Current Situation and Actions for ZEB in Japan




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This article provides information regarding current net-zero energy building (ZEB) activities, including the ZEB definitions and methodologies in Japan.

Keywords: ZEB, Methodology, Definition, Current activities in Japan, Best practices

This article has been revised to include contents presented at the REHVA Conference held in Brussels in November 2017. Herein, we will introduce the concepts, definitions, and latest trends related to net-zero energy buildings in Japan. Note that definition and evaluation method related to ZEB were released by the Society of Heating, Air-Conditioning and Sanitary Engineers of Japan (SHASE.J), the Subcommittee on ZEB Definition (Chaired by Dr. Hideharu Niwa) in August 2015, and that the Ministry of Economy, Trade and Industry (METI) of Japan issued a national ZEB definition based on the SHASE.J definition in December that same year.

In this report, the latest ZEB trends will be introduced, along with related design guidelines and advanced ZEB practices. In addition, the details of one of the advanced practices will be introduced as an example of the energy saving and renewable energy technologies being used for achieving ZEB. We will conclude this article by reviewing the future prospects for ZEB activities in Japan.

Current situation and methodology for ZEB in Japan

Activities related to ZEB in Japan were launched since the 2008 Toyako Summit [1] held in Hokkaido, after which numerous efforts were made to promote ZEB from global warming and energy conservation viewpoints. Furthermore, in the aftermath of the East Japan Great Earthquake in 2011, ZEB realization came to be recognized as an important task in terms of energy supply stabilization and security concerns.

It has been said that the origin of ZEB in Japan can be found in traditional Japanese houses, such as the one shown in **Figure 1**, which are designed to facilitate a pleasant transition from outdoor to indoor environments, minimize cooling and heating demands, and maximize the use of renewable energy and natural materials. These characteristics can still be considered acceptable measures for ZEB in the present day.

Figure 2 shows an overview of the ZEB design method. These include optimizing both internal and external building environments (1, 2), suppress heating and cooling load by using passive technologies (3, 4), and improving energy efficiency by adopting active technologies (5, 6, 7). Through these efforts, we aim to achieve the ultimate energy saving and furthermore aim to realize ZEB with renewable energy usage (8), and appropriate energy management (9).

ZEB definitions and evaluations in Japan

The characterization of ZEB definition in Japan dates back to 2009 when a qualitative definition was presented by the METI study group on realization and development of ZEB [3]. Thereafter, in August 2015, SHASE.J released its Guideline on ZEB Definition and Evaluation via its ZEB Definition Subcommittee [4], thereby providing a concrete and quantitative definition that reads in part, "*A net zero-energy building is a building that has high energy saving through load reduction, natural energy use and high efficient systems and appliances without decreasing the environmental quality both indoors and outdoors. With the introduction of on-site renewable energies, the on-site energy generated will be equal to or greater than the actual energy consumed within*

Figure 1. Traditional Japanese house "kyo machi ya". [2]

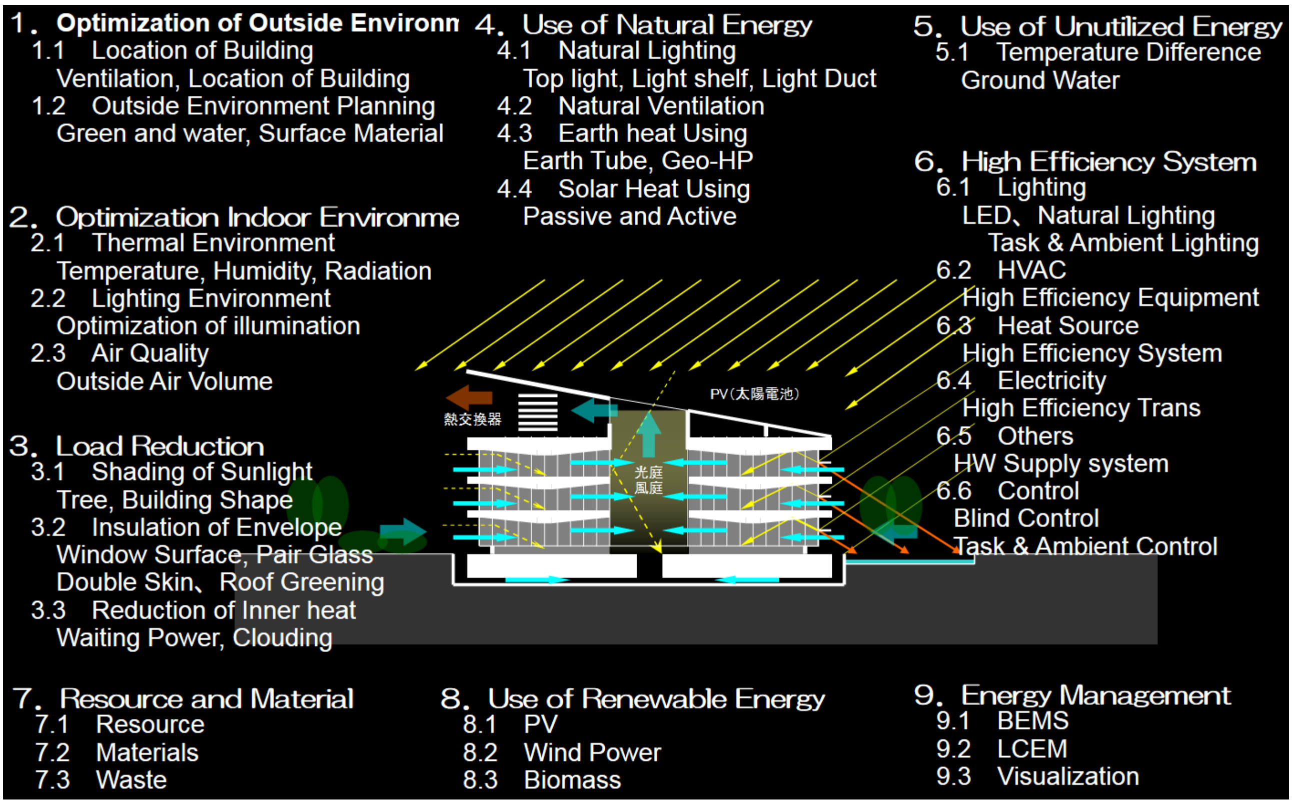


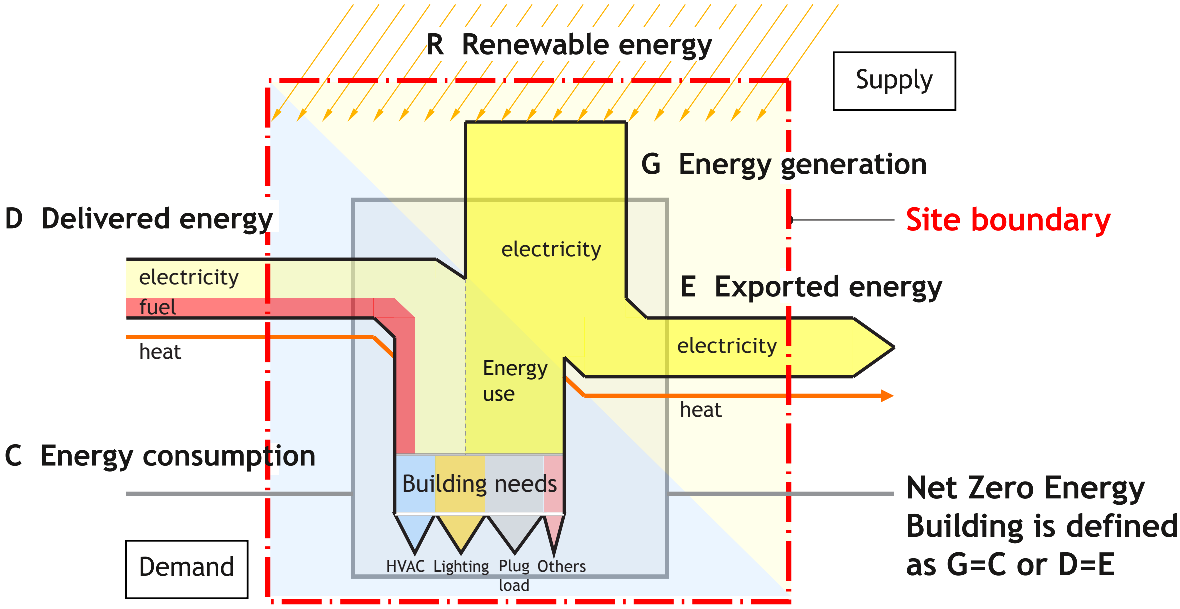
Figure 2. ZEB design methods overview.

the building in the course of a year." A graphical overview of this quantitative definition is shown in **Figure 3**.

ZEB definition boundary conditions, energy performance measurement indicators, and evaluation standards, etc., are also shown in the guideline. In principle, the indicator is primary energy consumption, but carbon dioxide (CO_2) emissions or energy costs can also be used.

The primary energy coefficient (conversion factor), which basically follows the regulations contained in the Japan Energy Conservation Act, allows the primary energy coefficient to be set up on a case-by-case basis.

Figure 4 shows the ZEB evaluation method. Depending on degree of energy saving achievement and renewable energy usage, they are ranked as ZEB, Nearly ZEB,



G*: Normalized energy supply = <Energy generation of target building> / <Energy consumption of reference building>
C*: Normalized energy demand = <Energy consumption of target building> / <Energy consumption of reference building>

Figure 3. ZEB quantitative definition.

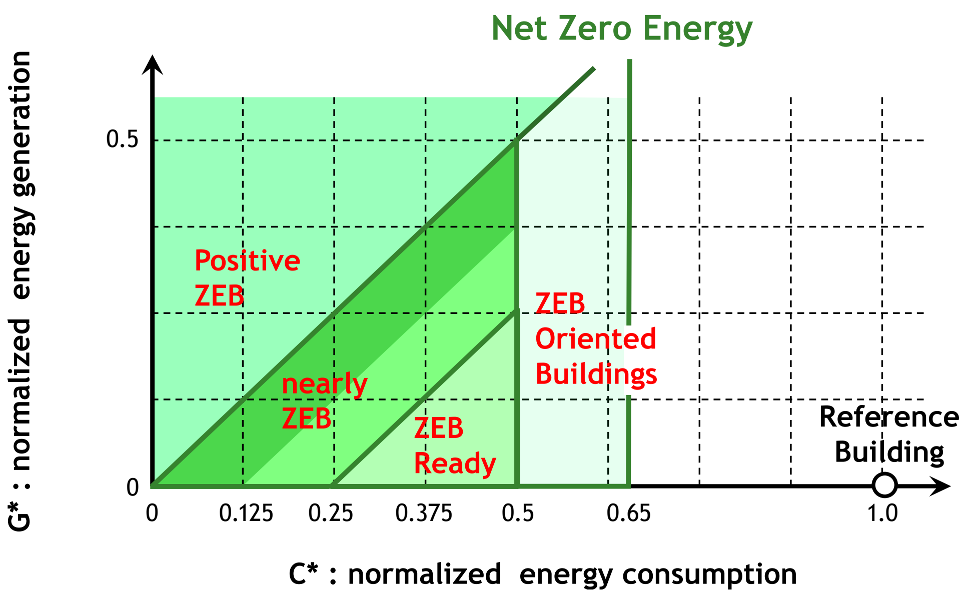


Figure 4. ZEB evaluation.

ZEB Ready, and ZEB Oriented. This guideline contributed to the development of the national ZEB definition issued by METI in December 2015 [5].

Current ZEB activities in Japan

The Japanese government aims to achieve ZEB with regard to new public building by 2020 and with regard to all new buildings on average by 2030 [6]. To facilitate these goals, the government has conducted various policy development activities including formulating the ZEB roadmap [5] shown in **Figure 5**, developed demonstration projects, and published a design guideline [7][8] shown in **Figure 6**.

Regarding the ZEB road map, distinctions were made between government and private organization promotion projects instituted to achieve ZEB status. To date, ZEB design guidelines for small offices, large offices, hospitals, and supermarkets have been published, but other facilities will be added in the future.

SHASE.J, which has made an overwhelming commitment to spreading ZEB activities in its 21st century vision [9], has published ZEB advanced case collections [10], has been developing ZEB design methods, and trying to make cooperative research with REHVA.

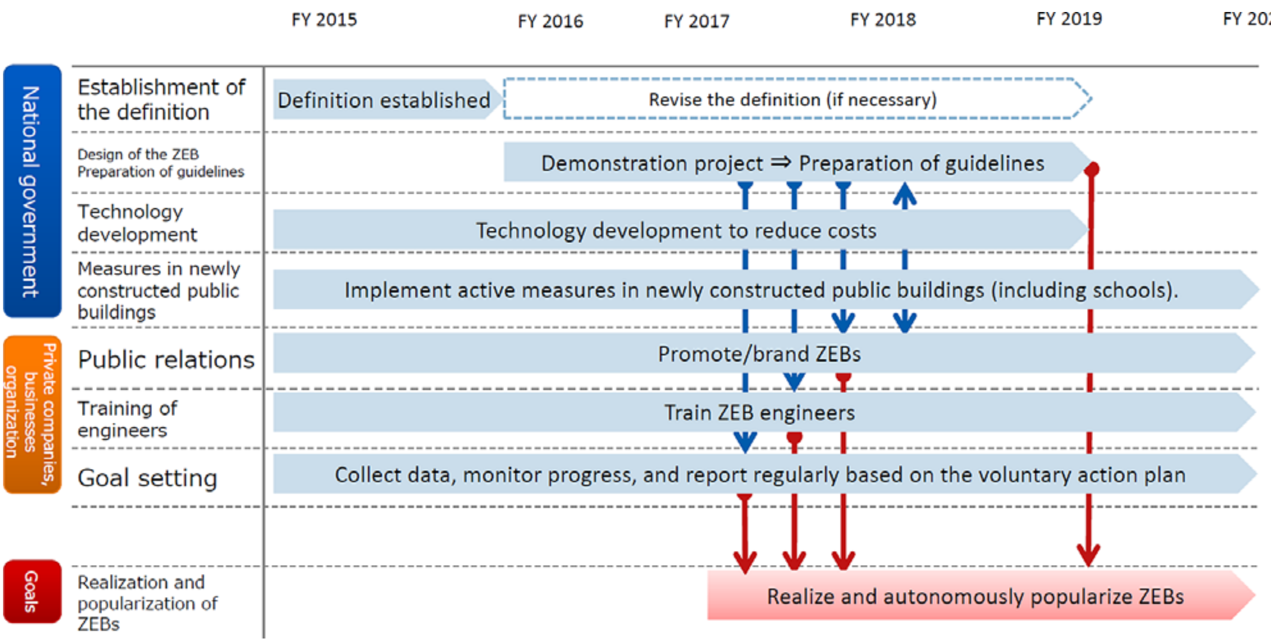


Figure 5. ZEB roadmap.

Figure 6. ZEB design guideline.

Figure 7 shows the ZEB advance case collections published by SHASE.J. Since Japan has both high temperature and high humidity climates, both cooling and heating demands are required. A previous study has shown that while a three-story office building can achieve ZEB, it is difficult to accomplish this for buildings having more than three floors.

In the above-mentioned case collection book, 14 advanced buildings are introduced, and various effective approaches under Japan climate conditions are presented. These examples are organized under the ZEB definition and evaluation methods formulated by SHASE.J. The major usages presented are office, research, and education facilities. Of the 14 building examples, 11 are new constructions and three are renovations. A total of four of the 14 buildings have actually been ranked as ZEB.

Figure 8 shows the Taisei Corp. ZEB demonstration building, while **Table 1** shows an outline of the building. This office building, which is listed in the "Zero Building Advanced Case Collection", has achieved 76% energy saving and 27% energy generation. As a result, it is actually ranked as a "net Plus Energy Building". The main energy saving technologies are its "T-Light Cube" day-lighting system and its task ambient systems for lighting and air-conditioning. The air-conditioning system uses the wasted heat exhausted from a fuel cell. For energy generation, newly developed organic thin film photovoltaic (PV) modules were mounted on the walls.

Figure 8. ZEB Best Practice example (Taisei Corp.).

Table1. Building outline.

Location	Yokohama city, JAPAN
Building type	Office
Total floor area	1,277.32 m²
Number of floors	3 floors, 1 penthouse floor
Completion	June 2014
Certification	CASBEE S rank, BELS ★★★★★ (five star), LEED-NC platinum

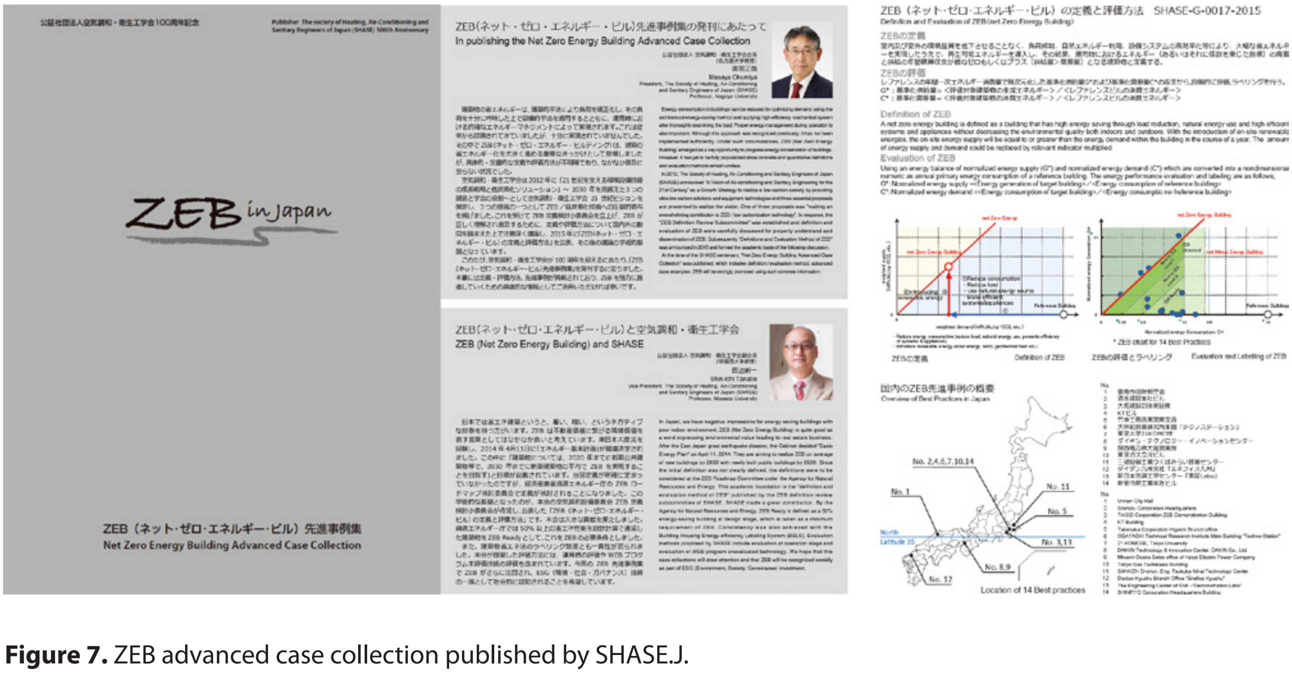


Figure 7. ZEB advanced case collection published by SHASE.J.

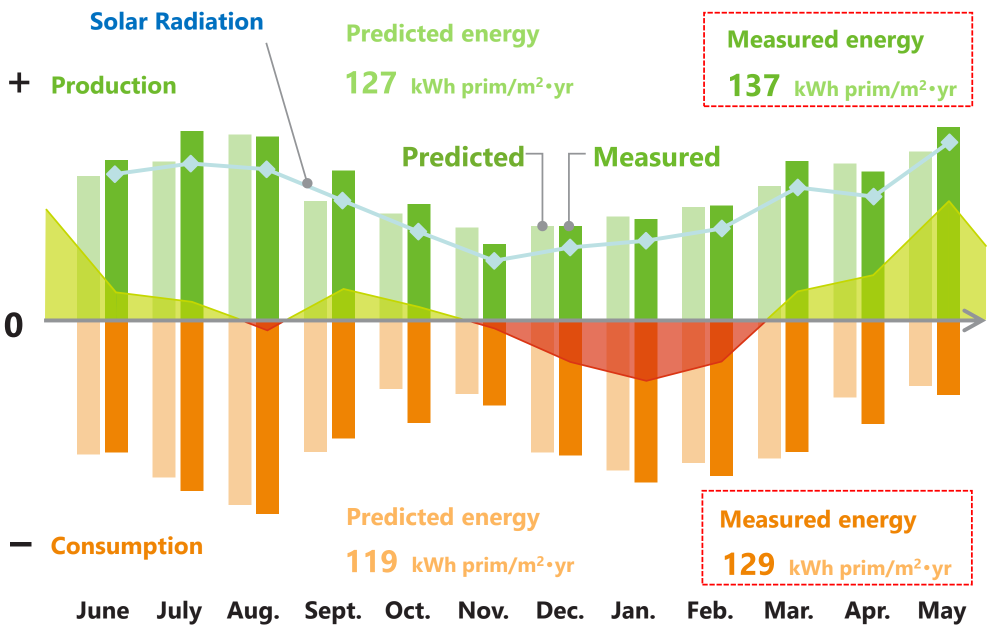


Figure 9. Annual primary energy balance.

Figure 9 shows the energy balance for one year following the building's completion. The annual primary energy consumption was 129 kWh/m², while the generated energy was 137 kWh/m². Thus, ZEB status has been realized.

Conclusion

In Japan, the importance of ZEB realization has been increasing from the viewpoints of global warming, energy conservation, and energy security. Since the definitions and evaluation methods were announced in 2015, various policies and measures have been instituted aimed at spreading and promoting ZEB buildings. In order to further facilitate these goals, in addition to cost reductions and further technology developments, increasing the social value of ZEB will be of paramount importance. ■

Acknowledgments

The authors would like to acknowledge specifically the contributions of the members of subcommittee on Guideline for Design of ZEB in SHASE.J.

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MLIT: Ministry of Land, Infrastructure, Transport and Tourism

MOE: Ministry of the Environment