Energy efficiency building standards in Japan

Japan's regulation of building energy efficiency falls under the Energy Conservation Law that was first adopted in 1979. Subsequently amended several times, the last major revision was in 1999. There are separate regulations for "buildings," i.e., commercial buildings, and "houses," i.e., residential buildings. Beyond regulations, Japan has also fostered a number of non-regulatory programs to promote building energy efficiency, including an Energy Efficiency Center of Japan (ECCJ), the CASBEE rating system for green buildings, and a four-level ranking system for housing performance. In the two and a half decades since energy conservation was identified as a high priority for the government, Japan has established a multi-tiered system for promoting building energy efficiency.

Status of Building Energy Efficiency Standards

Japan's building energy regulations are part of the national Energy Conservation Law that was first adopted in 1979. Within the Energy Conservation Law, there are several sections that apply to the building sector, including Criteria for Clients on the Rationalization of Energy Use for Buildings, and the Design and Construction Guidelines on the Rationalization of Energy Use for Houses. The first applies to non-residential and the second to residential buildings. Although these standards are defined as voluntary, there are numerous aspects that are enforceable. For example, building owners are obligated to submit a report on energy conservation measures prior to new construction, extension, alteration, as well as major renovations, which must be reviewed and approved. Furthermore, in 2002 this reporting for "buildings", i.e., commercial buildings, was made mandatory. The government is also planning to make both standards mandatory in 2007.

In the Kyoto implementation plan, the Japanese government projects that energy codes will save $5.3 billion per year while avoiding annual 34.0 million metric tons of CO_2 emissions by 2010.

Government statistics have indicated that the compliance rate has been growing in recent years, increasing from 13 percent in 2000 to 32 percent in 2004 for residential buildings, and from 34 percent in 1999 to 74 percent in 2004 for commercial buildings. After the standards are made mandatory, compliance is expected to exceed 80 percent.

Scope. The commercial standard for non-residential commercial buildings was first adopted in 1979, and the residential standard, in 1980, as parts of Japan's national Energy Conservation Law. The current versions of the two standards were adopted on March 30, 1999.

Contents.

Residential Buildings:

The residential building energy standard ("Design and Construction Guidelines on the Rationalization of Energy Use for Houses") has both a prescriptive and a performance option. The prescriptive requirements for heat transfer coefficients are listed in Table 1, and those for the resistance of insulation materials in Table 3. Figure 1 shows the six climate regions for Japan. In addition to these heat transfer and insulation requirements, there are also requirements for adding air barriers, heat transfer coefficients for doors, and “summer insulation entry rate”, i.e., summer Solar Heat Gain Coefficients (SHGC), of windows.

Table 1. Requirements for heat transfer coefficients of houses of reinforced concrete, masonry, or similar structure, excluding heat bridges through structural members

Type of house	Insulation material & construction method	Building component		Standard heat transfer coefficient					
				Area classification					
				I	II	III	IV	V	VI
Houses of reinforced concrete structure, etc.	Constructions using interior insulation	Roof or ceiling		0.27	0.35	0.37	0.37	0.37	0.37
		Wall		0.39	0.49	0.75	0.75	0.75	1.59
		Floor	Portions exposed to open air	0.27	0.32	0.37	0.37	0.37	-
			Other portions	0.38	0.46	0.53	0.53	0.53	-
		Floor edge in contact with earth	Portions exposed to open air	0.47	0.51	0.58	0.58	0.58	-
			Other portions	0.67	0.73	0.83	0.83	0.83	-
	Constructions using exterior insulation	Roof or ceiling		0.32	0.41	0.43	0.43	0.43	0.43
		Wall		0.49	0.58	0.86	0.86	0.86	1.76
		Floor	Portions exposed to open air	0.38	0.46	0.54	0.54	0.54	-
			Other portions	-	-	-	-	-	-
		Floor edge in contact with earth	Portions exposed to open air	0.47	0.51	0.58	0.58	0.58	-
			Other portions	0.67	0.73	0.83	0.83	0.83	-
Other houses		Roof or ceiling		0.17	0.24	0.24	0.24	0.24	0.24
		Wall		0.35	0.53	0.53	0.53	0.53	0.53
		Floor	Portions exposed to open air	0.24	0.24	0.34	0.34	0.34	-
			Other portions	0.34	0.34	0.48	0.48	0.48	-
		Floor edge in contact with earth	Portions exposed to open air	0.37	0.37	0.53	0.53	0.53	-
			Other portions	0.53	0.53	0.76	0.76	0.76	

The performance option specifies criteria for the maximum allowable annual heating and cooling loads, or heat loss coefficient and summer solar heat gain coefficient, depending on the same area classification as in Tables 1 and 3. Table 2 shows the maximum allowable heating and cooling loads of a house by climate area classification.

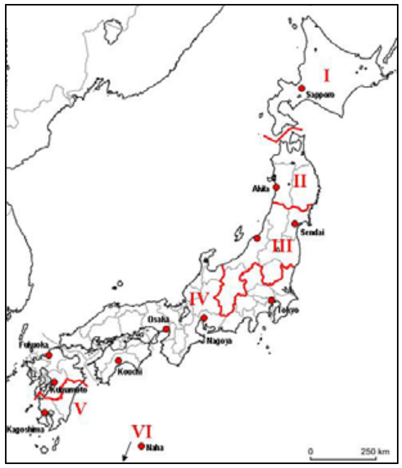
Table 2. Maximum allowable space conditioning loads for houses by climate areas

Area classification	I	II	III	IV	V	VI
Standard annual heating and cooling load (unit: $MJ/m^3/year$)	390	390	460	460	350	290

Table 3. Requirements for resistance of insulation materials of houses of reinforced concrete, masonry, wood-frame, or similar structures

Type of house	Construction method and insulation	Portion		Resistance of insulation material (unit: $m^2 \cdot °C/watt$)					
				I	II	III	IV	V	VI
Houses of reinforced concrete structure, etc.	Constructions with interior insulation	Roof or ceiling		3.6	2.7	2.5	2.5	2.5	2.5
		Wall		2.3	1.8	1.1	1.1	1.1	0.3
		Floor	Portions exposed to outside air	3.2	2.6	2.1	2.1	2.1	-
			Other portions	2.2	1.8	1.5	1.5	1.5	-
		Floor edge in contact w/ earth	Portions exposed to outside air	1.7	1.4	0.8	0.8	0.8	-
			Other portions	0.5	0.4	0.2	0.2	0.2	-
	Constructions with exterior insulation	Roof or ceiling		3.0	2.2	2.0	2.0	2.0	2.0
		Wall		1.8	1.5	0.9	0.9	0.9	0.3
		Floor	Exposed to air	2.2	1.8	1.5	1.5	1.5	-
			Other portions	-	-	-	-	-	-
		Foor edge in contact w/earth	Exposed to air	1.7	1.4	0.8	0.8	0.8	-
			Other portions	0.5	0.4	0.2	0.2	0.2	-
Wooden houses	Constructions with cavity-filled insulation	Roof or ceiling	Roof	6.6	4.6	4.6	4.6	4.6	4.6
			ceiling	5.7	4.0	4.0	4.0	4.0	4.0
		Wall		3.3	3.3	2.2	2.2	2.2	2.2
		Floor	Exposed to air	5.2	5.2	3.3	3.3	3.3	-
			Other portions	3.3	3.3	2.2	2.2	2.2	-
		Floor edge in contact w/earth	Exposed to air	3.5	3.5	1.7	1.7	1.7	-
			Other portions	1.2	1.2	0.5	0.5	0.5	-
Houses with frame wall construc-tion	Constructions with cavity-filled insulation	Roof or ceiling	Roof	6.6	4.6	4.6	4.6	4.6	4.6
			ceiling	5.7	4.0	4.0	4.0	4.0	4.0
		Wall		3.6	2.3	2.3	2.3	2.3	2.3
		Floor	Exposed to air	4.2	4.2	3.1	3.1	3.1	3.1
			Other portions	3.1	3.1	2.0	2.0	2.0	-
		Floor edge in contact w/earth	Exposed to air	3.5	3.5	1.7	1.7	1.7	-
			Other portions	1.2	1.2	0.5	0.5	0.5	-
Wooden houses, frame houses, or steel-frame houses	Constructions with exterior insulation method	Roof or ceiling		5.7	4.0	4.0	4.0	4.0	4.0
		Wall		2.9	1.7	1.7	1.7	1.7	1.7
		Floor	Exposed to air	3.8	3.8	2.5	2.5	2.5	-
			Other portions	-	-	-	-	-	-
		Floor edge in contact w/earth	Exposed to air	3.5	3.5	1.7	1.7	1.7	-
			Other portions	1.2	1.2	0.5	0.5	0.5	-

Figure 1. Climate Regions of Japan (simplified)



Commercial Buildings

The commercial building energy standard ("Criteria for Clients on the Rationalization of Energy Use for Buildings") is a performance standard that uses two indicators for assessing the energy performance of a building: the PAL, or Perimeter Annual Load, for the performance of the building envelope, and the CEC, or Coefficient of Energy Consumption, for the performance of the building equipment.

$$\text{PAL} = \frac{\text{Annual space conditioning load in the perimeter zone (MJ/year)}}{\text{Area of perimeter zone (m}^2\text{)}}$$

$$\text{CEC} = \frac{\text{Actual Energy Consumption (MJ/year)}}{\text{Standard Energy Consumption (MJ/year)}}$$

The values for the PAL and CEC depend on the building type, as shown in Table 4.

Table 4. PAL and CEC requirements by commercial building type

Building type	Hotel	Hospital or clinic	Retail	Office	School	Restaurant
PAL*	420	340	380	300	320	550
CEC/HVAC**	2.5	2.5	1.7	1.5	1.5	2.2
CEC/V**	1.0	1.0	0.9	1.0	0.8	1.5
CEC/L**	1.0	1.0	1.0	1.0	1.0	1.0
CEC/HW**	1.5	1.7	1.7	-	-	-
CEC/VT**	1.0	-	-	1.0	-	-

*PAL (Perimeter Area Load) defined as annual thermal load (sum of heating and cooling loads) of perimeter spaces within 5m of exterior wall, plus the top story just under the roof, in units of MJ/m^2.yr. There are also area correction factors to account for differing surface-to-volume ratios.

** CEC (Coefficient of Energy Consumption) for the building's HVAC, ventilation (V), lighting (L), hot water (HW), and vertical transportation (VT) systems. For V, L, HW, and VT, equations are provided for calculating the actual and standard energy consumptions.

Jurisdiction.

The Ministry of Land, Infrastructure and Transport (MLIT) is responsible for developing building energy standards in Japan. MLIT was established in 2001 through the consolidation of the former Ministry of Construction, Ministry of Transportation, National Land Agency, and the Hokkaido Development Agency. However, the adoption of standards is the joint responsibility of MLIT and the Ministry of Economy. In addition, the Energy Conservation Center of Japan (ECCJ), a non-government organization established in 1978 with numerous industrial partners to promote the efficient use of energy, protection against global warming, and sustainable development, is also active in providing technical assistance in energy-efficient building construction and operations.

Status of Voluntary Non-Regulatory Programs

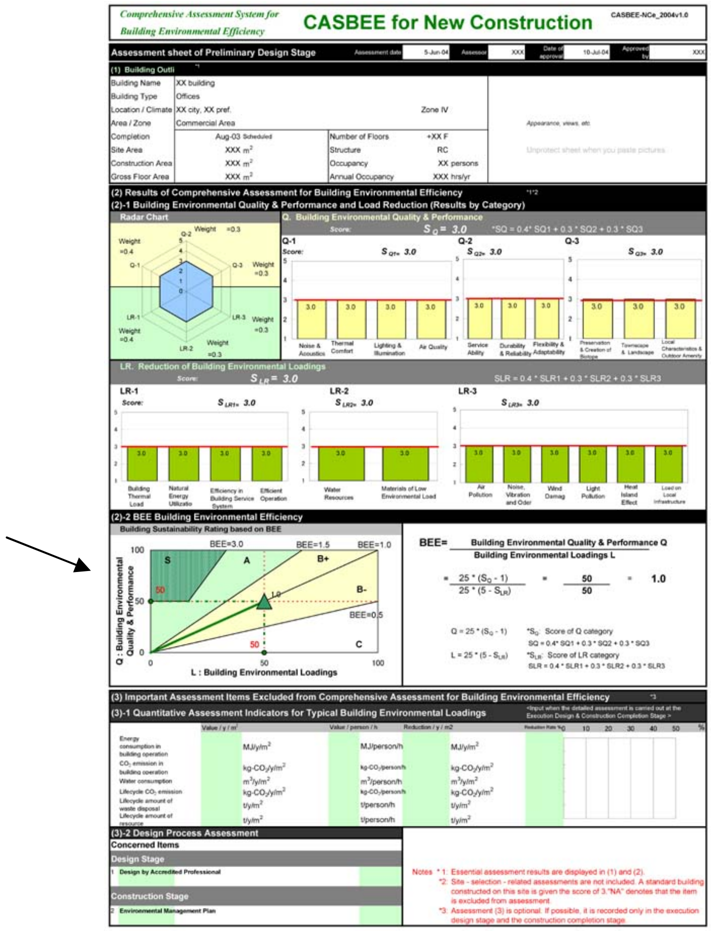
In addition to the mandatory building standards, Japan also has implemented an assortment of voluntary programs to stimulate building energy efficiency. The first two of the following are directed at housing, while the last is directed at commercial buildings:

1. The Housing Quality Assurance Law (2000) is a voluntary housing performance labeling system for the protection of consumers. It contains standardized criteria for evaluating a wide variety of housing performance, including the building's structural stability, fire safety, indoor air quality, acoustics, lighting and thermal environment, consideration for the aged, etc. Building energy efficiency is rated as part of the assessment of the building's thermal environment. The government establishes the assessment standards and registers private companies qualified to do the assessments.

2. Environmentally Symbiotic Housing Model Projects (1993). MLIT subsidizes one-third of the costs for surveys and planning, the installation of "environmentally symbiotic facilities," including permeable pavement or facilities that utilize natural energy sources, and skeleton infill systems or those that use recycled materials.

3. CASBEE (2001). CASBEE stands for "Comprehensive Assessment System for Building Environmental Efficiency", a green building rating system developed by the Japan Sustainable Building Consortium to assess the "environmental efficiency" of buildings. The CASBEE-NC assessment tool draws a virtual boundary between a building and its environment, and compares the environmental quality and performance delivered by the building, Q, against its environmental loading in terms of energy, resources and materials, and environmental impact, L. The buildings with the highest BEE (Building Environmental Efficiency) are those in the upper left quadrant that have a high Q, but low L (see arrow in Figure 2).

Figure 2. CASBEE Assessment Result Sheet



CASBEE is a voluntary program being implemented by local governments, with training for the assessors and third party assessment.

Related end-use efficiency programs

Since 1998, Japan has been implementing the Top Runner Program© to set energy conservation standards for home and office appliances and a fuel economy standard for automobiles. In many countries, the energy efficiency of electrical appliances is enhanced by Minimum Efficiency Performance Standards (MEPS). Japan followed a different strategy. Instead of setting a MEP, its Top Runner Program searches for the most efficient model on the market and then stipulates that the efficiency of this top runner model should become the standard within a certain number of years. By the target year, each manufacturer must ensure that the weighted average of the efficiency of all its products in that particular category is at least equal to that of the top runner model. This approach eliminates the need to ban specific inefficient models from the market. At the same time, manufacturers are made accountable and, perhaps most important, they are stimulated to voluntarily develop products with an even higher efficiency than the top runner model.

In the Kyoto implementation plan, Top Runner is projected to prevent the output of 29 million tons of CO_2 by 2010, or 3 percent of the Japanese GHG emission target of 2010.

An energy-saving labeling system has been introduced to inform consumers of the energy efficiency of various home appliances, and to promote energy-efficient products. As of April 2005, labeling has been applied to 13 products: air conditioners, refrigerators, freezers, fluorescent lights, televisions, space heaters, gas cooking appliances, gas or oil water heaters, electric toilet seats, computers, magnetic disks, and transformers.

To further promote energy-efficient products, an energy-efficient product retailer assessment system was introduced in 2003 to give recognition to retailers who actively promote energy-efficient products or provide appropriate energy conservation information. In addition, for commercial buildings there are programs to promote high-efficiency boilers, air-conditioning systems, and energy management utilizing information technology. Finally, the government provides partial subsidies, or low-interest loans, to private enterprises or local governments in setting up Energy Service Companies (ESCOs).

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