The Definition of Zero Energy Buildings—Frequently Asked Questions

Definitions in quotes are from A Common Definition for Zero Energy Buildings *<https://buildingdata.energy.gov/cbrd/resource/1938>, as established by the Building Technology Office at the U.S. Department of Energy.*

What is a zero energy building?
A zero energy building is a building that produces as much energy as it consumes. More formally, it is:

"An energy-efficient **building** where, on a **source energy** basis, the actual **annual delivered energy** is less than or equal to the on-site renewable **exported energy**."

Note that this is an operational definition, meaning that to comply with the definition requires actual measured data. Each **bolded** term has its own formal definition. These and other definitions as well as calculation methodologies can be found in *A Common Definition for Zero Energy Buildings* <https://buildingdata.energy.gov/cbrd/resource/1938>.

How is a building defined?
A building is "a structure wholly or partially enclosed within exterior walls, or within exterior and party walls and a roof, affording shelter to persons, animals, or property." The key is to define the boundary for the building. Often this boundary is at the point of the utility meters or the point of delivery of fuels (such as oil and propane). The building may include a grouping of closely related buildings such as an office building and its parking garage or parking lot.

What is source energy?
Source energy is "energy as measured at the building site plus the energy consumed in the extraction, processing, and transport of primary fuels such as coal, oil, and natural gas; energy losses in thermal combustion in power generation plants; and energy losses in transmission and distribution to the building site." It represents the total energy impacts of using the energy at the building site. Source energy is an energy metric that most closely captures the overall environmental impacts of using energy.

How is source energy measured?
The purpose of source energy is to embody the inefficiencies of producing and transporting energy in a way that accounts for its environmental consequences. From the building perspective, the only energy that can be measured is at the building's site boundary, usually defined as the point of purchase of the energy, such as a utility meter or propane or oil delivery. Traditionally, a multiplier is applied to the measured site energy to approximate the source energy.

With respect to the zero energy building definition, how does a site-based zero energy building compare with a source-based zero energy building?
As long as source energy is computed based on fixed multipliers from site energy, it is as easy or easier to meet the definition using a source energy definition than it is using a site energy definition (i.e., less on-site renewable energy is required). If the building is all-electric, a site-

based zero energy building and a source-based zero energy building are the same based on the site-to-source multiplier being the same whether energy is "bought" or "sold" and because there is only fuel type (electricity).

Can I use Portfolio Manager to determine if my building is zero energy?
Portfolio Manager is a widely used tool for conveniently gathering and storing energy consumption data, so its use is encouraged. This consumption data can be used with the formulas in *A Common Definition for Zero Energy Buildings* <https://buildingdata.energy.gov/cbrd/resource/1938> to determine whether the building meets the zero energy definition. However, Portfolio Manager currently does not have the feature to directly determine if a building is Zero Energy. Portfolio Manager is designed to capture the energy consumption of a building and to value a building on its energy efficiency measures. Because of this, on-site renewable energy production and building energy consumption data is entered separately on the portal.

Why local on-site renewable energy?
Local solar photovoltaics (PV) use a building's existing footprint, and don't require additional land resources or grid infrastructure. If done properly, PV can be a distributed and resilient means of providing electricity that adds value for owners, communities, and utilities.

What is a renewable energy certificate?
A renewable energy certificate (REC) is a financial instrument that is generated for every 1,000 kilowatt-hours (1 megawatt-hour) of energy produced by a renewable energy system. The REC only exists after the energy is generated. It provides a means of tracking and trading the "renewable energy" attributes of energy, separate from the value of the energy itself. It also prevents the ownership of the same renewable energy generation from being claimed twice. Only those that own RECs can "say" that they are powered by renewable energy. Note that some use the word "credit" instead of "certificate." The concept is that the renewable energy has already been produced, however, so "credit" doesn't accurately capture the intent.

Issues arise when a building owner has sold (knowingly or unknowingly) the RECs and still claims that to be using renewable energy. Many state and utility incentive programs own the RECs in exchange for the financial incentive. Some of these entities then either sell these RECs to recoup their investment or retire the RECs to help meet the requirements of a renewable portfolio standard. To retire means that the renewable energy attributes cannot be claimed by another entity. Retaining the RECs means that the owner of the REC can claim the renewable energy attributes.
See: http://apps3.eere.energy.gov/greenpower/markets/certificates.shtml

What is delivered energy?
Delivered energy is "any type of energy that could be bought or sold for use in the building, including electricity, steam, hot water, or chilled water; natural gas, biogas, landfill gas, coal, coke, propane, petroleum, and its derivatives; residual fuel oil, alcohol-based fuels, wood, biomass, and any other material consumed as fuel."

What is exported energy?

Exported energy is "on-site renewable energy supplied through the site boundary and used outside the site boundary." This is typically electricity exported to the grid, but could also be energy exported to other buildings such as in a campus. Energy used to charge electric vehicles that are used outside the building site boundary also is considered an export.

How are delivered and exported energy measured for a grid-independent building?
Grid-independent buildings are not connected to the electrical utility. Often these buildings purchase non-renewable fuels such as oil or propane. This energy must be accounted for as delivered energy when determining whether the building meets the zero energy definition. It is also possible for a grid-independent building to export energy by, for example, charging the batteries in electric vehicles that operate outside the building site boundary.

Is it possible for a grid-independent building to be zero energy?
The challenge with off-grid buildings is that they almost always have a fossil fuel backup system (either propane or diesel generators). Even though the loads might be very small and on-site renewable energy (often PV) produces almost all the load, the reliability still comes from fossil fuels and a small amount is often consumed. These, by definition, are not zero energy (but are very energy-efficient and good performers). However, electric cars could be recharged and that is considered an export of on-site renewable energy. This is one method to offset the fossil fuels used on site.

What is the difference between a zero energy building and a zero net energy building?
The names net-zero energy, zero-net energy, and zero energy all refer to the same thing. The "zero net" term is used primarily in California and is often related to the societal value of energy using California-based "time-dependent valuations." The net zero terminology is still used in some parts of the country, and "net" has been dropped in others.

Other terms such as "net positive" are sometimes used to refer to buildings that generate more energy than they consume, although this has raised questions about how much more energy must be produced to justify the designation. Similarly, near-zero energy buildings don't meet the definition but still sometimes use the acronym that is used for net zero energy buildings. These buildings are "close" to zero energy, but how close is often not defined.

From an engineering perspective, the word "net" represents a summation of energy flows across a boundary. The key in this instance is that we *choose* only to measure those flows that are commoditized (can be bought and sold—electricity and natural gas, for example). A more appropriate term would be net-commoditized energy buildings. Zero energy is easier to understand and say and many feel that it has broader, more long-term market appeal.

Can I use combined heat and power systems in a zero energy building?
Yes, combined heat and power (CHP) is an effective way to reduce the source energy footprint of a building, because it uses the waste heat produced from generating electricity to provide energy services such as space conditioning and water heating. This in turn can reduce the amount of on-site renewable energy required to meet the zero energy definition. Note, however, that only on-site renewable energy can be exported to the grid and used in offsetting delivered energy. All the power generated by the CHP system must be used in the building. This applies for any

technology that is taking one offsite fuel source and converting it to electricity and heat including micro-turbines and fuel cells.

Can all buildings achieve zero energy status?
Not all buildings can achieve the lofty status of a zero energy building. It requires a large reduction in building loads such that on-site renewables can meet the remaining loads. The limiting factor is often how much solar energy falls on the site—building loads cannot exceed this value. Often buildings that cannot meet the target can operate at very low energy levels and be aggregated with other buildings that have excess generation capacity to create a zero energy campus, portfolio, or community.

Can an industrial building become a zero energy building?
Yes—there is no restriction on the end use of the building in the zero energy definition.

Are plug loads (and other non-regulated loads) included in the building load?
Yes—all the building loads are counted. In today's zero energy buildings, plug loads can account for 50% to 75% of the total load and have an energy and environmental footprint. This energy load needs to be offset with on-site renewable energy.

How can I submit additional questions?
Questions may be sent to high.performance@nrel.gov with "ZEB Question" in the subject line. Questions will not be individually answered and will not be acknowledged, but may be answered in this FAQ forum.