Definitions and Evaluation Method of ZEB（net Zero Energy Building）

1　ZEB objectives/Significance and Ripple effects

1.1 Objectives/Significance

① Reduce environmental impact and realize a sustainable society
② Improve energy security
③ Promote building energy conservation, develop a renewable energy industry, and contribute to the advancement of energy technologies in the world by exporting traditional Japanese architectural methods, which utilize many natural resources as building materials and have developed in response to the Japanese climate.

1.2 Ripple Effects

① Create a new value in architecture and change in people's lifestyle
② Overwhelming contributions to a sustainable low-carbon society
③ Develop and advance sustainable energy technology and application of renewable energy

2　Target timeline to implement ZEB

ZEB will be realized in 2 phases; "ZEB Promotion stage" for becoming ZEB in specified buildings in early-stage and "ZEB Dissemination Stage" for expanding ZEB in typical buildings.

(1) Realization in specified buildings (ZEB Promotion stage)

Completion of the promotion stage is targeted by 2020 (within five years).

(2) Expansion to typical buildings (ZEB Dissemination Stage)

In accordance with the roadmap[1)2)3)] of METI (Ministry of Economy, Trade and Industry), MLIT (Ministry of Land, Infrastructure and Tourism) and MOE (Ministry of Environment), expansion to typical buildings is targeted by 2030.

3　Target building for ZEB realization

In principle, all commercial buildings (excluding residential housing) are expected for ZEB realization as target building which is defined in the Japanese Act on the Rational Use of Energy[4)] whatever the construction is a new or existing building. However, in the promotion stage, schools and office buildings (suburbs type) shall be the priority to achieve ZEB, followed by the office buildings (urban type), commercial buildings, and other facilities in the dissemination stage.

4　ZEB definitions and evaluation method

4.1 ZEB Definition

(1) Qualitative definition (see Figure 1)

Buildings that achieve significant energy conservation through load reduction, natural energy use, and increased efficiency of equipment systems without decreasing indoor and outdoor environmental quality. They also introduce renewable energy, resulting in a nearly zero or positive annual cumulative balance (consumption and generation, or balance with outside of the boundary) of energy (or an index where energy is multiplied by some factor) demand and supply during operation (i.e., supply amount > demand amount).

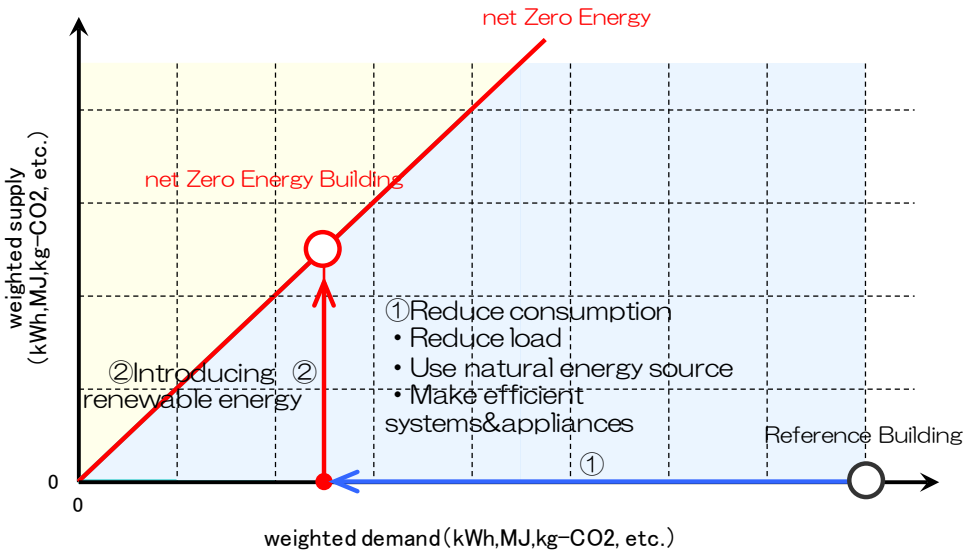
(2) Quantitative definition (see Figure 2, Figure 3)

Defined by Eq. (1) or Eq. (2) according to the balance of supply and demand at the set boundary. (1) expresses the generation/consumption balance, and (2) expresses the delivery/export balance.

G ≥≒ C ・・・・・・・(1)
E ≥≒ D ・・・・・・・(2)

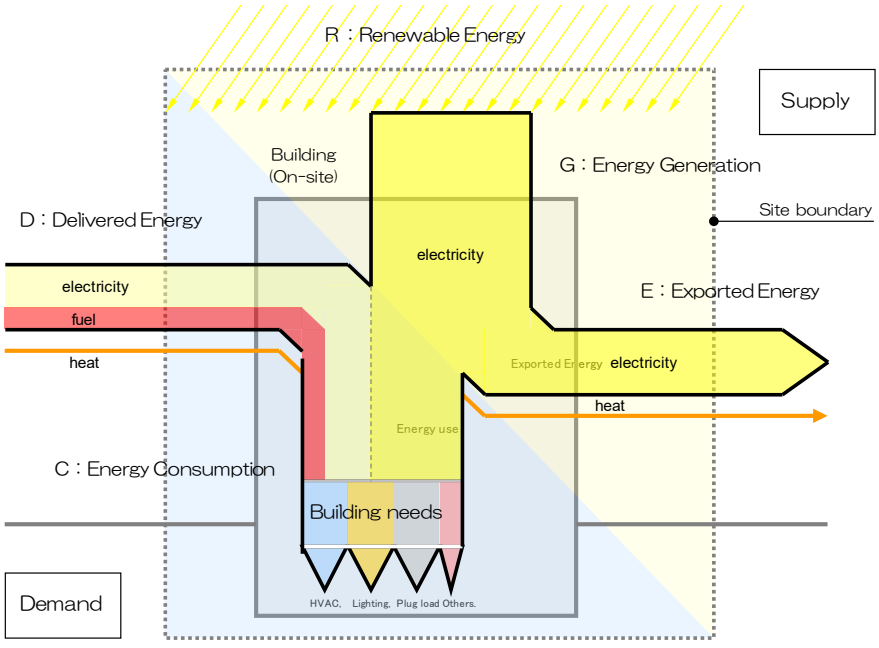
Energy supply
G: Generated Energy　　E: Exported (i.e., supplied to outside of boundary) energy

Energy demand
C: Consumed Energy　　D: Delivered (i.e., supplied from outside of boundary) energy



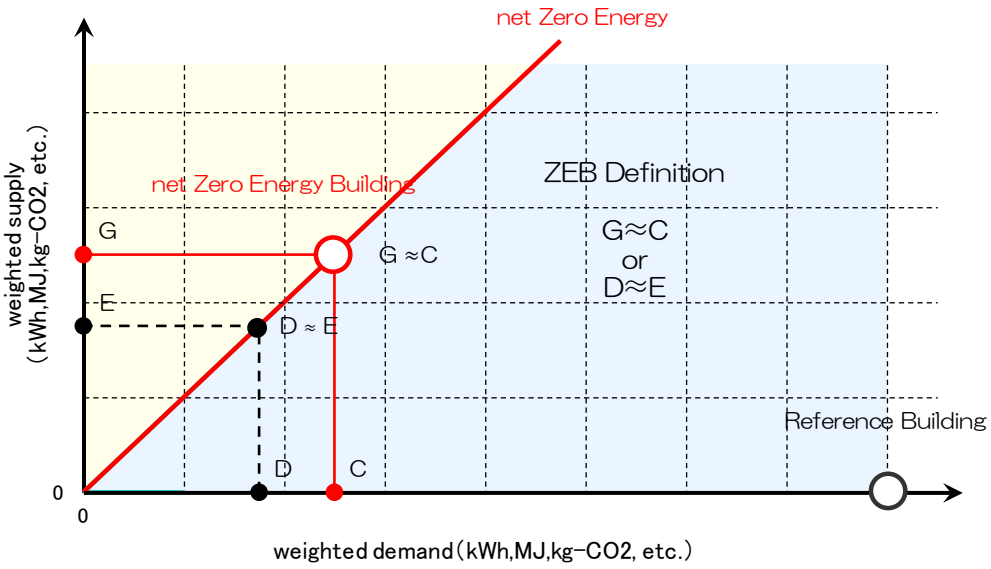
• Reduce energy consumption (reduce load, natural energy use, promote efficiency of systems & appliances)
• Introduce renewable energy (solar energy, wind, geothermal heat etc.)

Figure 1 Method of approach to realizing ZEB (net Zero Energy Building)



• A Site boundary identifies the physical site boundary (used for zero energy accounting).
• G (Energy Generation)/C (Energy Consumption) balance
• D (Delivered (supplied from outside) Energy)/ E (Exported (supplied to outside) Energy) balance
• In principle, ZEB is measured through actual annual source energy.
• Energy generated on-site is used for building needs: Air conditioning, lighting, plug load, others (ventilation, sanitary system, EV, etc.)
• In the case the appliance energy is measured, it is possible to exclude appliance energy consumption from the building needs because it does not influence the building quality and also it is out of the control of building designer.

Figure 2 Balance between ZEB（net Zero Energy Building） energy demand and the supply



• The weighted demand and the supply should be in principal primary energy consumption.
• If multiplied with coefficient, CO2 emissions and energy cost can be replacable by weighted supply and demand.
• Physical definition of ZEB is represented by G≈ C or D≈ E.

Figure 3 Definition of ZEB (net Zero Energy Building)

4.2 Boundaries

(1) Physical boundary

Generally, this is considered the site boundary. However, a virtual boundary can be set if evaluations are needed at multiple buildings including neighboring buildings. This would be treated as a physical boundary. A virtual boundary can also be set when only one building is targeted in a site with multiple buildings.

(2) Balance boundary (Targeted energy usage)

The energy consumption needed for maintaining building quality is targeted.

* Details on the applications of energy consumption needed for maintaining building quality should be confirmed each time.

* Plug power consumption cannot be controlled by the designer, so if it can be measured, this can be excluded from the target consumption applications.

(3) Renewable energy supply option

Generally, the renewable energy in the site (Classification I or II) is targeted. However, Classifications III and IV are also included if a conversion factor, etc., can be specified.

Classification I: Those which use renewable energy generated on the building.
Classification II: Those which, in addition to classification I, use renewable energy generated on the site.
Classification III: Those which, in addition to classes I and II, convert and use electricity and heat from sources of renewable energy generated outside the site.
Classification IV: Those which, in addition to classes I, II, and III, use renewable energy generated outside the site as is

Here, the term “renewable energy” refers to alternative energy from renewable energy sources (e.g., solar, wind, hydroelectric, geothermal, solar heat, atmospheric heat, other naturally occurring heat sources, biomass) according to the Act on the Promotion of Use of Non-fossil Energy Sources and Effective Use of Fossil Energy Materials by Energy Suppliers (henceforth, Energy Supply Structure Advancement Act).

4.3 Evaluation index

Generally, the evaluation index is set as the primary energy consumption amount (this is called the source ZEB. The unit system is written with both MJ and kWh). The conversion factor for primary energy conforms to the Energy Conservation Act. Those which are not in the Energy Conservation Act are set as needed.

Indices can also be defined where a factor is multiplied with the energy usage amount, such as the CO2 emission amount or energy cost (this is called the emission ZEB, or cost ZEB). The CO2 emission factor, in this case, uses the Act on Promotion of Global Warming Countermeasures[5)], and the emission factor stipulated by the local government. Energy costs are set as needed.

4.4 Evaluation period, evaluation time

Generally, this is set as the annual cumulative value. However, special buildings such as those used in the short term will set the evaluation period based on the usage period.

4.5 Handling of delivered (i.e., supplied from outside of the boundary) energy

Delivered (i.e., supplied from outside of the boundary) energy is evaluated based on primary energy conversion. These conversion factors either use those from the Energy Conservation Act, or the conversion factors which match the actual circumstances.

4.6 Handling of exported (i.e., supplied to outside of the boundary) energy

Exported (i.e., supplied to outside of the boundary) energy is evaluated based on primary energy conversion. These conversion factors use either those from the Energy Conservation Act or the conversion factor which matches the actual circumstances.

5 ZEB evaluation criteria

5.1 Indoor environment evaluation criteria

A favorable indoor environment is maintained.

*For example, the CASBEE Q (environment quality) score is 3.0 or higher.

5.2 Net energy amount evaluation criteria (see Figure 4)

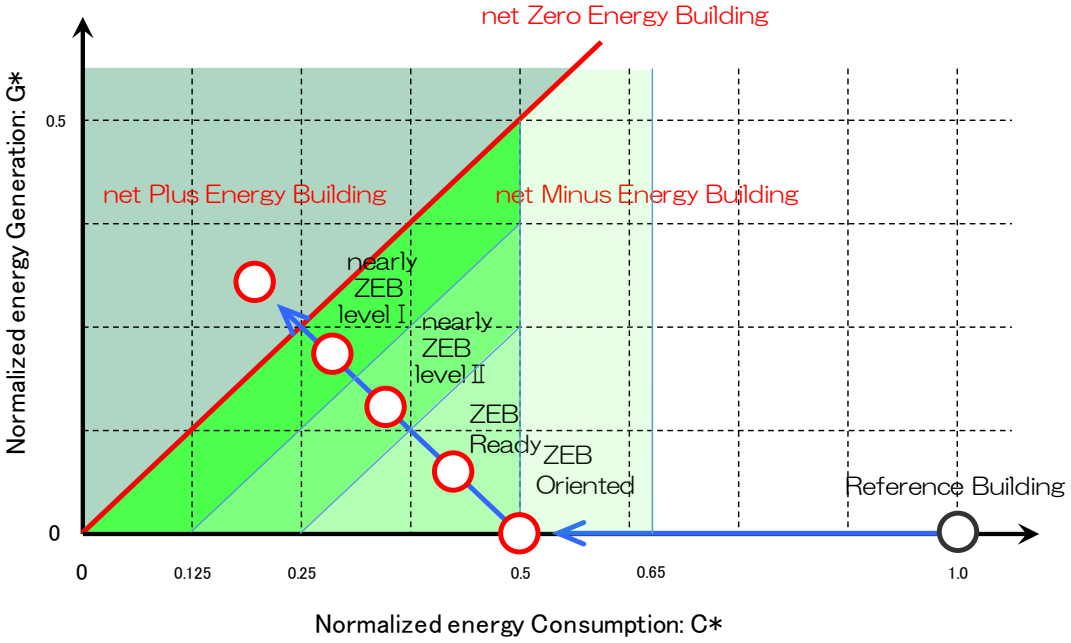
The balance between the standardized supply amount, G*, which is the dimensionless form of the annual primary energy consumption of a reference building, and the standardized demand amount, C*. It is used to evaluate and label in a stepwise manner, as shown below.

G*: Standardized supply amount
= energy generation of evaluated building/energy consumption of reference building.
C*: Standardized demand amount
= energy consumption of evaluated building/energy consumption of reference building.

Net Plus Energy Building:
Standardized supply amount exceeds the standardized demand amount, $(G^*–C^*) > 0$.
Net Zero Energy Building:
Standardized supply amount and standardized demand amount are nearly equal, $(G^*−C^*) \fallingdotseq 0$
Nearly ZEB: Level I: $-0.125<(G^*-C^*)<0$ (here, $C^*<0.5$)
Level II: $-0.25<(G^*-C^*)<-0.125$ (here, $C^*<0.5$)
ZEB Ready: $-0.5<(G^*-C^*)<-0.25$ (here, $C^*<0.5$)
ZEB Oriented: $C^*<0.65$

*Thresholds were tentatively set according to the current trends of the latest energy conservation buildings, but these need further investigation in the future.

*The annual primary energy consumption amount of a reference building is separately determined by, for example, DECC data[6]. The same applies to emission ZEB and cost ZEB.



G*: Normalized energy generation = energy generation of target building/ energy consumption of reference building
C*: Normalized energy consumption = energy consumption of target building/ energy consumption of reference building

Figure 4 Stepwise evaluation of ZEB (net Zero Energy Building)

6 Renewable energy use evaluation criteria

Renewable energy use is evaluated by the renewable energy use rate as shown in Eq. (3).

$$\sum RE / (\sum RE + \sum PE) \quad \cdots\cdots\cdots (3)$$

$\sum RE$: Sum of renewable energy $\sum PE$: Sum of Non-renewable energy

Here, the target renewable energy includes all the renewable energy sources in the Energy Supply Structure Advancement Act.

References

1) Regarding the Realization and Development of Net Zero Energy Buildings (ZEB): Towards the Realization of ZEB by 2030, Study Group on the Realization and Development of ZEB, November 2009.
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2) Roadmap Towards the Construction of a Low-Carbon Society, Low-Carbon Energy Study Group for Creating a Low-Carbon Society, March 2012.
*Japanese web site (http://www.env.go.jp/earth/report/h24-08/index.html) and the relevant PDF (http://www.env.go.jp/earth/report/h24-08/01_full.pdf)

3) Process Chart on the Promotion of Residences and Ways of Living Toward a Low-Carbon Society, Residence and Way of Living Promotion Conference Toward a Low-Carbon Society, July 2012.
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4) The Japanese Act to Partially Amend the Act on the Rational Use of Energy (Energy Conservation Act) (Act No. 25 in 2013)

5) The Japanese Act on Promotion of Global Warming Countermeasures (Act No. 117 of October 9, 1998)
6) Japan Sustainable Building Consortium, DECC- Data-base for Energy Consumption of Commercial building
7) REHVA nZEB technical definition and system boundaries for nearly zero energy buildings, REPORT NO. 4, Federation of European Heating, Ventilation and Air Conditioning Associations (REHVA), 2013.