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Country Report on Building Energy Codes in Japan

M Evans
B Shui
T Takagi (NILIM)

April 2009

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Foreword

Buildings account for about 30% of all energy consumption globally and a significant share of greenhouse gas emissions. Building energy codes help ensure that new buildings use energy efficiently, and this can reduce building energy use by 50% or more compared to buildings designed without energy efficiency in mind. This is important because buildings typically last 30-50 years, and it is much less expensive and time-consuming to design for energy efficiency than to retrofit a building later. Based on the experience of the Asia-Pacific region, it is clear that building energy codes, when implemented, save energy and improve comfort in new buildings. By design, most building energy codes are cost-effective, saving consumers significant amounts of money on their energy bills.

The Asia-Pacific Partnership on Clean Development and Climate (APP) is a public-private collaboration to accelerate the development and deployment of clean energy technologies. APP partners include Australia, Canada, China, India, Japan, Republic of Korea, and the United States (the U.S.). APP countries account for more than half of the global economy, energy consumption and greenhouse gas emissions. APP's Buildings and Appliance Task Force (BATF) provides a forum for APP partners to work together on energy efficiency in buildings and appliances. This report was prepared under the framework of BATF, in particular a BATF project called "Survey building energy codes and develop scenarios for reducing energy consumption through energy code enhancement in APP countries" (BATF-06-24).

At the request of the U.S. Department of Energy, the Pacific Northwest National Laboratory's Joint Global Change Research Institute has prepared a series of reports surveying building energy codes in the seven APP countries. These reports include country reports on building energy codes in each APP partner country and a comparative report based on the country reports. This particular report is the country report on building energy codes in Japan.

Acknowledgements

This report owes its existence to the Asia-Pacific Partnership on Clean Development and Climate. We would like to thank all the APP partner countries and experts who collaborated on this project. We are particularly grateful to Dr. Seung-Eon Lee at the Korean Institute of Construction Technology for his oversight of the APP project under which this report was prepared (BATF 06-24). We would also like to thank Mark Ginsberg, Jean Boulin and Marc LaFrance from the U.S. Department of Energy for their leadership and financial support of this work.

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1. Introduction and Background

1.1 A Glance at the Economy and Energy

Japan is a major economic power. In 2007, the gross domestic product (GDP) of Japan was US$4.4 trillion,[1] the second largest in the world (IMF, 2008). Japan has limited natural reserves of fossil fuels, so it is the world's largest net importer of coal, the second largest of petroleum and the third largest of natural gas (EIA, 2008a). As the fourth largest primary energy consumer, Japan emitted 1,247 Mt of carbon dioxide in 2006, which was 4.3% of the global total that year (EIA, 2008b).

1.2 Buildings Sector

Japan had 12.6 million non-residential buildings in 2006, with a total floor space of 0.68 billion square meters. Non-residential buildings include, but are not limited to, attached buildings (60% of the total floor space of commercial buildings in 2006), factories and warehouses (15%), mixed-use buildings (other than houses) (10%), offices, banks and retails (9%), and temples and religious buildings (4%) (Ministry of Internal Affairs and Communications, 2008).

In 2006, there were 32.1 million residential buildings in Japan, with a total floor space of 3.4 billion square meters. Residential buildings consist of single-detached houses (85% of total floor space of residential buildings), houses in the agriculture sector (6%), condominiums (5%) and mixed-use houses (4%) (Ministry of Internal Affairs and Communications, 2008).

According to the International Energy Agency (IEA), the buildings sector in Japan became the largest energy end-user in 1999 (IEA, 2007). In 2005, the buildings sector consumed 116 million tons of oil equivalent (Mtoe), or 33% of Japan's total final energy use[2], which is higher than that of either the industrial or transportation sectors (Figure 1). Within the buildings sector, the commercial sector consumes 12% more energy than the residential sector. Between 1990 and 2005, the average annual growth rate of energy demand in the buildings sector was 1.6% (commercial was 1.4% and residential was 1.9%). This is much higher than that of the industrial (-0.5%) and transportation sectors (0.2%) (IEA, 2007).

Reducing building energy use and related CO_2 emissions has long been a stated priority of Japan's energy policies.

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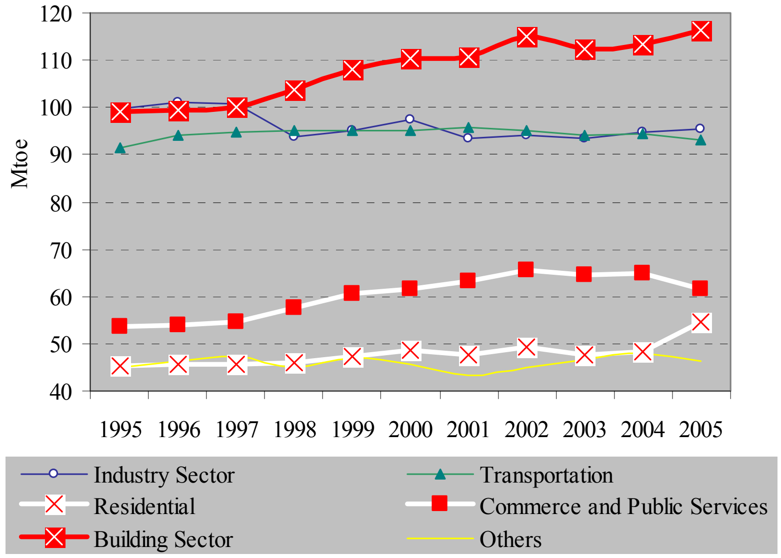
[1] Nominal GDP in current U.S. dollars. Japan's GDP based on purchasing power parity was US$4.3 in 2007.

[2] Final energy use includes consumption of renewable and waste energy.

Figure 1 Energy Consumption by Sector in Japan, 1990-2005



Notes: Energy consumption in this figure refers to final energy use, which includes consumption of renewable and waste energy

Source: IEA, 2007

1.3 Relevant Regulations

Japan was hit hard by the 1973 oil crisis, as its oil consumption contributed to 80% of its total primary energy demand that time. Since then, the Japanese government has been committed to making energy efficiency one of its priorities in national development. Today, Japan has one of the most efficient economies in the world as measured by energy intensity.

Japan's Rational Use of Energy, or Energy Conservation, Law was first issued in 1979. Initially, it was primarily focused on promoting energy efficiency in the industrial sector. The law served as the foundation of Japan's energy efficiency policies and was updated numerous times, including in 1983, 1993, 1998, 2002, 2005 and 2008[3]. The 2002 revision required that owners of new commercial buildings larger than 2,000 square meters submit energy saving plans to the government. The 2005 revision, which took effect in 2006, strengthened energy efficiency measures for residential buildings and the construction sector. Owners of buildings with over 2,000 square meters must submit energy saving plans for renovation permits (IEA, 2008b, c, d and e). Recent revisions to the Energy Conservation Law expand the number of buildings for which energy saving plans are required; the revisions go into effect in 2009. The revisions require owners of small and medium-sized buildings (300 to 2,000 square meters) to submit energy saving plans before construction or renovations. Also, construction companies building more than 150 houses per year would need to improve the energy performance of the houses they built.

[3] Part of the 2008 version of the law will enter into force in April 2009, and the remainder in April 2010.

Under the Energy Conservation Law, Japan has issued a set of building energy standards for commercial and residential buildings. The Criteria for Clients on the Rationalization of Energy Use for Buildings (CCREUB) was first issued in 1979, and the newest version was released in 1999 by the Ministry of International Trade and Industry (MITI) and the Ministry of Construction (MoC). There are two building energy standards related to residential buildings: (1) Design and Construction Guidelines on the Rationalization of Energy Use for Houses (DCGREUH), issued by MoC in 1980, and later revised in 1992 and 1999; and (2) Criteria for Clients on the Rationalization of Energy Use for Houses (CCREUH), issued by MITI and MoC in 1980, and later revised in 1992 and 1999.

According to recent statistics, houses that comply with the latest building energy standard consume 40% less energy than houses without insulation, offices that meet the latest standard use 75% less energy than those that do not (MLIT, 2007).

The Ministry of Land, Infrastructure and Transport (MLIT) issued the "Basic Program for Housing" in 2006, which aimed to improve housing standards by 2015. Two of the 21 targets MLIT announced include (1) 40% of housing should have energy saving measures, and (2) the life span of housing should be increased from 30 years in 2003 to 40 years by 2015 (IEA, 2008a). Buildings in Japan typically have a shorter life span than those in most other APP countries. This fast turnover of buildings presents on-going opportunities to create a more efficient building stock, but it also means that the buildings designed for short lives may not be built with as much attention to energy efficiency.

1.4 Implementation

MLIT and the Ministry of Economy, Trade and Industry (METI) are in charge of implementing the Energy Conservation Law. Under the law, owners of buildings and homes larger than 2,000 square meters are responsible for submitting a so-called mandatory report on energy conservation to local authorities whenever there is new construction, an extension, alternation, major repair or remodeling.

All mandatory reports are reviewed by the local authorities who receive the reports, and the local authorities may give instructions to the property owners and publicize building names if the measures are unsatisfactory. From April 2009, with the most recent amendment of the Energy Conservation Law, local authorities can impose penalties if mandatory reports of homes and buildings larger than 2,000 square meters do not meet the regulatory requirements.

The mandatory report submission rate is almost 100% according to MLIT. According to data from the mandatory reports, in 2005 85% of commercial buildings complied with the 1999 energy efficiency requirements in the design stage. A survey of housing evaluated under the Housing Quality Assurance Law showed that 36% of new homes complied with the 1999 energy efficiency requirements in 2006. No data is available on compliance in actual construction, and Japan does not inspect buildings for compliance with the energy efficiency standards. However, compliance does seem to be improving. For example, only 34% of commercial building designs met the standards in 2000, compared to 85% in 2005 (the latest year for which data was available). This is particularly impressive considering that the mandatory reports were not obligatory on buildings until 2003. Mandatory reports became obligatory for houses in 2005, which is probably one of the reasons that compliance is lower for houses (MLIT, 2007 and Building Center of Japan, 2007).

In addition, building owners must also provide local authorities with reports on maintenance every three years.

The Institute for Building Environment and Energy Conservation holds training seminars to support implementation of the Energy Conservation Law. The seminars cover issues such as building design, construction techniques, insulation and calculations of energy efficiency under the building energy codes. For example, the institute is holding over 100 training sessions all around Japan to disseminate information on the latest amendment of the Energy Conservation Law. This institute also publishes detailed guidebooks on Japan's energy efficiency standards.[4]

Local governments also provide significant support of the building energy codes. For example, under the Sustainable Building Reporting System, many cities provide tools and information to help improve the energy efficiency of new buildings. Some cities also publish summaries of all new building energy saving plans. Moreover, some cities encourage energy efficiency by allowing builders to build taller or larger buildings than otherwise allowed if the building designs rank highly on energy efficiency. Other cities provide construction subsidies or low-interest loans for highly-ranked residential buildings.

Japan also has detailed testing, rating and labeling requirements for key building components, such as windows, insulation and combustion-based equipment. These test standards and ratings are referenced in the building energy codes.

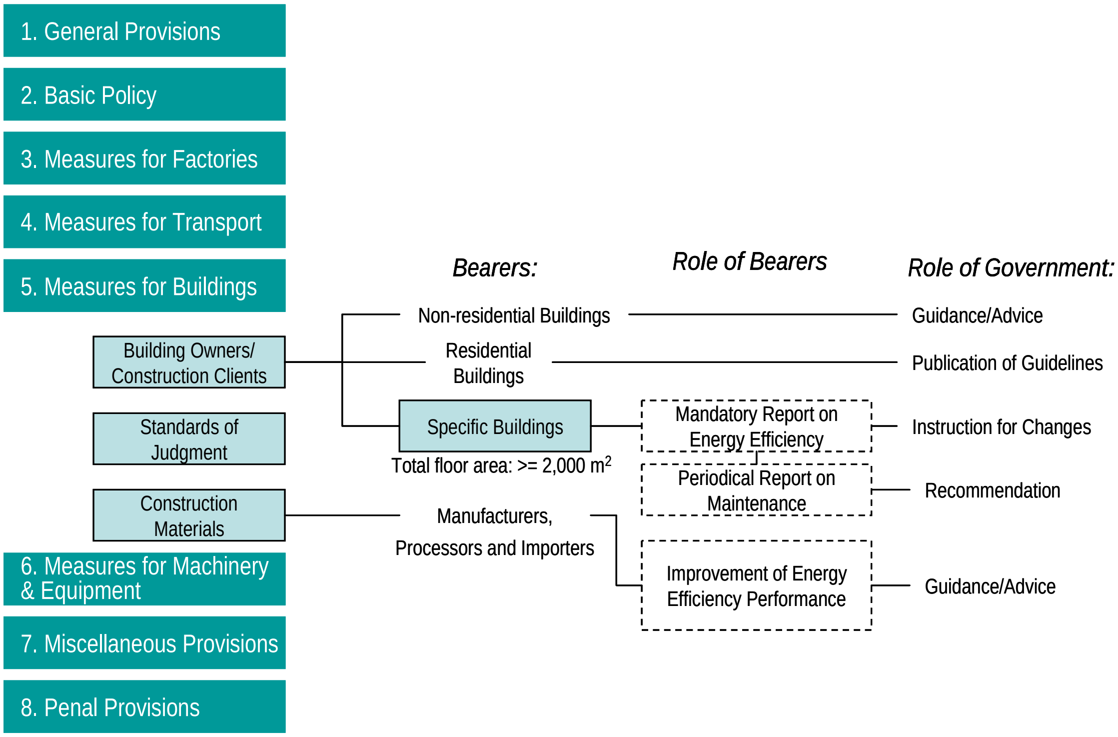
2. Buildings Sector in Energy Conservation Law (the 2005 Revision)

The Energy Conservation Law, revised in August 2005, focuses on four sectors: factories, transport, buildings, and machinery and equipment. The chapter on buildings, entitled "Measures for Buildings", covers the energy conservation responsibilities of building owners and construction clients[5], jurisdiction, and building materials (Figure 2).

[4] For additional information, please see: www.ibec.or.jp/.

[5] Under Japanese regulations, a construction client is the person or legal entity for whom a structure is constructed. In most cases but not all cases, it is the same as the property or building owner. This report uses the terms property or building owner for ease of reading, except in the referring to the actual titles of Japanese documents.

Figure 2 Buildings Sector in Japan's Energy Conservation Law (2005)



Revised based on the figure presented in Section 2.4 of Japan Energy Conservation Handbook 2007 (The Energy Conservation Center, 2007)

The contents of the section "Measures for Buildings" include:

Responsibility of Property Owners
Property owners should contribute to energy efficiency in buildings by properly implementing measures to prevent heat loss and to improve the energy efficiency of heating and air conditioning systems, and other building equipment.

Responsibility of Government and Jurisdiction
In order to improve building energy efficiency, METI and MLIT must establish and publicize regulations for property owners. A government agency with jurisdiction (such as a municipality or special ward that has a district construction inspector pursuant to the Building Standards Act) may provide guidance and advice on energy efficiency to property owners of regulated (so called "specified") buildings. As noted above, Japan does not inspect on-going construction for energy efficiency provisions, although inspectors do check buildings at several stages for compliance with structural and fire code requirements.

Specified Buildings
The term "specified buildings" in the Japanese code refers to buildings that must comply with the building energy requirements. A specified commercial buildings must have a total floor area of at least 300 square meters. Residential buildings can be smaller and there are no set limits on the size. Owners of specified buildings, who intend to construct

or extensively modify the buildings (including apartment buildings[6]), are required to submit a mandatory report on the planned energy conservation measures to the authorities before construction. After the completion of construction or modification, the property owners must also submit periodic reports on the maintenance of the buildings with respect to energy-saving measures. If the local authority finds the energy-saving measures to be insufficient, the authority provides guidance and advice to the owners for improvement. If an owner does not follow the authority's advice and instructions for improvement, the authority can publicize the owner's name on a list for non-compliance (The Energy Conservation Center, 2007). The 2008 edition of the law added penalties for non-compliance of up to JPY 1,000,000 or about US$11,000.

Building Materials
METI may provide guidance and advice to businesses that manufacture, process or import building materials to help them improve and ensure the thermal insulation properties of the materials. This is in addition to the work of testing laboratories that certify the energy efficient characteristics of building materials.

3. Energy Codes for Commercial and Residential Buildings

3.1 Overview

Japan has three building energy codes. One covers commercial buildings and the other two cover houses.

Criteria for Clients on the Rationalization of Energy Use for Buildings (1999), or CCREUB, is a mixture of performance and prescriptive energy codes for commercial buildings. It covers insulation of the building envelope as well as heating, ventilation and air conditioning (HVAC), lighting, water heating, and lifting equipment.

Japan has two building energy codes for residential buildings or houses (Table 1). The prescriptive-based Design and Construction Guidelines on the Rationalization of Energy Use for Houses (1999), or DCGREUH, includes insulation of the building envelope, HVAC, water heating, as well as guidance on maintenance and operations in its section entitled "how to live." The Criteria for Clients on the Rationalization of Energy Use for Houses (1999), or CCREUH, a mixture of performance and prescriptive-based building energy codes, has a heavy focus on HVAC. It also provides performance-based annual heating and cooling loads by building type.

The energy code for commercial buildings references three climate zones: ordinary, cold and tropical. Most areas in Japan fall into the ordinary zone.[7] The energy codes for residential buildings or houses also provide values adjusted for regional and climate differences for insulation-related indictors. However, there are six climate zones in the

[6] The apartment buildings include condominium buildings.
[7] The cold zone includes Hokkaido, Aomori, Iwate, Akita prefectures; the ordinary zone includes all districts not considered cold or tropical; and the tropical zone includes Okinawa Prefecture, Tokara Archipelago, Amami Islands of Kagoshima Prefecture and Ogasawara Islands of Tokyo Metropolitan Prefecture.

residential energy codes (Table 2 and Figure 3). Climate zones I and II are located in northern areas with cold winters and hot summers, and climate zones V and VI are located in southern areas with warm winters and hot summers.

Table 1 Structure of the Building Energy Codes in Japan

	Commercial	Residential	
	CCREUB	DCGREUH	CCREUH
Building Envelope	1. Heat loss through the building envelope	1. Thermal insulation 2. Thermal performance of the building envelope 3. Thermal performance of windows and doors	1. Maximum annual heating and cooling loads by climate zone 2. Standards for equivalent clearance areas by climate zone 3. Condensation control
HVAC	2. Air conditioning and heating 3. Mechanical ventilation (except for air conditioning and heating)	4. Ventilation plans 5. Heating, cooling and hot water supply plans 6. Airflow plans	4. Ventilation volume 5. Prevention of indoor air contamination from heating and hot water systems 6. Planned operation of heating and cooling systems 7. Ventilation routes for heat dissipation
Lighting	4. Lighting	Not Applicable (N.A.)	N.A.
Hot water	5. Hot water supply	(See 5. Heating and cooling, and hot water supply plans	N.A.
Other	6. Lifting equipment	7. Information on building operation and maintenance (“ how to live”)	N.A.

Sources: CCREUB 1999, DCGREUH 1999 and CCREUH 1999

Figure 3 Residential Climate Zones in Japan

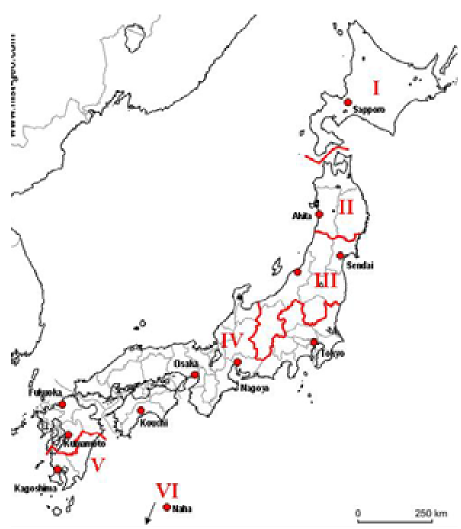


Table 2 Residential Climate Zone Definitions

	Heating Degree Days (HDD) in SI Units
I	HDD $18^{o}C > 3,500$
II	$3,000 <$ HDD $18^{o}C \leq 3,500$
III	$2,500 <$ HDD $18^{o}C \leq 3,000$
IV	$1,500 <$ HDD $18^{o}C \leq 2,500$
V	$500 <$ HDD $18^{o}C \leq 1,500$
VI	HDD $18^{o}C \leq 500$

3.2 Energy Codes for Commercial Buildings - Criteria for Clients on the Rationalization of Energy Use for Buildings (CCREUB)

The CCREUB is a mixture of performance-based and prescriptive energy codes. It provides information on the minimal required energy performance for commercial buildings (Table 3).

Table 3 Essential Features of the CCREUB

Section Number and Title	Selected Provisions
1. Heat loss through the building envelope	(1) Orientation of outer walls and layouts of the rooms should be considered in site planning, (2) Building materials with high thermal insulation properties should be used in the outer walls, floors and other parts of the building envelope, (3) Measures for windows and tree planting should be used to limit solar heat gain.
2. HVAC	(1) The load characteristics of rooms and other factors should be taken into consideration in the design of HVAC systems, (2) Ducts, piping and other equipment designed for high heat retention should be considered in the building plans, (3) A proper control method should be adopted for HVAC equipment, and (4) A high-efficiency heat source should be used.
3. Mechanical ventilation	(1) A plan to reduce energy losses from air ducts should be included in the design, (2) Mechanical ventilation equipment should have proper controls, and (3) Energy-efficient equipment should be used for ventilation.
4. Lighting	(1) Energy-efficient lighting should be used, (2) Lighting equipment should have proper controls, (3) Lighting equipment should be installed in a manner that facilitates easy maintenance and management, and (4) The arrangement of lighting equipment, the level of luminance, and the selection of room shape and interior finish should be properly determined.
5. Hot water supply	(1) Shorter piping routes and thermal insulation of piping should be considered in plumbing design, (2) Hot water supply equipment should have proper controls, and (3) The heat source system should be energy efficient.
6. Lifting equipment (elevators)	(1) Lifting equipment should have proper controls, (2) Drive systems should be energy efficient, and (3) The installation plan for the required transport capacity should be properly designed.

Source: CCREUB 1999

Some of provisions of the CCREUB are relatively general, although others include specific values or calculation methodologies.

The CCREUB has requirements for specific building envelope components by climate zone. The specific components selected receive different scores depending on their impact on energy efficiency. For example, there are three levels of insulation considered, each with a different score. The total score of the building envelope is corrected for the location, shape, orientation and function of the building. Each building must have a total score of at least 100. The CCREUB also employs two energy indicators (Table 4) to measure energy performance of a building. The perimeter annual load (PAL) is for the energy performance of the building envelope, and the coefficient of energy consumption (CEC) for the energy performance of the building equipment.

$$\text{PAL}= \frac{\text{Annual thermal load of the inside perimeter zone (MJ/year)}}{\text{Total floor area of the inside ambient space of each floor (m}^2\text{)}} \qquad \text{CEC}= \frac{\text{Annual actual energy consumption of a piece of building equipment (MJ/year)}}{\text{Standard energy consumption of the same building equipment (MJ/year)}}$$

Table 4 Minimal Energy Performance for Building Envelopes (PAL) and Building Equipment (CEC) in Commercial Buildings

Building Type	PAL* (MJ/m²·yr)	CEC				
		HVAC	Ventilation	Lighting	Hot Water	Lifting Equipment
Restaurant	550	2.2	1.5	1	When 0 < A ≤ 7, CEC = 1.5 When 7 < A ≤ 12, CEC = 1.6 When 12 < A ≤ 17, CEC = 1.7 When 17 < A ≤ 22, CEC = 1.8 When 22 < A, CEC = 1.9	-
Assembly hall	550	2.2	1	1		
Hotel	420	2.5	1	1		1
Retail	380	1.7	0.9	1		-
Hospital or clinic	340	2.5	1	1		-
School	320	1.5	0.8	1		-
Office	300	1.5	1	1		1
Factory and other				1		

Notes: PAL* is the unadjusted value without the integration of scale correction coefficients.
The term "A" represents the total length of circulation pipes for hot water supply (m) divided by the average daily volume of hot water consumed (m³).

Source: CCREUB 1999

In addition, the PAL should be corrected for building size using scale correction coefficients (Table 5).[8]

Table 5 Scale Correction Coefficients

Number of Floors, excluding Basement	Average Floor Area (Square Meters)			
	50 or Less	50 to 100	100 to 200	300 or More
1	2.40	1.68	1.32	1.20
2 or more	2.00	1.40	1.10	1.00

Source: CCREUB 1999

[8] For example, in the case of a restaurant with 2 floors, excluding the basement and where the average floor area is between 50 and 100 square meters, the PAL would be 770 (i.e., 550 * 1.40 = 770).

3.3 Energy Codes for Residential Buildings (Houses)- Design and Construction Guidelines on the Rationalization of Energy Use for Houses (DCGREUH)

The DCGREUH is a set of prescriptive building energy codes for residential buildings (houses).

3.3.1 Thermal Insulation

Section 2 of the code describes the building components which must be insulated. Specifically, external roofs, ceilings, walls and floors should be insulated, while sheds, garages, attics, eaves, sleeve walls and verandas do not have to be insulated.

3.3.2 Thermal Performance of the Building Envelope

Section 3 covers three provisions related to the thermal insulation of the building envelope (building envelope design, insulation material construction and air-tight layers).

(1) **Building envelope design** includes the maximum heat transfer coefficient for the building envelope, and the minimum heat resistance for insulation materials. These values are categorized by type of house, portion of the building envelope and climate zone (Tables 6 and 7).

(2) **Insulation material construction** details the proper measures for installing thermal insulation (such as an air stopper) in meeting areas between the walls and the roof, or the floor of a thermally insulated structure. It also covers sealing recessed lighting in the ceiling or roof of an insulated structure, preventing moisture condensation which may degrade insulation performance, reducing heat losses from thermal bridges and preventing moisture condensation on their surfaces.

(3) **Airtight layer construction** details the proper construction measures for high thermal performance through airtight layer construction.

Table 6 Standard Heat Transfer Coefficients (U-values) of Building Envelopes by Climate Zone

Unit: watt/ °C . square meter

Type of House	Heat-Insulation Construction	Component		Standard Heat Transfer Coefficient by Climate Zone					
				I	II	III	IV	V	VI
Houses with a reinforced concrete structure	Interior heat-insulation construction method	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	Exposed to open air	0.27	0.32	0.37	0.37	0.37	-
			Others	0.38	0.46	0.53	0.53	0.53	-
		Peri-phery of earthen floors	Exposed to open air	0.47	0.51	0.58	0.58	0.58	-
			Others	0.67	0.73	0.83	0.83	0.83	-
	Exterior heat-insulation construction method	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	Exposed to open air	0.38	0.46	0.54	0.54	0.54	-
			Others	-	-	-	-	-	-
		Peri-phery of earthen floors	Exposed to open air	0.47	0.51	0.58	0.58	0.58	-
			Others	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	Exposed to open air	0.24	0.24	0.34	0.34	0.34	-
			Others	0.34	0.34	0.48	0.48	0.48	-
		Peri-phery of earthen floors	Exposed to open air	0.37	0.37	0.53	0.53	0.53	-
			Others	0.53	0.53	0.76	0.76	0.76	-

Source: DCGREUH 1999

Note: The DCGREUH uses the term "standard heat transfer coefficient", which is similar to a maximum allowable heat coefficient.

Table 7 Minimum Heat Resistance (R-value) for Insulation Materials by Climate Zone

Unit: m^2. °C/watt

Type of House	Heat-insulation Construction	Component		Standard Heat Resistance for Heat-insulation Material					
				I	II	III	IV	V	VI
Houses with a reinforced concrete structure	Interior insulation construction method	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	Exposed to open air	3.2	2.6	2.1	2.1	2.1	-
			Others	2.2	1.8	1.5	1.5	1.5	-
		Periphery of earthen floors	Exposed	1.7	1.4	0.8	0.8	0.8	-
			Others	0.5	0.4	0.2	0.2	0.2	-
	Exterior insulation construction method	Roof or ceiling		3	2.2	2	2	2	2
		Wall		1.8	1.5	0.9	0.9	0.9	0.3
		Floor	Exposed	2.2	1.8	1.5	1.5	1.5	-
			Others	-	-	-	-	-	-
		Periphery of earthen floors	Exposed	1.7	1.4	0.8	0.8	0.8	-
			Others	0.5	0.4	0.2	0.2	0.2	-
Wooden houses	Fill insulation construction method	Roof or ceiling	Roof	6.6	4.6	4.6	4.6	4.6	4.6
			Ceiling	5.7	4	4	4	4	4
		Wall		3.3	3.3	2.2	2.2	2.2	2.2
		Floor	Exposed	5.2	5.2	3.3	3.3	3.3	-
			Others	3.3	3.3	2.2	2.2	2.2	-
		Periphery of earthen floors	Exposed	3.5	3.5	1.7	1.7	1.7	-
			Others	1.2	1.2	0.5	0.5	0.5	-
Houses made with the framework wall construction method	Fill insulation construction method	Roof or ceiling	Roof	6.6	4.6	4.6	4.6	4.6	4.6
			Ceiling	5.7	4	4	4	4	4
		Wall		3.6	2.3	2.3	2.3	2.3	2.3
		Floor	Exposed	4.2	4.2	3.1	3.1	3.1	3.1
			Others	3.1	3.1	2	2	2	-
		Periphery of earthen floors	Exposed	3.5	3.5	1.7	1.7	1.7	-
			Others	1.2	1.2	0.5	0.5	0.5	-
Wooden houses, houses made with the framework wall construction method, or steel frame houses	Exterior lining insulation construction method	Roof or ceiling		5.7	4	4	4	4	4
		Wall		2.9	1.7	1.7	1.7	1.7	1.7
		Floor	Exposed	3.8	3.8	2.5	2.5	2.5	-
			Others	-	-	-	-	-	-
		Periphery of earthen floors	Exposed	3.5	3.5	1.7	1.7	1.7	-
			Others	1.2	1.2	0.5	0.5	0.5	-

Source: DCGREUH 1999

3.3.3 Thermal Performance of Windows and Doors (Openings)

The maximum heat transfer coefficient (U-values) of windows and doors ranges from 2.33 in colder areas (climate zones I and II) to 6.51 in hotter areas (climate zone VI) (Table 8).

Table 8 Maximum Heat Transfer Coefficients (U-values) of Windows and Doors by Climate Zone

Unit: watts/m^2.^{o}C

Climate Zone					
I	**II**	**III**	**IV**	**V**	**VI**
2.33		3.49	4.65		6.51

Source: DCGREUH 1999

In the coldest zones (I and II), windows must generally have triple-glazed glass, or double-glazed glass and a storm window. Double-glazed windows are required in zones III to V.

The maximum summer solar heat gain coefficients (SHGC) range from 0.52 in colder areas (climate zones I and II) to 0.6 in hotter areas (climate zone VI) (Table 9). Window orientation is also a factor in determining the maximum SHGC. Certain types of windows are exempt from these requirements, in particular, windows that are very small compared to the total floor area and skylights providing direct sunlight.

Table 9 Maximum Summer SHGC by Climate Zone

Window Direction	Climate Zone					
	I	**II**	**III**	**IV**	**V**	**VI**
Pointing +/-30° from due North	0.52		0.55			0.6
Other orientations	0.52		0.45			0.4

Source: DCGREUH 1999

This section of the code also provides details on design and construction measures to improve the thermal performance of openings.

3.3.4 Ventilation Plans

Kitchens, bathrooms and other spaces that locally generate peculiar air contaminants should be mechanically ventilated. One-storied houses and rooms of apartment houses should have a mechanical ventilation system unless the necessary volume of fresh air can be ensured with natural ventilation or an exhaust emission tower. Houses with two or three floors can have either a natural or mechanical ventilation system. However, a mechanical ventilation system should always be used for houses that are air-conditioned or heated continuously. The code also provides suggestions regarding the design of ventilation plans, including pre-heating air, the size and location of openings for natural ventilation, the hourly volume of air that mechanical ventilation systems should provide per person and room type, and measures to prevent condensation in mechanical ventilation systems.

3.3.5 Heating, Cooling and Hot Water Plans

Buildings should have energy efficient heating and cooling equipment. Combustion-based heating and hot water equipment should be enclosed or outdoors. Semi-enclosed heating and hot water systems must have adequate precautions to prevent exhaust air from entering occupied spaces, such as an air supply opening with local ventilation to prevent the backward flow of exhaust gas. In addition, heating and cooling equipment must be designed to allow residents to choose among continuous heating, partial heating and intermittent heating.

3.3.6 Airflow Plans

In order to provide comfortable airflow to residents, each room must have a window or door. Meanwhile, proper measures for these openings are needed to prevent insect infestation and burglary. In addition, designers should consider trees planted to screen the house from the outside.

3.3.7 Information on Building Operations and Maintenance ("How to Live")

In contrast to the residential building codes of other APP countries, Japan's residential building energy code also provides instructions regarding the operation and maintenance of the house, including the following:

- Open combustion heating systems should be equipped with a device to prevent incomplete combustion,
- Proper measures should be taken to prevent moisture condensation in an open heating system,
- Proper ventilation is needed when significant amounts of chemical substances, offensive odors and vapors are generated inside the house.
- Filters on ventilation systems and heating and cooling equipment should be cleaned regularly.
- Rooms must be ventilated by windows when there is a small difference between the inside and outside temperature, except during the heating season.

Under the Energy Conservation Law, owners of large houses and buildings must provide local authorities with reports on maintenance every three years.

3.4 Energy Codes for Residential Houses - Criteria for Clients on the Rationalization of Energy Use for Houses (CCREUH)

The CCREUH contains a mixture of prescriptive and performance-based energy efficiency provisions, mainly focused on HVAC (Table 10). It provides the maximum allowable annual heating and cooling loads (Table 11).

Table 10 Essential Features of CCREUH

Section Number and Title	Selected Contents
1. Maximum allowable annual heating and cooling loads by climate zone	This section provides maximum allowable annual heating and cooling loads, and related parameters and calculation methods.
2. Standards for equivalent clearance areas by climate zone	This section provides the definition of equivalent clearance areas, which appears to relate to air exchange through the building envelope.
3. Condensation control	In order to prevent condensation that may reduce insulation performance and house durability, the property owner should prevent surface moisture condensation and moisture condensation within walls with proper measures.
4. Ventilation volume	The property owner should develop a ventilation plan for the entire house and for local ventilation near sources of contaminants by taking into consideration inflow and outflow routes for fresh air.
5. Prevention of indoor air contamination from heating and hot water systems	When installing a combustion-type heating or hot water supply system, the property owner should take measures to minimize contamination of the inside air.
6. Planned operation of heating and cooling systems	When installing a heating or cooling system, the property owner should consider how the system will be used, as well as its energy efficiency.
7. Ventilation routes for heat dissipation	The property owner should employ ventilation routes in houses in areas where ventilation is effective against heat in summer. The ventilation openings should be designed so that they do not cause trouble or inconvenience to daily living (by permitting the entry of burglars or excessive noise)

Source: CCREUH 1999

The maximum allowable annual heating and cooling loads are essentially performance standards for the building envelope as a whole. They provide a maximum budget that designers must work within. The budget is largest in the central part of the country, probably because buildings in the center usually have both heating and air conditioning.

Table 11 Maximum Allowable Annual Heating and Cooling Loads by Climate Zone

Unit: MJ/m^3/year

Climate Zone	I	II	III	IV	V	VI
Maximum Load	390	390	460	460	350	290

Source: CCREUH 1999

4. Other Developments

4.1 Environmentally Symbiotic Housing

In 1993, the MoC issued the Environmentally Symbiotic Housing and Urban District Guidelines. Compliance with the guidelines then became a prerequisite for financial support for construction of model housing complexes. A model housing complex is defined as one with “low impact” (energy efficient and low use of other natural resources), “high contact” (harmony with the surrounding environment) and “health” (a healthy environment with amenities) (The Association for Environmentally Symbiotic Housing, 2007).

The Association for Environmentally Symbiotic Housing, comprised of private companies, agencies and municipalities related to housing and local development, has been promoting Environmentally Symbiotic Housing nationwide.

MLIT subsidizes one-third of the costs of surveys, planning and installation of environmentally symbiotic facilities, including permeable pavement, facilities that utilize natural energy sources or those that use recycled materials (Hong et al., 2007).

4.2 The Housing Quality Assurance Law

The Housing Quality Assurance Law, adopted in 2000, includes three systems, (1) a housing performance labeling system, (2) a dispute settlement system, and (3) a liability system with warranties against defects. The housing performance labeling system is a voluntary system for housing suppliers, purchasers or sellers of existing homes. This system is not directly aimed at improving building energy efficiency. It covers housing performance broadly, including structural stability, fire safety, mitigation of degradation, indoor air quality, thermal environment, air environment, light and visual environment, acoustical environment, and considerations for the elderly. The rating for the thermal environment is a measure of energy conservation performance. This rating has four grades, based on compliance with existing and previous building energy codes:

- Grade 4 (highest): complies with the 1999 Standard,
- Grade 3: complies with the 1992 Standard,
- Grade 2: complies with the 1980 Standard, and
- Grade 1 (lowest): none.

By providing energy ratings of homes and comparisons to other buildings, the Housing Quality Assurance Law provides consumers with the information needed to make rational choices.

MLIT establishes the housing performance labeling system and certifies private companies to conduct the assessments. The law also provides for several inspections of housing during construction to ensure that buildings are properly rated for structural stability and fire safety.

For more information, please refer to www5.cao.go.jp/otodb/english/houseido/hou/lh_9999-71.html.

4.3 Comprehensive Assessment System for Building Environmental Efficiency - CASBEE[9]

In order to promote building energy efficiency and environmental performance, Japan established the Japan GreenBuild Council (JaGBC) / Japan Sustainable Building Consortium (JSBC) together with its secretariat administered by the Institute for Building Environment and Energy Conservation (IBEC) in 2001. With the support of MLIT, in 2001 the JSBC launched the Comprehensive Assessment System for Building Environmental Efficiency (CASBEE).

CASBEE was developed to reflect a building's life cycle. The CASBEE family contains the following tools:

- CASBEE for New Construction,
- CASBEE for New Construction (Brief Version),
- CASBEE for Existing Building,
- CASBEE for Renovation,
- CASBEE for Heat Island,
- CASBEE for Urban Development,
- CASBEE for an Urban Area + Buildings, and
- CASBEE for Home (Detached House).

CASBEE was originally a voluntary program, but is now employed as a tool for developing and reviewing mandatory reports. The local CASBEEs are made and administrated by local governments, although JaBEC administers the national program through IBEC with MLIT support.

Currently, there are 13 prefectures and cities which employ the Sustainable Building Reporting System with local CASBEE. Tokyo Metropolitan Government has its own tool for the Sustainable Building Reporting System. Under the local CASBEE programs, many towns provide incentives for more efficient buildings. For example, a building that rates highly in CASBEE may be allowed to have an additional floor or more floor space than zoning would otherwise allow. Owners of such buildings may also be eligible for certain construction subsidies and low-interest loans.

Building developers, architects and others can download the CASBEE tools to evaluate any new building or renovation on their own. Building developers and owners can also hire trained architects to conduct the assessments (Hong et al., 2007).

For more information, please refer to www.ibec.or.jp/CASBEE/english/overviewE.htm.

5. Conclusions

Building energy efficiency is an important component of the Japanese government's efforts to promote energy efficiency. Japan's Law on Energy Conservation devotes one-fifth of its contents to building energy efficiency, including issues related to efficient

[9] Please see more information at www.ibec.or.jp/CASBEE/english/overviewE.htm.

building materials, and the responsibilities of property owners, government entities and local jurisdictions.

Building energy codes in Japan are technically voluntary and there are no checks on actual construction, but compliance appears to be relatively high. The national energy conservation law mandates the submission of an energy savings report prior to any new construction, major extension or alteration of a building. Local authorities review these reports and provide instructions for improvement. Japan is also adopting a penalty scheme to ensure that large buildings and houses are energy efficient. Moreover, there is substantial technical support for builders and owners through the CASBEE program and IBEC's training seminars, making it easier to build more efficient buildings. Local governments also encourage more efficient building designs by giving owners incentives like access to relaxed building height and size restrictions, and financial support for very efficient buildings. In addition, the CCREUB includes a scoring system that allows the code to include consideration of issues like building orientation and shape.

The codes also address the issue of operations and maintenance. Building owners must submit maintenance reports every three years, and the residential building energy codes have a separate provision regarding operation and maintenance to improve energy efficiency. This is unique among the existing building codes of APP countries.

List of Acronyms

APP	Asia-Pacific Partnership on Clean Development and Climate
CASBEE	Comprehensive Assessment System for Building Environmental Efficiency
CCREUB	Criteria for Clients on the Rationalization of Energy Use for Buildings
CCREUH	Criteria for Clients on the Rationalization of Energy Use for Houses
CEC	Coefficient of Energy Consumption
DCGREUH	Design and Construction Guidelines on the Rationalization of Energy Use for Houses
ECCJ	Energy Conservation Center, Japan
EIA	U.S. Energy Information Agency
GDP	Gross domestic product
HDD	Heating degree day
HVAC	Heating, ventilation and air conditioning
IBEC	Institute for Building Environment and Energy Conservation
IEA	International Energy Agency
IMF	International Monetary Fund
JaGBC	Japan GreenBuild Council
JSBC	Japan Sustainable Building Consortium
METI	Ministry of Economy, Trade and Industry
MITI	Ministry of International Trade and Industry
MJ	Megajoule
MLIT	Ministry of Land, Infrastructure and Transport
MoC	Ministry of Construction
Mtoe	Million ton of oil equivalent
NILIM	National Institute for Land and Infrastructure Management
OECD	Organisation for Economic Co-operation and Development
PAL	Perimeter Annual Load
R&D	Research and development
SHGC	Solar heat gain coefficient
SI	International system (or metric) units

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Useful Websites

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3. Ministry of Land, Infrastructure and Transport, www.mlit.go.jp/index_e.html

The Asia-Pacific Partnership on Clean Development and Climate

The Asia-Pacific Partnership on Clean Development and Climate is an innovative new effort to accelerate the development and deployment of clean energy technologies.

Partner Countries

APP partners Australia, Canada, China, India, Japan, Republic of Korea, and the United States have agreed to work together and with private sector partners to meet goals for energy security, national air pollution reduction, and climate change in ways that promote sustainable economic growth and poverty reduction. The Partnership will focus on expanding investment and trade in cleaner energy technologies, goods and services in key market sectors. The Partners have approved eight public-private sector task forces covering:

- Aluminum
- Buildings and Appliances
- Cement
- Cleaner Use of Fossil Energy
- Coal Mining
- Power Generation and Transmission
- Renewable Energy and Distributed Generation
- Steel

The seven partner countries collectively account for more than half of the world's economy, population and energy use, and they produce about 65 percent of the world's coal, 62 percent of the world's cement, 52 percent of world's aluminum, and more than 60 percent of the world's steel.

Buildings and Appliances Task Force

Reducing our use of energy for buildings and appliances decreases the demand for primary energy and is a key means to deliver better economic performance, increase energy security and reduce greenhouse gas and air pollutant emissions. Partner countries have recognized for some time the importance of cooperating on energy efficiency for buildings and appliances, and have already taken a range of bilateral and other collaborative actions in this area. As the Partners represent a majority of the world's manufacturing capacity for a diverse range of appliances, we have the potential to drive significant regional and global improvements in energy efficiency in this sector. The Partners will demonstrate technologies, enhance and exchange skills relating to energy efficiency auditing, share experiences and policies on best practices with regard to standards and codes, as well as labeling schemes for buildings, building materials and appliances.

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