btu

Domain 2: Energy Fundamentals**Demand (kW)**

Rate of power use, usually the highest reading over a short interval

kVA

Apparent power: $\text{kW} \div \text{power factor}$

Power factor

Ratio of real power (kW) to apparent power (kVA)

1 therm

100,000 Btu

1 MMBtu

1,000,000 Btu (10 therms)

1 HP

746 W (not 3,412 W)

Domain 2: Energy Fundamentals**Btu**

British thermal unit: heat needed to warm 1 lb of water by 1°F

MJ

Megajoule, an SI energy unit: 1 MJ is about 948 Btu

Propane energy content

About 95,000 Btu per gallon

Primary vs secondary energy

Primary: raw fuels. Secondary: electricity or steam made from them

Efficiency

Useful energy output ÷ energy input

CCF

100 cubic feet of gas; converted to therms using the gas heat content

Domain 3: Utility Rate Structures**Commodity vs distribution**

Commodity is the energy itself; distribution is the cost of delivering it

Customer charge

Fixed monthly charge, independent of use

Energy charge

Charge per kWh (or per therm) consumed

Demand charge

Charge based on the peak kW or kVA in the billing period

Load factor

Average demand ÷ peak demand; high means steady use

Power factor adjustment

Surcharge (or credit) when power factor is below (or above) a set level

Domain 3: Utility Rate Structures**Block rate**

Price per unit changes as use passes set blocks or tiers

Time-of-use (TOU) rate

Price varies by time of day and season

Real-time pricing

Price follows the hourly wholesale market

Interruptible vs firm power

Interruptible gets a lower rate but can be curtailed; firm cannot

Primary vs secondary service

Primary: higher voltage, customer owns the transformer. Secondary: utility steps it down

Power cost adjustment

Pass-through of fuel and purchased-power cost changes onto the bill

Domain 3: Utility Rate Structures**Bundled vs transportation**

Bundled: utility sells and delivers.
Transportation: you buy elsewhere, utility delivers

PPA

Long-term contract to buy electricity at an agreed price from a specific project

VPPA

Financial contract for the price difference; no physical delivery; true-up costs apply

Green power

Electricity from renewable sources, bought through premium rates or certificates

DSM

Demand-side management: utility programmes that cut or shift customer load

Rate analysis

Comparing bills under different rate schedules to find the lowest cost

Domain 3: Utility Rate Structures**Demand ratchet**

Sets a minimum billing demand based on a past peak

Rate development

Regulators set rates to recover utility costs plus an allowed return

Standby charge

Charge for the utility standing ready to supply when on-site generation is down

Tariff

Published schedule of a utility's rates and rules

kVA demand billing

Demand charged on kVA, so low power factor raises the bill

Riders

Extra charges or credits for specific programmes added to the base rate

Domain 4: Electric and Gas Procurement**Procurement risk**

Exposure to price swings, supply, credit and regulatory change

Hedging

Locking in prices to reduce exposure to market swings

Fixed-price contract

Price set for the whole term, giving budget certainty

Index-price contract

Price floats with a market index, so it carries price risk

Price discovery

How trading in a market sets the price of a fuel

Henry Hub

US natural gas pricing point and benchmark for futures

Domain 4: Electric and Gas Procurement**Basis**

Price difference between a local gas point and Henry Hub

RFP

Request for Proposal: formal bid process to select a supplier

Layered purchasing

Buying in tranches over time to average the price

Competitive supplier

Third-party supplier chosen by the customer in a deregulated market

Hydrogen

Fuel with no CO₂ at point of use; carbon impact depends on how it is made

Aggregated purchasing

Pooling the load of several sites to get better pricing

Domain 4: Electric and Gas Procurement**Spot price**

Price for immediate delivery of gas or power

Forward contract

Agreement for future delivery at a price set today

Futures contract

Exchange-traded contract to buy a fuel at a set price on a future date

Take-or-pay

Contract term requiring payment for a minimum volume even if unused

Load profile

Pattern of use over time, which suppliers use to price supply

Deregulation

Opens energy supply to competition while utilities keep delivery

Domain 5: Energy Accounting, Carbon Auditing, Metering & EIS**Point-of-use cost**

Fuel price $\div$ combustion efficiency, per unit of delivered heat

Break-point price

Fuel price at which two fuels cost the same per unit of useful heat

Independent variable

Factor that drives energy use, such as weather, occupancy or production

Interval data

Energy or demand readings at short fixed intervals, such as 15 minutes

EUI

Energy Use Index: annual energy per unit of floor area (Btu/ft²/yr or MJ/m²/yr)

Benchmarking

Comparing energy use with similar buildings or past performance

Domain 5: Energy Accounting, Carbon Auditing, Metering & EIS**Heating degree days**

Degrees below a base temperature (65°F), summed daily; measures heating need

Cooling degree days

Degrees above a base (65°F), summed daily; an 81°F day adds 16

End-use analysis

Splits energy use into lighting, HVAC, process and other loads

Scope 1, 2 and 3

Direct emissions; purchased energy emissions; other indirect value-chain emissions

Carbon neutrality

Net zero CO₂: reduce first, then offset or remove what remains

Sequestration

Capturing and storing carbon dioxide, for example in forests or underground

Domain 5: Energy Accounting, Carbon Auditing, Metering & EIS**Life cycle carbon**

Emissions from raw materials through use and disposal (cradle to grave)

CT-rated metering

Current transformers scale high current for the meter; match phase and polarity

Sub-metering

Metering individual loads or areas behind the main utility meter

AMR

Automatic Meter Reading: remote collection of meter data

EIS

Energy Information Services: software that collects, stores and analyses meter data

Revenue meter

Utility meter used for billing electricity or gas

Domain 5: Energy Accounting, Carbon Auditing, Metering & EIS**Carbon trading**

Buying and selling emission allowances or credits

Electrification

Replacing fuel-burning equipment with electric ones, such as heat pumps and EVs

Pressure and temperature correction

Adjusts gas volumes to standard conditions on high-pressure meters

Estimated vs actual read

Estimated reads are calculated; actual reads are taken from the meter

Cost-centre metering

Assigns energy cost to departments or tenants for budgeting

Energy forecasting

Predicting future use from drivers such as weather and production

Domain 6: Energy Assessment and Instrumentation**Energy assessment**

Systematic review of energy use to find savings opportunities

Type I audit

Preliminary walk-through that finds no-cost and low-cost measures

Type II audit

Detailed survey with measurements, analysis and cost estimates

Investment-grade audit

Detailed audit with firm costs and savings to support financing

Master audit

Comprehensive audit that also collects equipment operating and maintenance procedures

O&M review

Checks procedures and equipment condition for no-cost savings

Domain 6: Energy Assessment and Instrumentation**Data logger**

Records readings such as power, temperature or run time over time

Power meter

Measures kW, kVA, power factor, voltage and current

Infrared camera

Shows surface temperature differences to find heat losses and hot spots

Combustion analyser

Measures flue gas O₂, CO₂ and CO to find combustion efficiency

Ultrasonic leak detector

Finds compressed air, steam and gas leaks by sound

Assessment report

Documents findings, savings, costs and priorities

Domain 6: Energy Assessment and Instrumentation**Common deficiencies**

Typical findings: lights on in empty spaces, leaks, poor controls, oversized equipment

Light meter

Measures illuminance in footcandles or lux

Clamp-on ammeter

Measures current without breaking the circuit

Anemometer

Measures air velocity

Psychrometer

Measures dry-bulb and wet-bulb temperature to find humidity

Ultrasonic flow meter

Measures liquid flow from outside the pipe

Domain 7: Energy Economics and Alternative Financing**Simple payback**

Investment $\div$ annual savings; ignores the time value of money

NPV

Present value of savings minus investment; positive means it beats the MARR

MARR

Minimum Attractive Rate of Return: the discount rate a project must beat

IRR

Discount rate that makes NPV equal zero

SIR

Savings-to-Investment Ratio: present value of savings $\div$ investment

Life cycle cost

All costs of owning an asset over its life

Domain 7: Energy Economics and Alternative Financing**Annual worth**

NPV converted into an equivalent
uniform yearly amount

LCOE

Levelized cost of energy: lifetime cost
÷ lifetime energy produced

Direct purchase

Buying with cash or a loan; the owner
keeps the savings and the risk

Lease

Paying to use equipment over a term,
with lower upfront cost

**Performance
contracting**

ESCO funds and installs measures and
is paid from the guaranteed savings

**Choosing a finance
method**

Weigh capital available, risk, ownership
and tax treatment

Domain 7: Energy Economics and Alternative Financing**Time value of money**

A dollar today is worth more than a dollar received later

Cash flow

Money going in and out of a project over time

Energy price escalation

Expected yearly rise in energy prices, used in economic analysis

Salvage value

Value of equipment at the end of its life

Capital lease

Treated as ownership, with the asset on the balance sheet

Operating lease

Rental in which the lessor keeps ownership

Domain 8: Commissioning and Measurement & Verification**Commissioning**

Process confirming systems are designed, installed and operate as intended

Retro-commissioning

Commissioning an existing building that was never commissioned

Recommissioning

Repeating commissioning on a building that was commissioned before

Real-time commissioning

Ongoing monitoring and tuning to keep performance on target

Seasonal commissioning

Testing systems under different seasonal conditions

Commissioning RFP

Request for proposal defining scope and deliverables for a commissioning provider

Domain 8: Commissioning and Measurement & Verification**M&V**

Measuring and verifying the actual energy savings from a project

IPMVP

International Performance Measurement and Verification Protocol

IPMVP Options A-D

A: key-parameter isolation. B: all-parameter isolation. C: whole facility. D: calibrated simulation

Baseline

Energy use before the project, adjusted to current conditions

Routine adjustment

For expected recurring changes, such as weather (degree days)

Non-routine adjustment

For unexpected changes to the baseline, such as added floor area or load

Domain 8: Commissioning and Measurement & Verification**Commissioning phases**

Planning, design, construction,
acceptance and occupancy

**Commissioning
benefits**

Lower energy cost, fewer complaints
and longer equipment life

**Commissioning
documentation**

Records of plans, test results, issues
and the final report

Reasons for M&V

Proves savings, supports financing and
manages performance risk

**Measurement
boundary**

Defines which equipment and energy
uses an M&V option covers

Avoided energy use

Adjusted baseline energy minus energy
used in the reporting period

Domain 9: Building Systems**Lumen**

Unit of light output from a source

Footcandle / lux

Illuminance: lumens per ft² (footcandle)
or per m² (lux)

Efficacy

Lumens per watt of a lamp or lighting
system

CRI

Colour Rendering Index: how naturally
a source shows colours (0-100)

LLD

Lamp Lumen Depreciation: loss of light
output over lamp life

LPD

Lighting Power Density: connected
lighting watts ÷ floor area

Domain 9: Building Systems**EER / SEER**

Cooling output (Btu/h) ÷ power (W), at one point (EER) or over a season (SEER)

COP

Cooling or heating output ÷ electrical input, in the same units

IEER / IPLV

Efficiency ratings that weight part-load performance

Economizer

Uses cool outside air for free cooling

Chilled-water reset

Raises chilled-water supply temperature when the load is low

ERV

Energy Recovery Ventilator: transfers heat and moisture between exhaust and incoming air

Domain 9: Building Systems**MERV**

Minimum Efficiency Reporting Value: air filter rating

HEPA

Filter that removes at least 99.97% of 0.3 micron particles

CO₂ control

Adjusts ventilation to occupancy using CO₂ sensors

Open vs closed loop

Closed loop uses feedback from the output; open loop does not

PID control

Proportional-Integral-Derivative control that adjusts to reduce error

BAS

Building Automation System: central control of HVAC, lighting and other systems

Domain 9: Building Systems**Colour temperature**

Appearance of white light in kelvin: low is warm, high is cool

LLF

Light Loss Factor: overall allowance for dirt and lamp depreciation

LED

Solid-state lamp with high efficacy and long life

Relamping

Replacing lamps with more efficient ones, often keeping the fixtures

Relative humidity

Moisture in the air as a percentage of the most it can hold at that temperature

Air vs water-based systems

Air-based move heat with air; water-based use chilled or hot water pipes

Domain 10: Industrial Process and Utility Equipment**Vapor compression cycle**

Evaporator, compressor, condenser and expansion valve move heat

Heat pump

Vapor-compression system that moves heat from a cold space to a warm one

Ton of cooling

12,000 Btu/h of cooling

Induction motor

Most common AC motor; runs slightly below synchronous speed

Synchronous motor

Runs at synchronous speed; can improve power factor

DC motor

Excellent starting torque and easy speed control

Domain 10: Industrial Process and Utility Equipment**Squirrel-cage rotor**

Rotor of bars joined by end rings, used in induction motors

VFD

Varies motor speed and frequency to match load; big savings on fans and pumps

Affinity law (power)

Power varies with speed cubed: 85% speed needs about 61% power

Fire-tube boiler

Hot gases flow through tubes surrounded by water

Water-tube boiler

Water flows through tubes heated by hot gases outside

Condensing boiler

Recovers latent heat from flue gas; efficiency can exceed 90%

Domain 10: Industrial Process and Utility Equipment

Turbine / expander

Converts steam or gas pressure drop into shaft power

Heat exchanger

Transfers heat between fluids without mixing them

Compressed air leaks

Often a major waste because they run every hour the system is on

Air pressure reduction

Lowering compressed air pressure cuts compressor energy (about 1% per 2 psi)

Power quality

Voltage and frequency stability, including sags, surges and harmonics

Local distribution company

Delivers gas or electricity to end users

Domain 10: Industrial Process and Utility Equipment**Chiller**

Machine that cools water for building or process cooling

Cooling tower

Rejects heat from condenser water by evaporation

Premium-efficiency motor

Motor built to higher efficiency standards, with lower losses

Boiler efficiency

Heat delivered to steam or water ÷ fuel energy input

Steam trap

Releases condensate while holding back steam

Air system components

Compressor, dryer, filters, receiver and piping

Domain 11: Combined Heat and Power and On-site Generation**CHP**

Combined Heat and Power: one fuel makes electricity and useful heat

CHP efficiency

Total efficiency (power plus heat) is often 60-80%

Good CHP candidates

Sites with steady, simultaneous electric and heat demand

Distributed generation

Generation located at or near the point of use

Smart grid

Electric grid with two-way communication and automation

Combustion turbine

Gas turbine; its hot exhaust suits heat recovery

Domain 11: Combined Heat and Power and On-site Generation**Microturbine**

Small high-speed turbine, from tens to hundreds of kW

Reciprocating engine

Piston engine fuelled by diesel, natural gas or hydrogen

Fuel cell

Converts fuel, often hydrogen, to electricity electrochemically without combustion

Concentrating solar

Mirrors focus sunlight to make heat, then power

Solar PV

Converts sunlight directly into electricity

Wind turbine

Converts wind energy into electricity

Domain 11: Combined Heat and Power and On-site Generation**Organic Rankine cycle**

Uses an organic fluid to make power from low-temperature heat, such as geothermal

Battery storage

Stores electricity chemically; rated in kW (power) and kWh (energy)

Discharge duration

How long storage can supply rated power: $\text{kWh} \div \text{kW}$

Flywheel / capacitors

Fast-response storage for short bursts of power

Compressed air / hydraulic

Stores energy as compressed air or pumped water for long-duration use

Barriers to CHP / DG

High upfront cost, utility interconnection, standby rates and permitting

Domain 11: Combined Heat and Power and On-site Generation**Steam turbine**

Uses steam pressure to turn a generator, often paired with a CHP boiler

Geothermal

Heat from the earth used for power or direct heating

Ocean and tidal

Power from waves, tides and currents

Green / premium rate offerings

Utility options to buy renewable or premium-reliability power

Power vs energy rating

Power (kW) is how fast storage delivers; energy (kWh) is how much it holds

Pumped hydro

Pumps water uphill when power is cheap and releases it to generate later