Status of Energy Efficient Building Codes in Asia

(China, Hong Kong, Taiwan, Japan, Korea, Malaysia, Philippines, Singapore, Thailand, India)

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Energy efficiency building standards in China

Summary

China adopted building energy standards in stages, starting with an energy design standard for residential buildings in the Heating Zone in north China in 1986, and revised in 1995. This was followed by a standard for tourist hotels in 1993, and then standards for residential buildings in the Hot-Summer Cold-Winter Region in central China in 2001 and the Hot-Summer Warm-Winter Region in south China in 2003. A national energy efficient design standard for public buildings (similar to commercial buildings) was adopted in 2004. Lastly, a revised national energy design standard for residential buildings that combines the three previous regional standards has been under development since 2005 and is expected to be completed in early 2007. Preceding these national or regional standards, there have been also local standards in major cities, such as Beijing, Shanghai, Wuhan, and Chongqing.

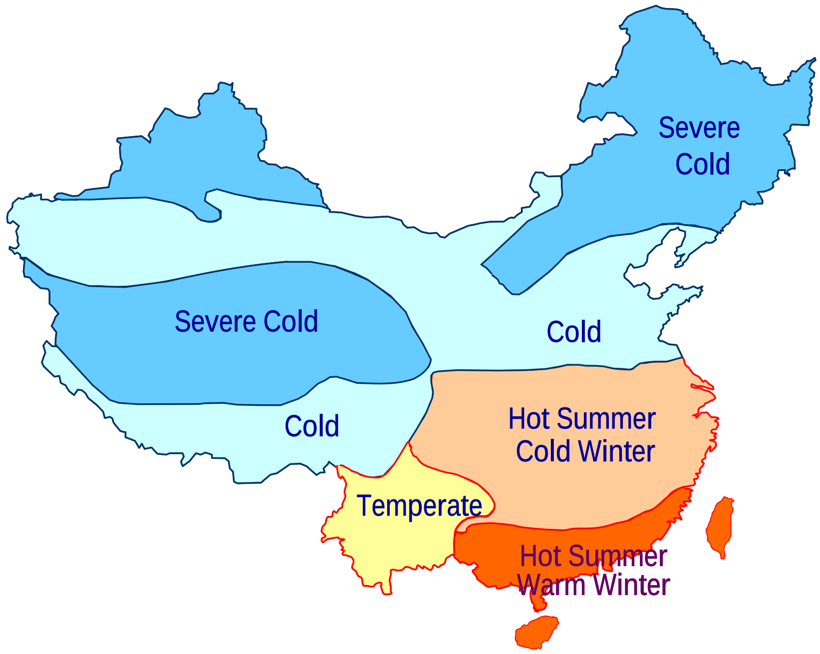
Enforcement of building energy standards have been problematic, particularly in the early years, but with continuing programs led by the Ministry but implemented locally, compliance to the energy standards is now good in the leading cities, e.g. Beijing and Shanghai, adequate in the major cities, but still spotty in the smaller cities and towns. Although China's building energy efficiency program remains focused on the enforcement of building energy codes, there have been recent efforts to go beyond that through demonstration buildings, building performance ratings (2006), and green building rating systems (ecological housing 2001, green Olympics 2004, green buildings 2006). Although these remain exploratory, public concern about the environment, energy waste, and climate change has increased rapidly in recent years, and may lead to major changes in China's booming construction industry.

Status of Building Energy Efficiency Standards

From an institutional point of view, China has benefit of a centralized Ministry of Construction (MOC) responsible for regulating a building industry that over the past decade has built roughly half of the new construction of the entire world. Under the MOC, there is a network of Construction Commissions in the major cities and provinces to oversee building construction, including the granting of building permits and enforcement of building codes, as well as a parallel network of building research institutes to provide technical expertise and support to the MOC and the building industry. Within the MOC, building energy standards fall under the jurisdiction of the Department of Standards and Norms. However, the technical development of building energy standards is the responsibility of the Department of Science and Technology, in collaboration with building research institutes, universities, and industry representatives. For example, for the current residential and public building standards, Code Compilation Committees were organized under the leadership of the China Academy of Building Research.

Scope. China's first building energy standard was one for residential buildings in the Heating Zone in north China that was developed in 1986, and then revised in 1995 (JGJ 26-95, see map in Figure 1 for the boundaries for the 4 climate regions designated by the MOC). Buildings in the Heating Zone are required by law to be heated, with mandated heating budgets in kilograms of coal per square meter of floor area, and prior to the 1990's, were the only buildings that used significant amounts of energy for space conditioning. The target of the standard was to reduce building energy consumption compared to pre-existing construction by 30% in the 1986 version, and by 50% in the 1995 version of the standard. The 1986 version aimed at reducing the heat losses of the building envelope by 30%, while the 1995 revision also added a 20% improvement in heating system efficiency Since this and the following two regional residential standards will be shortly superseded in 2007 by a national residential building energy standard, their technical details will not be discussed in this report.

Figure 1. China climate regions defined by the Ministry of Construction
(the Cold and Severe Cold regions are often also referred to together as
the Heating Zone, where heating is required by law)



Concern about the high energy use of Western-style hotels built starting in the late 1980's led to the development of a national building energy standard for "tourist hotels" in 1986, that was adopted by the MOC in 1993 (GB 50189-93). The enforcement of this standard is not well-known, but probably spotty given its early date of adoption. This standard was superseded by the 2004 national public building energy standard, and is no longer in force.

With China's rapid economic growth in the 1990's, air-conditioning and space heating (mostly with heat pumps) became very common in residential buildings in central and south China, leading to an explosive increase in residential electricity use. In response to this situation, MOC developed a building energy standard for residential buildings in the Hot-Summer Cold-Winter region (HSCW) in central China in 2001 (JGJ 134-2001), and another for the Hot-Summer Warm-Winter region (HSWW) in south China in 2003 (JGJ 75-2003). The target for both standards was to reduce building energy use by 50% compared to pre-existing buildings. These two standards marked the first efforts in China to analyze cooling energy use using computer simulations, and to introduce a performance option to comply with the building energy standard. Both are essentially envelope standards with prescriptive requirements for wall, roof, and window conductance, and for the control of window solar gain, particularly in the HSWW standard. Requirements for equipment efficiency make reference to other standards and ratings that have been developed for HVAC equipment. Like the earlier Heating Zone standard, these two standards will be superseded in 2007 by a national residential energy standard, so their technical contents will not be discussed in this report.

In 2002, the MOC also authorized the development of a national energy efficient design standard for public buildings (GB 50189-2005).[1] The previous residential standards had been industry standards, so that the designation of this as a national standard indicates an increased importance attached to building energy efficiency. This standard was completed and adopted by the MOC in 2005. It, too, set the target at 50% energy reductions compared to pre-existing buildings, but here the savings would be achieved partly by improving the building envelope (22%) but mostly by improving the performance of the HVAC system (28%). Like the newer residential standards, this standard also includes a computer-based performance option.

Lastly, in 2005 the MOC decided to update the three regional residential building energy standards (Heating Zone, HSCW, and HSWW), and combine them into a single national energy design standard for residential buildings. This effort was originally scheduled to be completed by the end of 2006, but will now be completed in early 2007. The contents of this standard will be described in the following section on Contents.

Contents: One characteristic shared by all of China's building energy standards is their narrow scope. The residential standards are largely envelope standards; the public building standard also addresses HVAC system efficiency, but not that of the lighting, electric power, or hot water systems. One reason for this is that the MOC has separate energy standards for lighting, room air-conditioners, and commercial HVAC equipment, to which the building standards refer. Another reason is that is residential buildings, air-conditioning is installed by the apartment owner, making any requirements in the building standard difficult to enforce and largely of advisory nature.

Tables 1 through 5 lists the prescriptive envelope requirements of the national residential standard due to be completed in 2007, which vary by climate and the number of floors of the building. The window requirements vary by the window-to-wall ratio, with more stringent U-value (in the heating-dominant climates) or Shading Coefficient (in the cooling-dominant climates) requirements for larger window areas. Tables 6 through 10 lists the prescriptive envelope requirements of the 2005 national standard for public buildings. Compared to the residential standard, for the same climate region the public building energy standard have similar to somewhat lower U-value requirements for both opaque surfaces and fenestration, but noticeably more stringent Shading Coefficient requirements in recognition of the higher cooling loads in public buildings.

In addition to these prescriptive requirements, both the new residential and public building standards contain performance options whereby a building is deemed to meet the standard so long as its calculated building energy use is below that of a reference building. This "custom budget" approach is similar to that used in US standards such as ASHRAE 90.1, and differs from the "fixed budget" approach used in several other Asian countries. For doing the compliance calculations, several building research institutes and at least one architectural software company have developed computer programs either for internal use by Construction Commission staff or by the design firms

[1] The MOC's definition of "public buildings" is somewhat analogous to what are called "commercial buildings" in many other countries.

Table 1. Envelope requirements for residential buildings in the Severe Cold Region

Bldg envelope component		Heat Transfer Coefficient (W/(m2·K)		
		Severe Cold A (5500<HDD<8000)	Severe Cold B (5000<HDD18<5500)	Severe Cold C (3800<HDD18<5000)
Roof	≥10 story bldg	0.40	0.40	0.45
	7～9 story bldg	0.40	0.40	0.45
	4～6 story bldg	0.40	0.40	0.45
	≤3 story bldg	0.33	0.36	0.36
Exterior wall	≥10 story bldg	0.48	0.45	0.50
	7～9 story bldg	0.40	0.45	0.50
	4～6 story bldg	0.40	0.45	0.50
	≤3 story bldg	0.33	0.40	0.40
Suspended or outward projecting floors exposed to outdoor air		0.48	0.45	0.45
Walls & floors bet. unheated and heated spaces		0.70	0.80	0.80
Entrance door		1.5	1.5	1.5
Lower portion of balcony door		1.0	1.0	1.0
Slab	Perimeter Slab	0.28	0.35	0.35
	Non- Perimeter Slab	0.28	0.35	0.35
Ext. window (incl.transparent portion of balcony)	WWR≤20%	2.5	2.8	2.8
	20%＜WWR≤30%	2.2	2.5	2.5
	30%＜WWR≤40%	2.0	2.3	2.3
	40%＜WWR≤50%	1.7	1.8	2.1

Table 2. Envelope requirements for residential buildings in the Cold Region

		Heat Transfer Coefficient (W/(m2·K)		
Bldg envelope component		Cold A (2000<HDD18<3800, CDD26<100)	Cold B (2000≤HDD18＜3800, CDD26≤200)	
			Light const.	Heavy const.
Roof	≥10 story bldg	0.50	0.50	0.60
	7～9 story bldg	0.50	0.50	0.60
	4～6 story bldg	0.50	0.50	0.60
	≤3 story bldg	0.45	0.45	0.50
Exterior wall	≥10 story bldg	0.50	0.50	0.60
	7～9 story bldg	0.50	0.50	0.60
	4～6 story bldg	0.50	0.50	0.60
	≤3 story bldg	0.45	0.45	0.50
Suspended or outward projecting floors exposed to outdoor air		0.50	0.60	
Walls & floors bet. unheated and heated spaces		1.2	1.0	
Entrance door		2.0	2.0	
Lower portion of balcony door		1.7	1.7	
Slab	Perimeter Slab	0.50		
	Non- Perimeter Slab	0.50		
Ext. window (incl.transparent portion of balcony)	WWR≤20%	2.8	3.2	
	20%＜WWR≤30%	2.8	3.2	---
	30%＜WWR≤40%	2.5	2.8	0.70/---
	40%＜WWR≤50%	2.0	2.5	0.60/---

Table 3 Envelope requirements for residential buildings in the Hot-Summer Cold-Winter Region

Bldg envelope component		Heat Transfer Coefficient (W/(m2·K)			
		Region A (1000≤HDD18<2000, 50<CDD26≤150)		Region B (1000≤HDD18<2000, 150<CDD26≤300)	
		Light const.	Heavy const.	Light const.	Heavy const.
Roof	≥10 story bldg	≤0.4	≤0.8	≤0.4	≤0.8
	7～9 story bldg	≤0.4	≤0.8	≤0.4	≤0.8
	4～6 story bldg	≤0.4	≤0.8	≤0.4	≤0.8
	≤3 story bldg	≤0.4	≤0.6	≤0.4	≤0.6
Exterior wall	≥10 story bldg	≤0.5	≤1.0	≤0.5	≤1.0
	7～9 story bldg	≤0.5	≤1.0	≤0.5	≤1.0
	4～6 story bldg	≤0.5	≤1.0	≤0.5	≤1.0
	≤3 story bldg	≤0.4	≤0.8	≤0.4	≤0.8
Suspended or outward projecting floors exposed to outdoor air		≤1.5		≤1.5	
Walls & floors bet. unheated and heated spaces		≤2.0		≤2.0	
Entrance door		≤3.0		≤3.0	
		Heat Trans. Coeff. (W/m^2 K)	Shad.Coeff (ESW/N)	Heat Trans. Coeff. (W/m^2 K)	Shad.Coeff (ESW/N
Ext. window (incl.transparent portion of balcony)	WWR≤20%	≤4.7	---	≤4.7	---
	20%<WWR≤30%	≤3.2	≤0.80/---	≤3.2	≤0.70/0.80-
	30%<WWR≤40%	≤3.2	≤0.70/0.80	≤3.2	≤0.60/0.70
	40%<WWR≤50%	≤2.5	≤0.60/0.70	≤2.5	≤0.50/0.60
Skylight	Skyl <-4% roof area	≤3.2	≤0.60	≤3.2	≤0.50

Bldg envelope component		Heat Transfer Coeff.t (W/(m2·K)	
		Region C (600≤HDD18<1000, 100<CDD26≤300)	
		Light const.	Heavy const.
Roof	≥10 story bldg	≤0.5	≤1.0
	7～9 story bldg	≤0.5	≤1.0
	4～6 story bldg	≤0.5	≤1.0
	≤3 story bldg	≤0.4	≤0.8
Exterior wall	≥10 story bldg	≤0.75	≤1.5
	7～9 story bldg	≤0.75	≤1.5
	4～6 story bldg	≤0.75	≤1.5
	≤3 story bldg	≤0.6	≤1.2
Suspended or outward projecting floors exposed to outdoor air		≤1.5	
Walls & floors bet. unheated and heated spaces		≤2.0	
Entrance door		≤3.5	
		Heat Trans. Coeff. (W/m^2 K)	Shad.Coeff (ESW/N)
Ext. window (incl.transparent portion of balcony)	WWR≤20%	≤4.7	---
	20%<WWR≤30%	≤4.0	≤0.70/0.80-
	30%<WWR≤40%	≤3.2	≤0.60/0.70
	40%<WWR≤50%	≤2.5	≤0.50/0.60
Skylight	Skyl <-4% roof area	≤4.0	≤0.50

Table 4 Envelope requirements for residential buildings in the Hot-Summer Warm Winter Region

Bldg envelope component		Heat Transfer Coefficient (W/(m2·K)	
		Light const.	Heavy const.
Roof	≥10 story bldg	≤0.5	≤1.0
	7～9 story bldg	≤0.5	≤1.0
	4～6 story bldg	≤0.5	≤1.0
	≤3 story bldg	≤0.4	≤0.8
Exterior wall	≥10 story bldg	≤1.0	≤2.0
	7～9 story bldg	≤1.0	≤2.0
	4～6 story bldg	≤1.0	≤2.0
	≤3 story bldg	≤0.7	≤1.5
Suspended or outward projecting floors exposed to outdoor air		≤2.0	
		Heat Trans. Coeff. (W/m^2 K)	Shad.Coeff (ESW/N)
Ext. window (incl.transparent portion of balcony)	WWR≤20%	---	---
	20%＜WWR≤30%	---	≤0.65/0.75-
	30%＜WWR≤40%	---	≤0.55/0.65
	40%＜WWR≤50%	---	≤0.45/0.55
Skylight	Skyl <-4% roof area	---	≤0.40

Table 5 Envelope requirements for residential buildings in the Temperate Region

Bldg envelope component		Heat Transfer Coeff.icient (W/(m^2·K)	
		Light const.	Heavy const.
Roof	≥10 story bldg	≤0.4	≤0.8
	7～9 story bldg	≤0.4	≤0.8
	4～6 story bldg	≤0.4	≤0.8
	≤3 story bldg	≤0.5	≤0.6
Exterior wall	≥10 story bldg	≤0.5	≤1.0
	7～9 story bldg	≤0.5	≤1.0
	4～6 story bldg	≤0.5	≤1.0
	≤3 story bldg	≤0.4	≤0.8
Suspended or outward projecting floors exposed to outdoor air		≤1.5	
Walls & floors bet. unheated and heated spaces		≤2.0	
Entrance door		≤3.0	
		Heat Trans. Coeff. (W/m^2 K)	Shad.Coeff (ESW/N)
Ext. window (incl.transparent portion of balcony)	WWR≤20%	≤4.7	---
	20%＜WWR≤30%	≤4.0	≤0.80/0.80-
	30%＜WWR≤40%	≤3.2	≤0.70/0.70
	40%＜WWR≤50%	≤2.5	≤0.60/0.60
Skylight	Skyl <-4% roof area	≤4.0	≤0.60

Table 6. Envelope requirements for public buildings in the Severe Cold Region A

Bldg Envelope Component		Shape Coefficient ≤ 0.3 Heat Transfer Coefficient ($W/m^2 \cdot K$)	0.3 < Shape Coefficient ≤ 0.4 Heat Transfer Coefficient ($W/m^2 \cdot K$)
Roofs		≤0.35	≤0.30
Exterior wall (Including non-transparent curtain wall)		≤0.45	≤0.40
Suspended or projecting floors with underside exposed to outdoor air		≤0.45	≤0.40
Walls and floors between unheated and heated spaces		≤0.6	≤0.6
Exterior window (including transparent curtain wall)			
exterior window by orientation (including transparent curtain wall)	WWR ≤0.2	≤3.0	≤2.7
	0.2< WWR≤0.3	≤2.8	≤2.5
	0.3< WWR ≤0.4	≤2.5	≤2.2
	0.4< WWR ≤0.5	≤2.0	≤1.7
	0.5< WWR ≤0.7	≤1.7	≤1.5
Roof skylight area		≤2.5	

Table 7. Envelope requirements for public buildings in the Severe Cold Region B

Building Envelope Component		Shape Coefficient ≤ 0.3 Heat Transfer Coefficient ($W/m^2 \cdot K$)	0.3 < Shape Coefficient ≤ 0.4 Heat Transfer Coefficient ($W/m^2 \cdot K$)
Roofs		≤0.45	≤0.35
Exterior wall (Including non-transparent curtain wall)		≤0.50	≤0.45
Suspended or projecting floors with underside exposed to outdoor air		≤0.50	≤0.45
Walls and floors between unheated and heated spaces		≤0.8	≤0.8
Exterior window (including transparent curtain wall)			
exterior window by orientation (including transparent curtain wall)	WWR ≤0.2	≤3.2	≤2.8
	0.2< WWR≤0.3	≤2.9	≤2.5
	0.3< WWR ≤0.4	≤2.6	≤2.2
	0.4< WWR ≤0.5	≤2.1	≤1.8
	0.5< WWR ≤0.7	≤1.8	≤1.6
Roof skylight area		≤2.6	

Table 8. Envelope requirements for public building in the Cold Region

Building Envelope Component		Shape Coefficient ≤ 0.3 Heat Transfer Coefficient ($W/m^2·K$)		0.3 < Shape Coefficient ≤ 0.4 Heat Transfer Coefficient ($W/m^2·K$)	
Roofs		≤0.55		≤0.45	
Exterior wall (Including non-transparent curtain wall)		≤0.60		≤0.50	
Suspended or projecting floors with underside exposed to outdoor air		≤0.60		≤0.50	
Walls and floors between unheated and heated spaces		≤1.5		≤1.5	
Exterior window (including transparent curtain wall)		Heat Transfer Coefficient $W/(m^2·K)$	Window Shading Coefficient (East, South, West/North)	Heat Transfer Coefficient $W/(m^2·K)$	Window Shading Coefficient (East, South, West/North)
exterior window by orientation (including transparent curtain wall)	WWR ≤0.2	≤3.5	—	≤3.0	—
	0.2< WWR≤0.3	≤3.0	—	≤2.5	—
	0.3< WWR ≤0.4	≤2.7	≤0.70/—	≤2.3	≤0.70/—
	0.4< WWR ≤0.5	≤2.3	≤0.60/—	≤2.0	≤0.60/—
	0.5< WWR ≤0.7	≤2.0	≤0.50/—	≤1.8	≤0.50/—
Roof skylight area		≤2.7	≤0.50	≤2.7	≤0.50

Table 9 Envelope requirements for public buildings in the Hot-Summer and Cold-Winter Region

Building Envelope Component		Heat Transfer Coefficient ($W/m^2·K$)	
Roofs		≤ 0.70	
Exterior wall (Including non-transparent curtain wall)		≤ 1.0	
Suspended or projecting floors with underside exposed to outdoor air		≤ 1.0	
Exterior window (including transparent curtain wall)		Heat Transfer Coefficient $W/(m^2·K)$	Window Shading Coefficient (East, South, West/North)
exterior window by orientation (including transparent curtain wall)	WWR ≤0.2	≤ 4.7	—
	0.2< WWR≤0.3	≤ 3.5	≤ 0.55/—
	0.3< WWR ≤0.4	≤ 3.0	≤ 0.50/0.60
	0.4< WWR ≤0.5	≤ 2.8	≤ 0.45/0.55
	0.5< WWR ≤0.7	≤ 2.5	≤ 0.40/0.50
Roof skylight area		≤3.0	≤0.40

Table 10. Envelope requirements for public buildings in the Hot-Summer and Warm-Winter Region

Building Envelope Component		K Heat Transfer Coefficient W/(m^2·K)	
Roofs		≤ 0.90	
Exterior wall (Including non-transparent curtain wall)		≤ 1.5	
Suspended floors or projecting floor slabs with the underside exposed to outdoor air		≤ 1.5	
Exterior window (including transparent curtain wall)		Heat Transfer Coefficient W/(m^2·K)	Shading Coefficient (East, South, West/North)
exterior window by orientation (including transparent curtain wall)	WWR ≤0.2	≤ 6.5	—
	0.2< WWR ≤0.3	≤ 4.7	≤ 0.50/0.60
	0.3< WWR ≤0.4	≤ 3.5	≤ 0.45/0.55
	0.4< WWR ≤0.5	≤ 3.0	≤ 0.40/0.50
	0.5< WWR ≤0.7	≤ 3.0	≤ 0.35/0.45
Roof skylight area		≤3.5	≤0.35

to demonstrate compliance. To date, the MOC or local offices have not established clearly-defined certification procedures for either the compliance software or the calculations.

The equipment portion of the residential standard contains many requirements on the efficient design of the heating system, which in North China is typically a centralized two-pipe hydronic system served by a large boiler. The standard stipulates minimum boiler efficiencies, pipe insulation levels, and individual controls.[2] For the cooling systems, which typically are individual through-the-wall split systems, or individually installed heating systems, the residential standard stipulates that they must meet a certain grade level of China's energy-efficiency rating system for air-conditioners or heat pumps. On a practical level, such requirements are impossible to enforce because in China space conditioning systems (with the exception of centralized heating in the North) are regarded as appliances and installed by the owner after purchase.

The equipment portion of the public building standard is similar that of the residential standard, except that the prevalence of central air-conditioning systems allows for more focus on efficient design principles. Whereas the ASHRAE-90.1 standard tries to be strictly neutral in the HVAC system type, the public building energy standard recommends certain system types from the point of view of energy rationalization and efficiency. The Chinese standard also tends to give more design guidance, rather than simply listing the requirements of the standard. For specific heating and cooling equipment, e.g., boilers, chillers, the standard, like the residential one, relies on existing energy efficiency grades and requires that the equipment be above a certain grade.

The public building energy standard also has a chapter on monitoring and controls, with mostly recommendations on how to control the building HVAC system for energy efficiency, and enabling the possibility of energy monitoring. The standard does not cover lighting systems, a

[2] a major problem in the traditional heating systems in North China has been the absence of controls.

very important aspect of energy efficiency in large buildings, which is covered in a separate lighting energy standards that was developed by the MOC in 2003.

Jurisdiction. The building energy standards developed by the MOC are model energy codes, analogous to the International Energy Code (IEC) or ASHRAE 90.1 in the United States, with their actual enforcement relegated to the local governments or Construction Commissions. In a number of instances, individual cities and provinces have developed their own standards, either before the MOC standard became available, or if the local standard was more stringent. For example, prior to the completion of the HSCW residential standard, Chongqing in 1999 and Wuhan in 2000 had both developed their own local codes. Similarly, Shanghai completed a public building standard in 2003 that got incorporated later into the national standard. and Beijing in 2005 has revised its building energy standards to be more stringent (65% savings) than that of the national standards. However, by and large the recent efforts in developing national building energy standards have made most of the local standards outdated and unnecessary.

Like in many other countries, the point of control in enforcing building energy standards is during design and construction, with non-compliance resulting in the building permit not being issued. Although the MOC has made both standards mandatory, enforcement remains a problem. When the Heating Zone standard was first introduced in the early 90's, it was generally acknowledged that enforcement occurred only in Beijing and Tianjin, but largely ignored in other parts of the Heating Zone. After the HSCW standard was adopted in 2001, MOC followed up with a training program in the major cities, and asked local authorities to develop implementation plans. Similarly, after the HSWW standard was adopted in 2003, 4 cities in the region were selected for pilot implementation of the building standard. According to a leading expert in the development of China's building energy standards, the enforcement of building energy standards is high (> 80%) in the major cities, and fair (50-80%) in the smaller cities. A survey conducted by the MOC in 2005 of code enforcement in northern China identified another problem: while over 70% of the buildings complied with the energy standard on paper, less than 30% were found to be compliant upon actual inspection.

Status of Voluntary Non-Regulatory Programs

Although the MOC continues to regard the enforcement of building energy standards as the linchpin in improving building energy efficiency, there has also been a number of pilot efforts or discussions about voluntary market-based programs, such as green building rating systems, building energy labeling, as well as DSM programs.

1. *Green Building Rating Systems.* There have been several efforts in China to develop green building rating systems, both within and outside the MOC. In 2001, professors from several universities and staff of the Science and Technology Promotion Center of the MOC developed a rating system for environmentally friendly ecological housing. In 2004, a Green Olympic Building Research Group led by Tsinghua University developed a Building for Green Olympic Building Assessment System (GOBAS) for evaluating the environmental qualities of buildings for the 2008 Olympics. The system is modeled primarily on Japan's Comprehensive Assessment System for Building Environmental Efficiency (CASBEE) and, to a lesser extent, LEED. In 2006, the MOC developed a "Evaluation standard for green building" (GB/T 50378-2006) that represents a preliminary

effort by the MOC to quantify and rate the environmental quality of both residential and public buildings.

2. *Building Energy Labeling.* Now that the building energy standards are in place, the MOC has shown increasing interest in the establishment of a building energy labeling system. In June 2006, the MOC in conjunction with the European Union convened an international workshop on "building energy performance evaluation and energy labeling", during which the MOC described a plan for establishing a legal system that would include mandatory energy labeling and energy efficiency management throughout the construction process for new buildings, and a program of energy efficiency retrofits for existing buildings. Following presenters described proposed building energy labeling systems developed by the China Academy of Building Research, Tsinghua University, and Shenzhen Institute of Building Research. In 2005, the Beijing city government adopted a standard for rating the energy efficiency of public buildings that requires detailed computer modeling of the building (DBJ/T01-100-205). The level of interest in building energy labeling is clearly rising, but the efforts so far are still exploratory, with no meaningful impact yet on the construction industry or marketplace.

Related end-use efficiency programs

3. *Appliance Labeling.* Starting in 1989, China has developed a comprehensive appliance standards and labeling program. This program includes minimum energy efficiency standards, a voluntary endorsement label and a proposed information label. The minimum energy efficiency standards are mandatory and been issued for 9 types of appliances and lighting products, including refrigerators, fluorescent lamps and lamp ballasts, and room air-conditioners, . The voluntary endorsement label has been issued for 15 types of appliances, lighting, and industrial products (Lin 2002).

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Energy efficiency building standards in Hong Kong

Status of Building Energy Efficiency Standards

Hong Kong's efforts to develop building energy standards started with the commissioning in 1990 of a consultant report on building energy regulations concluding with the recommendation that Hong Kong adopt an OTTV (Overall Thermal Transfer Value) standard for the building envelope. Such a Building (Energy Efficiency) Regulation was introduced in July 1995 with "suitable" OTT values for the walls and roofs of commercial buildings and hotels. "Commercial buildings" refer to offices, shops, department stores, and other buildings with commercial purposes, but do not include schools, residential buildings, factories, or garages. In practice, the code has been applied to any air-conditioned building.

A Code of Practice for Overall Thermal Transfer Values in Buildings (OTTV Code) was published by the Buildings Department to provide technical guidance on the OTT values. In addition to the OTTV standard, which affects only the construction of the building envelope, the Hong Kong government also develop separate standards for lighting, air-conditioning, and electrical equipment (all in 1998), and for lifts and elevators (2000). Thus, by 2000 these five standards together contained the same scope as more comprehensive standards such as ASHRAE 90.1 in the US. In 2005, all five of these standards were revised, with a performance-based option added to the building envelope standard.

Contents. An OTTV standard limits the maximum allowable Thermal Transfer Value, i.e., heat gain in cooling-dominant locations, for a building or portion of a building in W/m^2. The concept was originally proposed in the US for the ASHRAE 90-75 Standard in 1975, but subsequently dropped in later versions in favor of performance-based energy budgets generated through computer simulations. However, the OTTV method is still being used in a number of Asian countries or cities, including Hong Kong, Singapore, Thailand, Malaysia, etc., because of its relative ease of calculation, while still providing some flexibility of trade-offs between different parts of the envelope. The shortcoming of the OTTV method is that it does not account for the interactions between the envelope, internal gains, and equipment efficiency, as would a true performance calculation. Since most commercial buildings in Hong Kong consist of a tower on top of a larger podium, the 1995 standard contained different OTTV criteria of 35 W/m^2 for the tower and 80 W/m^2 for the podium.

In 2000, the building envelope standard was revised, with the OTTV criteria reduced downwards from 35 to 30 W/m^2 for the tower, and from 80 to 70 W/m^2 for the podium. In 2005, there was a major effort to update the four standards for lighting, air conditioning, electrical power, lifts and elevators, as well as add a performance approach to the building energy code. This performance approach is not meant to replace the five pre-existing standards, but to provide an alternate path of compliance by use of computer simulations to show that the proposed building uses the same or lower amount of energy than does a reference code-compliant building of the same size and function.

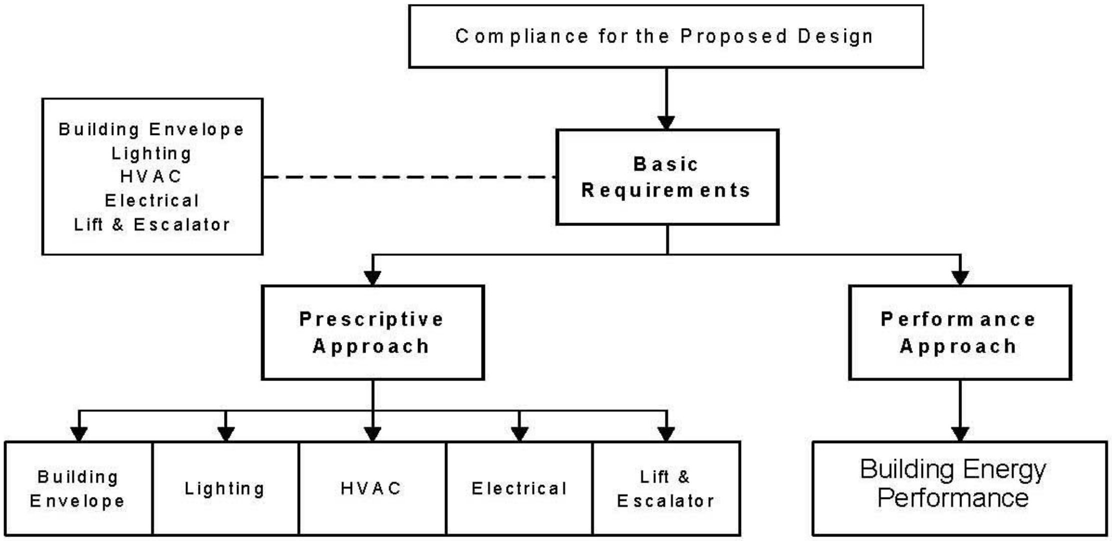

Figure 1. Compliance Framework for Hong Kong building energy standards

Figure 1 shows how the five standards and performance approach are related conceptually. Regardless of which approach is used, there are basic requirements to which a building must comply, Then, if the prescriptive approach is used, the building must meet separately the prescriptive requirements of the envelope, i.e., OTTV criteria, lighting,, HVAC, electrical e and lifts and elevators standards. Otherwise, with the performance approach a computer simulation is done to demonstrate that the overall energy use of the building is below that of a hypothetical reference building.

Strong aspects of the Hong Kong standards are that (1) they are freely available on the Web, and (2) each standard contains the standardized forms that users can fill out to demonstrate compliance.

Jurisdiction. The Hong Kong building energy standards are voluntary codes. The Electrical and Mechanical Services Department (EMSD) of the government is in charge of issuing the codes of practice, including the building energy codes. In 1994, EMSD established an Energy Efficiency Office (EEO) to provide technical expertise and promote adoption of the codes, as well as promote energy efficiency and conservation programs. To promote adoption of the voluntary standards, EMSD established an Energy Efficiency Registration Scheme for Buildings in 1998. Designers, developers, property management companies, etc., can submit details of their building for assessment. If the EEO determines that the building is in compliance with the standards, a registration certificate will be issued, and the building can use the scheme's energy-efficient building logo on their documents to publicize their achievement in energy efficiency (see Figure 2). As of December 2006, 1722 registration certificates have been issued for 713 building venues.

Status of Non-Regulatory Programs

In addition to the voluntary building energy standard, EMSD has also developed supportive non-regulatory programs such as establishing energy consumption indicators and benchmarks. Benchmarks have been established for offices, commercial outlets, hotels and boarding houses, universities, post-secondary colleges and schools, hospitals and clinics, private cars, light goods vehicles, medium goods vehicles, heavy goods vehicles, privates light buses, and non-franchised busses. The Web site for this program (http://www.emsd.gov.hk/emsd/eng/pee/classb.shtml) contains plots of the energy use of the buildings in the data base (see Figure 3 shows the energy use of shopping centers). The Web site also contains an on-line benchmarking tool that allows users to enter their energy consumption.

Related end-use efficiency programs

EMSD operates a voluntary Energy Efficiency Labeling Scheme for appliances, home and office equipment, and vehicles. The scheme now covers 17 types of household appliances and office equipment, The electric household appliances include refrigerators, room coolers, washing machines, electric clothes dryers, compact fluorescent lamps, electric storage water heaters, electric rice cookers, dehumidifiers, televisions, and electronic ballasts. The single gas household appliance participating in this scheme are instantaneous water heaters. The office equipment include photocopiers, multifunction devices, laser printers, LCD monitors, computers and fax machines dehumidifiers, televisions, and electronic ballasts.

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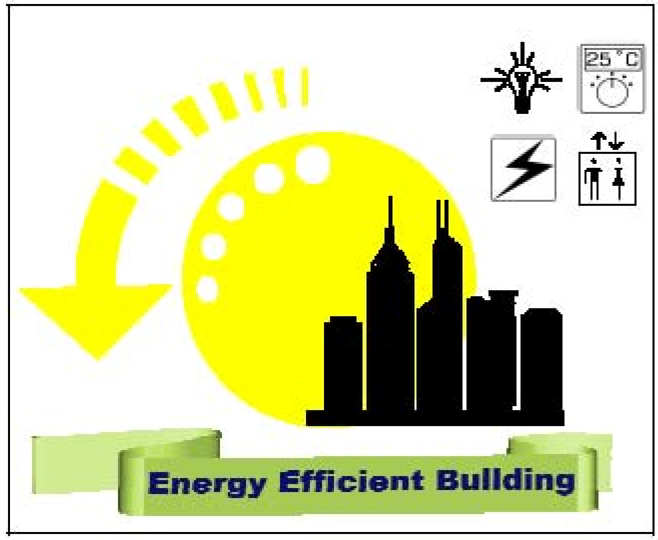

Figure 2. Energy-Efficient Building Logo

Figure 3. Benchmarking energy use of hotels

Energy efficiency building standards in Taiwan

Taiwan adopted building energy standards for air-conditioned non-residential buildings in 1995 and for residential buildings in 1997. These are mandatory national standards that are being rigorously implemented, with demonstrated compliance needed in order for a building permit to be granted. At present, the standards cover only the performance of the building envelope, although for the non-residential standard, energy performance criteria for the HVAC and lighting systems have been also proposed. In addition to the mandatory building energy standard, Taiwan has also been working towards voluntary building energy efficiency programs such as building energy labeling, a very successful green building certification program, as well as DSM programs.

Status of Building Energy Efficiency Standards

The government institutions responsible for building energy efficiency in Taiwan are the Bureau of Energy, Construction and Planning Agency of the Ministry of the Interior, the Architecture and Building Research Institute, and the Environmental Protection Administration. The building energy efficiency standards were developed by the Bureau of Energy and the Architecture and Building Research Institute, in collaboration with the Chinese Architecture and Building Center, National Cheng Kung University, National Sun Yat Sen University, and the National Taipei University of Technology.

Scope. There are two building energy efficiency standards, one developed in 1995 for air-conditioned non-residential buildings, and another in 1997 for residential buildings. These have been adopted at the national level and are mandatory for the building types to which they apply (offices, commercial buildings, hotels, and hospitals for the non-residential, housing for the residential standard). The enforcement of the standards is estimated at over 80%, with compliance needed for a building permit to be granted.

Contents. The Taiwan non-residential building energy standard is a simplified performance standard that, as of the date of this report (November 2006), covers only the energy performance of the building envelope. Instead of prescribing the levels of wall and roof insulation, or the thermal and optical properties of the windows, the standard uses a simple multi-linear regression equation, ENVLOAD, to calculate the annual cooling load of the perimeter spaces and sets maximum allowable loads for the building envelope. Minimum allowable efficiencies for the HVAC and lighting system have also been proposed, but these have yet to be implemented. The concept of separating the building energy performance into two parts – that of the building envelope and HVAC system efficiency – is very similar to the PAL (Perimeter Annual Load) and CEC (Coefficient of Energy Consumption) methods used in the Japan building energy standard.

ENVLOAD stands for "Envelope Load" and means the annual total sensible cooling loads in the building's perimeter zones extending inwards 5 meters from the exterior walls, as well as the top floor and bottom floor if the floor slab is exposed to the outside air. The cooling loads of the interior zones are considered to be dominated by internal gains, and controlled by requirements for the HVAC system efficiency. The ENVLOAD index is a regression equation made up of two meteorological variables (DH, IHk) and three architectural design variables (G, L, Mk). The meteorological variable DH describes the cumulative indoor-outdoor temperature differences (similar to degree days), while IHk describes the amount of solar radiation by orientation. These have been tabulated for seven climate zones of Taiwan. The architectural variable L describes the insulation performance of the building envelope, Mk its overall solar heat gain coefficient, and G its internal loads. The regression coefficients a_0, a_1, a_2, and a_3 in the general equation

$$ENVLOAD = a_o + a_1 * G + a_2 * L * DH + a_3 * \Sigma Mk * IHk$$

were computed from regression analysis of a large number of computer simulations. The equation gives the estimated annual perimeter cooling load in kWh/m^2·year for a building in a given location. The building standard sets maximum allowable ENVLOAD indices for different buildings in three parts of Taiwan (see Table 1). The three climate zones are shown in Figure 1.

Table 1. Maximum ENVLOAD indices for air-conditioned buildings allowed by the 1995 commercial building energy standard

Building Type	Climate Zome	Maximum ENVLOAD indices (kWh/ m^2·year)
Offices	North	80
	Central	90
	South	115
Commercial buildings	North	240
	Central	270
	South	315
Hotels	North	100
	Central	120
	South	135
Hospitals	North	140
	Central	155
	South	190

Figure 1. Climate Zones for Taiwan's Building Energy Standard

The Taiwan residential building energy standard was adopted in 1997, and is a prescriptive code with U-factor requirements for the roof and walls, and a Req index for fenestration. The standard has been approved at a national level, but there are regional variations.

Jurisdiction. The commercial standard was adopted as a national law in 1995, and the residential standard in 1997. Although they have been developed the Bureau of Energy and the Construction and Planning Agency of the Ministry of Interior, only the latter institution is responsible for its implementation. The standards have become a part of the building permit process for new buildings, which is also under the jurisdiction of the Construction and Planning Agency. To get a building permit, the building owner must submit documentation showing that the proposed building design meets the mandatory requirements set forth in Table 1. Failure to do so will result in denial of the building permit. It is estimated that as of 2006, over 80% of new construction are in compliance with the ENVLOAD requirements.

Status of Voluntary Non-Regulatory Programs

In addition to the mandatory building energy standard, Taiwan has also developed voluntary building energy efficiency programs such as an Energy Labeling Program and a very successful green building certification program called the Green Building Evaluation System, as well as DSM programs.

4. *Green Building Certification Program.* The Green Building Certification Program is a voluntary program but is mandatory for any new public building construction project which is funded by government more than about 1.5 million USD. In 1999, the Architecture Research Institute of the Ministry of the Interior developed a Green Building Evaluation System, called EEWH (Ecology, Energy, Waste and Healthy; EEWH) and *Evaluation Manual for Green Buildings in Taiwan* that, according to some experts, has been very successful and in many ways has taken the public spotlight from the building energy efficiency standard. The manual evaluates biodiversity, green landscaping, site water conservation, CO_2 Emission reduction, waste reduction, indoor environment, water resources, sewage and garbage treatment, as well as energy conservation. Compared to the ENVLOAD indices for the appropriate building type, the Green Building Certification program requires the efficient lighting system design and an additional 20% reduction in the building sensible space cooling load in perimeter zones, U Factor or Solar Heat Gain from fenestration, as well as an additional 20% reduction in building air-conditioning energy use.

5. *Building Energy Labeling.* The energy labeling program for building is not yet implemented. However, the Bureau of Energy has launched a Energy Labeling Program for appliances and office equipments and also announced the voluntary energy benchmark for many types of buildings (see http://www.moeaec.gov.tw/Promote/%AB%D8%BFv%AA%AB%A5%CE%B9q%B0%D1%A6%D2%AB%FC%BC%D0.doc)

6. *Demand-side Management Programs. These programs are* being promoted by the Bureau of Energy in conjunction with Taiwan Power Company. For the detail information, please refer to http://www.taipower.com.tw/left_bar/45453err/management_electricity.htm

Related end-use efficiency programs

7. For information on Appliance Labeling, please refer to http://www.energylabel.org.tw/)

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Energy efficiency building standards in Japan

Summary

Japan's regulation of building energy efficiency falls under the Energy Conservation Law that was first adopted in 1979, and subsequently amended several times, the last major revision being in 1999. There are separate regulations for "buildings", i.e., commercial buildings, and "houses", i.e., residential buildings. In addition to these 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, that 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. Government statistics have indicated that the compliance rate has been growing in recent years, increasing from 13% in 2000 to 32% in 2004 for residential buildings, and from 34% in 1999 to 74% in 2004 for commercial buildings. After the standards are made mandatory, compliance is expected to exceed 80%.

Scope. There are separate building energy standards in Japan for "buildings", i.e., non-residential commercial buildings, and "houses", i.e., residential buildings. The commercial standard were first adopted in 1979, and the residential standard adopted 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. The six climate regions into which the country has been divided are shown in Figure 1. In addition to these heat transfer and insulation requirements, there are also requirements for adding air barriers,

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	

heat transfer coefficients for doors, and "summer insolation entry rate", i.e., summer Solar Heat Gain Coefficients (SHGC), of windows.

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.

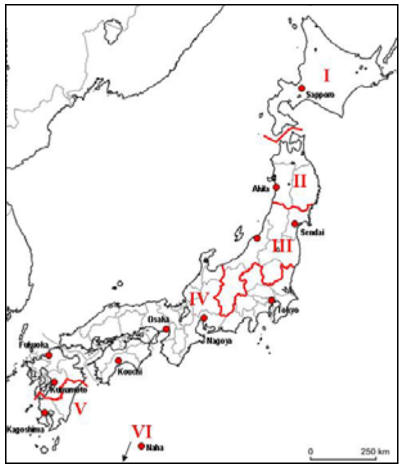
Table 2. Maximum allowable space conditioning loads for houses by climate areas

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•°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.

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

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

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 development of building energy standards falls in the jurisdiction of the Ministry of Land, Infrastructure and Transport (MLIT), which 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 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

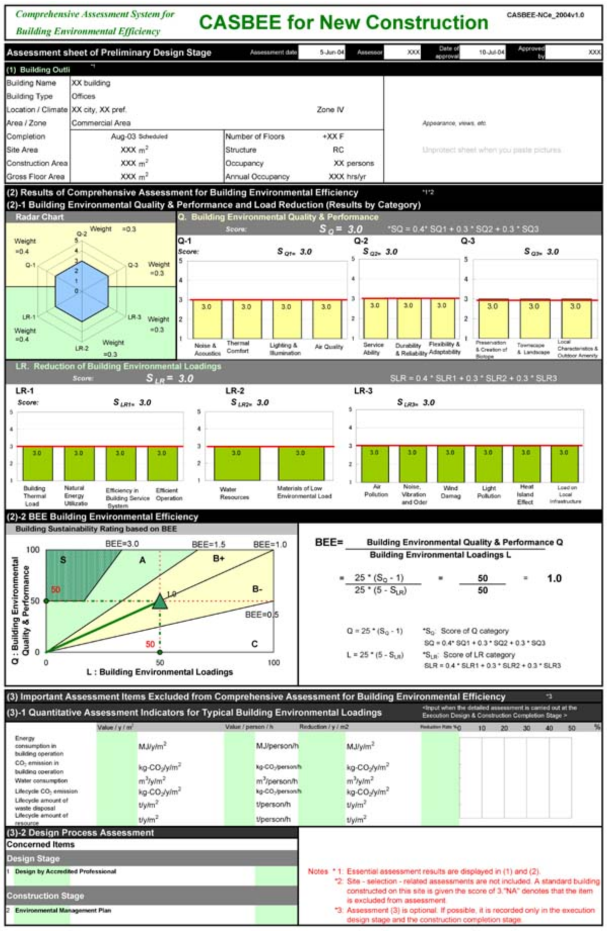
In addition to the mandatory building standards, Japan also has implemented an assortment of voluntary programs to stimulate building energy efficiency. The first two of the following are directed at housing, while the last is directed at commercial buildings:

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 1/3 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). CASBEE is a voluntary program being implemented by local governments, with training for the assessors and third party assessment

Figure 2. CASBEE Assessment Result Sheet



Related end-use efficiency programs

Japan has been implementing since 1998 the Top Runner Program© to set energy conservation standards for home and office appliances and a fuel economy standard for automobiles. 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 the following 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. Lastly, the government has provided partial subsidies, or low-interest loans to private enterprises or local governments in setting up Energy Service Companies (ESCOs).

Energy efficiency building standards in Korea

Summary

Although government-affiliated research institutes, universities, and utility companies have investigated building energy efficiency since the mid-80's, Korea did not formally adopt a building energy standard until 2004. However, despite how recent was that adoption, Korea has since put in place a comprehensive program to minimize building energy consumption coupling the mandatory standards with voluntary efforts in building energy labeling, a Green Building Certification program, and financial incentive programs.

Status of Building Energy Efficiency Standards

Korea has a mandatory building energy standard that was passed on Dec. 31, 2004 under Notification 2004-459 of the Ministry of Construction and Transportation (MOCT).

Scope. This standard is mandatory for all buildings where high energy consumption is expected, i.e., residential buildings with over 50 households, office buildings greater than 3,000 $m^{2,}$ public baths or swimming pools over 500 m^2, hotels and hospitals over 2,000 m^2, department stores over 3,000 m^2, and exhibit halls or schools over 10,000 m^2. For these buildings, an Energy Conservation Plan must be submitted before construction to show how much of the standard has been incorporated in the building design, and a point total estimated based on the Energy Saving Plan. All buildings required to submit an Energy Saving Plan must get a point total of at least 60 in order to comply.

Contents. The Korean building energy standard was developed after review of codes from several countries, including the US, UK, Germany, Japan, and Canada. Although the developers acknowledged the quality and detail of the more complex codes such as those in the US and Germany, they felt a simple prescriptive code, such as those in the UK and Japan, was most appropriate and easier to implement in Korea.

The standard that was developed contains three parts – mechanical, electrical, and architectural – each with mandatory and "encouraged" requirements. The mandatory requirements represent basic responsible design, while the "encouraged" requirements represent more innovative and "best practice" strategies. For the architectural portion, the mandatory requirements are to meet the specified thermal requirements for the building envelope in Table 1, install an air barrier inside the insulation to prevent condensation, and add vestibules to building entrances, while the "encouraged" requirements include design strategies such as better siting, minimizing the amounts of walls and windows, and utilizing daylighting, shading, and natural ventilation. For the mechanical portion, the mandatory requirements are to follow existing design conditions and insulation requirements, and minimize the use of electricity during peak hours by use of thermal storage or gas-driven cooling, while the "encouraged" requirements include using high-efficiency appliances and pumps, photovoltaics, heat recovery, ventilative cooling, etc. For the electrical portion, the mandatory requirements include the use of efficient transformers, motors, and lighting, and occupant sensors for entry lighting, while the "encouraged" requirements include induction motors, demand controllers for peak load conditions, energy-efficient elevators, and HID lamps for outdoor spaces (see Appendix 1 for complete listing of all mandatory and "encouraged" requirements).

Table 1. Shell requirements of the Mandatory Building Energy-Saving Standard
No. 2004-459, 31 Dec 2004, of the Ministry of Construction and Transportation

Building Element	Region		Overall Heat Transfer Value (W/m^2 K) Zone 1	Zone 2	Zone 3
Wall	Exposed to the outside air		0.47	0.58	0.76
	Semi-exposed to the outside air		0.64	0.81	110
Ground floor	Exposed to the outside air	Floor heating	0.35	0.41	0.47
		etc	0.41	0.47	0.52
	Semi-exposed to the outside air	Floor heating	0.52	0.58	0.64
		etc	0.58	0.64	0.76
Roofs in the top floor	Exposed to the outside air.		0.29	0.35	0.41
	Semi-exposed to the outside air		0.41	0.52	0.58
Side Walls in the Multi-Family Housing			0.35	0.47	058
Middle floor in multi-family units	Floor heating		0.51	0.81	0.81
	etc.		1.16	1.16	1.16
Glazing & door	Exposed to the outside air		3.84	4.19	5.23
	Semi-exposed to the outside air		5.47	6.05	7.56

The use of a point system for compliance effectively turns the Korean standard into a quasi-performance-based standard. To arrive at the required 60 points for compliance takes more than simply meeting all the mandatory requirements. The owner must also adopt at least some of the "encouraged" requirements, although their selection and choice are completely at the discretion of the owner. In the design of the point system, MOCT took into consideration not only the energy-saving potential of the "encouraged" measure, but also its ease of adoption in the actual building market. For example, a new technology that has a good energy-saving potential, but is expensive will be given higher points to encourage its use.

Although this is not exactly a performance-based standard, other information received from the Korean Energy Management Company (KEMCO) indicates that standard requirements equate to a heating energy consumption level of 123 kWh/m^2-year for residential and 116 kWH/m^2-year for commercial buildings.

Jurisdiction. The standard was developed by the Ministry of Construction and Transportation (MOCT), and is administered as part of the building permit process for new buildings. To get a building permit, the building owner must submit an Energy Conservation Plan signed by a licensed architect, a professional mechanical, and an electrical engineer, to the local government office in charge of building regulations. Some local offices review the Plan by themselves, but others that lack expertise can request help from KEMCO. The help of KEMCO is provided voluntarily to local authorities, but the final decision and responsibility for approving an Energy Conservation Plan rests with the local authorities. However, KEMCO does have the legal authority to pass Energy Conservation Plans.

The MOCT plans to examine and approve 1,450 Energy Saving Plans in 2005, 2000 in 2006, and 2500 in 2007. However, in actual practice, in the first year (2003-2004), 2,564 Energy Saving Plans had already been examined. To further improve the Korea's building energy code, the government asked Korea Institute of Construction Technologies (KICT) to investigate the status of the current code and policies, and recommend improvements. This investigation will be finished in December 2006, with the expectation that the scope of the code will be expanded to more buildings, and a performance-based energy code limiting the total energy use per square meter of floor area in new buildings will be developed. Simultaneously, the government has also announced that the insulation standard will be increased in stringency over time, and also extended from new construction to existing buildings. Lastly, the government is considering requiring that all real estate transactions include an energy efficiency certificate, with the associated document attached on all sales transactions.

Status of Voluntary Non-Regulatory Programs

In addition to the mandatory building standards, the Korean government has also established an impressive number of voluntary programs to stimulate building energy efficiency. These include:

1.Issuance of Certificates of Building Energy Efficiency (Grade 1-3) for buildings above a given energy performance standard. This is a regulatory financial support policy that is currently being implemented by KEMCO.

2. Issuance of certification for buildings that have the capacity to improve environmental performance and reduce energy consumption and GHG emissions through life cycle assessment. This is a planned financial support regulatory policy that is being implemented by KEMCO under Notification No. 2002-239 of the Ministry of Commerce, Industry and Energy. These cover co-generation, energy savings, ESCO, demand forecasting, or use of alternative energy (see Table 2).

Related end-use efficiency programs

1. Since Dec. 1996, Korea has been implementing a High Efficiency Equipment Certification Program that certifies high efficiency equipment and provides financial support and tax benefits. By 2001, 22 items have been certified, with plans to increase to 31 by 2004, and 41 by 2009.

2. Since 1992, efficiency standards (grades 1-5) and labels have been marked on products including refrigerators and automobiles. By 2001, 5,294 models of 11 items were classified and registered, of which 3,849 models were evaluated as high efficiency products of grades 1 and 2, representing 73% of the total number of products. The government plans to increase 1 to 2 items per year that are subject to efficiency classification. For example, compact fluorescents (CFLs) were added in 2003. The Minimum Energy Performance Standard (MEPS) will be continuously implemented and upgraded. Currently, refrigerators, air-conditioners, and gas boilers are subject to the MEPS.

3. Through the amendment of the Promotion Act for New and Renewable Energy Development, Utilization & Dissemination in February 2002 and the Energy Conservation Guideline for Public Institutions in April 2002, public institutions including government institutions.

Table 2. KEMCO's financial support for projects in the rational use of energy in the buildings area
(under Notification No. 2002-239 of the Ministry of Commerce. Industry and Energy)

			Incentives (Financial Support)
Project with Energy-Saving Facilities	Energy-Saving Project	- Co-Generation - Energy-Saving Facilities	Facility construction cost on loan (100% of the facility construction cost, at an annual interest of 5.25%) / 8-year grace period and loan payable in 7 years Under 10 billion won for each project owner
		- Voluntary Agreement	Facility construction cost on loan (100% of the facility construction cost, at an annual interest of 4.00%) / Under 10 billion won for each construction site / 8-year grace period and loan payable in 7 years Under 20 billion won for each project owner / Review energy-saving performance in last 5 years and energy-saving plan for upcoming 5 years
	ESCO (Energy Saving Company) Project	-	Facility construction cost on loan (100% of the facility construction cost, at an annual Interest of 4.00%) / 5-year grace period and loan payable In 5 years Under 10 billion won for each investor
	Demand Forecasting Project	- Demand Controlling Facilities - Thermal Storages	Facility construction cost on loan (100% of the facility construction cost, at an annual interest of 4.00%) / 3-year grace period and loan payable in 5 years. Under 20 billion won for each building
	Energy-Saving House Promotion Project	- Project Promoting Energy Efficiency Labeling Certification Program for Building Efficiency	Facility construction cost on loan (100% of the facility construction cost, at an annual interest of 4.00%) / 2-year grace period and loan payable in 2 years Under 15 billion won for each construction site (Under 30 billion won for each project owner) 30-40% energy efficiency, and grade 2 or higher grade required
Project with Alternative Energy Source		- Solar Energy Facilities - Alternative Energy Facilities	Facility construction cost on loan (100% of the facility construction cost, at an annual interest of 4.00%) / 3-year grace period and loan payable in 5 years Under 15 billion won for each project owner

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Appendix A.1 Mandatory and encouraged requirements for the mechanical section of Building Energy Saving Standard No. 2004-459, 31 Dec 2004, of the Ministry of Construction and Transportation

	Items	Design Standards and Requirements
Mandatory	- Design condition for outdoor temperature by regional groups	- Apply Regional Standards Example: Seoul : Summer : 31.2ºC DB. 25.5ºC WB Winter: -11.3ºC DB, 63% RH
	- Thickness of Insulating materials	- Comply with “Standard Specification for Mechanical Construction” of MOCT (Ministry of Construction and Transportation)
	- Electricity usage at night, thermal storage system, gas-type chillers	- During peak hours in the daytime, over 60% of energy should be generated by thermal storage or gas-type chiller Note: Buildings that have a central system where the total building area is more than 10,000 m^2 and office where the total floor area is more than 3,000 m^2 are subject to this category
Encouraged	- Indoor design condition by usage	- Apply according to building use Example: hotel rooms : Summer : 26 -28 ºC DB, RH 50-60% Winter: 20-24 ºC DB
	- High-efficient appliances	- Acquire priority purchase right when participating in government certification program. - Public corporations have priority purchase right
	- Photovoltaic power system	- In case the total building area of a public corporation building is more than 3,000 m^2, 5% of its construction fee has to be spent on facilities for alternative or recycled energy
	- Air/water flow control system that saves energy according to load parameters	- Apply on more than 60% of fans and pump motors
	- Heat recovery system	- For exhausting indoor air, heat exchange rate is over 90% and enthalpy efficiency is over 65%.
	- 100% natural air cooling system during mid-seasons	-
	- Efficient BAS for energy saving	-
	- Low-flow fixtures and grey water retention system	-

Appendix A.2. Mandatory and encouraged requirements for the electrical section of Building Energy Saving Standard No. 2004-459, 31 Dec 2004, of the Ministry of Construction and Transportation

	Items	Design Standards and Requirements
Mandatory	- Low-loss transformer	- Efficiency for single bushing pole transformer (oil type) is over 98.3% 3-phase transformer (oil type) is over 97.7%, 3-phase transformer (mold type) is over 97.8%
	- High-efficient lighting equipment	- Spec of a ballast equipped fluorescent lamp need to comply with KS C 7601 regulation. Example: Tested luminous efficiency is more than 87lm/w
	- Fluorescent lamp equipped with ballast	- Ballast specs need to comply with KS C 8100, KS C 8102 regulation and lamp specs need to comply with KS C 7601 regulation Example: BEF (Ballast Efficiency Factor) Is over 1.09 when operated
	- Flow meter for every transformer	-
	- Power factor improving condenser for every motor	-
	- Occupancy sensor, automatic luminance control lighting equipment at building entrances	-
	- Separation of control circuit for variable lighting	-
Encouraged	- High-efficient induction motor	- Specs need to comply with KS C 4202 regulation
	- Configure transformer bank controller	-
	- Demand controller for peak load time	-
	- Energy saving control system for elevator motors	-
	- High intensity discharge (HID) lamps for outdoor space	-
	- Controller for grouping elevator operation	–

Appendix A.3 Mandatory and encouraged requirements for the architectural section of Building Energy Saving Standard No. 2004-459, 31 Dec 2004, of the Ministry of Construction and Transportation

	Item	Design Standards and Requirements
Mandatory	- Insulation for building exterior	- Use appropriate thickness of insulating material according to the heat transfer coefficient of exterior wall Example) Exterior wall of a living room : 0.13 m^2 h ºC /kcal - Use appropriate thickness according to its insulating grade Example) For the central region in Korea, the Insulation thickness of grade "Ga" is 65mm if the wall of a living room is designed to be an exterior wall.
	- Airtight performance and prevention of condensation	- Install moisture-proof layer on the indoor-side of the insulating material for improving the performance of the insulating material and preventing surface condensation.
	- Vestibules at building entrances	- Entrances to the outside on the 1 st floor or grade level
Encouraged	- Site planning	- Buildings are recommended to face south or south-east
	- Floor planning	- Floor to floor height is recommended to be low and the area of exterior wall is recommended to be small to the extent possible
	- Insulation planning	- Windows are recommended to be smaller to prevent heat loss
	- Airtight performance planning	- Install airtight Windows (KS F 2278, KS F 2292 regulation)
	- Daylight planning	- Use daylight and sunshades to the extent possible
	- Ventilation planning	- Apply a system allowing natural and mechanical ventilation

6. Energy efficiency building standards in Malaysia

First Version of the standards

- **First Version:** In 1986 and 1987, Malaysia developed a first-draft energy efficiency standard for commercial buildings. This standard was launched as a national *voluntary* guideline in December 1989.

- The scope of the standard included: (1) building envelope, (2) air-conditioning, (3) lighting, (4) electrical, and (5) service water heating. This first version of the standard drew much of its overall approach and considerable material from (1) the 1983 Singapore standard and (2) early drafts of the emerging 1989 ASHRAE standard in the US. For example, the envelope requirements used an OTTV approach refined from Singapore and ASHRAE. An innovation in the Malaysian OTTV approach included consideration of surface absorptivity in addition to the standard variables. [3]

- The primary author of the standard was K.S. Kannan, then of the – University in KL, with input from international consultant (IC) team from Lawrence Berkeley Laboratory working under an ASEAN-USAID project. The Ministry of --- assembled an in-country technical committee representing the building industry, academia and government that reviewed the standard.

- **Compliance tools:** A draft compliance guideline was developed in the late 1980s by the manual funded by the IC team for use with the first version of the Malaysian standard.

- **Early International funding support:** The USAID funded ASEAN-USAID collaborative program supported the development of the first version of the Malaysian energy efficiency building standard, and also support several related university-based research efforts, but did not continue funding into subsequent implementation phases of the standard.

Revisions to the standards

- **Revisions**: In 2001, the standard was revised and was incorporated into Malaysian Standard MS 1525 as a "Code of Practice on Energy Efficiency and use of Renewable Energy for Non-residential Buildings." Compliance with this code of practice was also evidently voluntary.[4] As with the first version of the standard, the development of this revision was led by Dr. Kannan. This new version is reported to contain additional emphasis on building architectural features and passive solar compliance options.

- In 2006, the standard was revised and updated again, and is undergoing public review at the time of this writing. Actions are also now underway to incorporate several sections

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[3] Confirm this and cite reference.

[4] Confirm

(envelope, air-conditioning, lighting) of the latest version of the Code of Practice into the national building bylaws so that they will become mandatory.

Jurisdiction

The Ministry of Energy, Communications and Multimedia (formerly the Ministry of Energy, Telecommunications, and Posts) has been the responsible Ministry for developing and enforcing the energy efficiency buildings standards.

Infrastructure:

There has evidently been an effective, sustained, long-term collaboration between government and academia in Malaysia that has contributed to the development and refinement of the building energy standards.[5] Considerable technical capabilities for energy efficiency are resident in Pusat Tenaga Malaysia ("PTM"), or the "Malaysia Energy Center." This organization was established in 1998 as a focal point for various energy-related government and private-sector activities, specifically including energy planning and research, energy efficiency, and technological research, development and demonstration. While PTM is registered as a non-profit company it receives administrative support from the Ministry of Energy, Communications and Multimedia.

Implementation and Impacts

In the late 1980s an estimate was made of the potential savings from the proposed building energy standard. The estimate was projected using computer simulations of a typical high-rise office building with features thought to be typical of new Malaysian offices at that time. The annual energy use of this building was simulated, and compared with the building as re-designed to comply with the requirements of the new building energy standard. Savings of 20% were estimated from the use of the standard.[6]

However, there are indications of the general effectiveness of Malaysian energy policies applied to buildings. The following energy efficient technologies have been identified as entering the Malaysian building industry market.

- ***Lighting***

  More efficient 26 mm diameter 36 W and 18 W fluorescent tubes have replaced the 38 mm diameter 40 W and 20 W tubes in the market

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[5] However, we do not know if this collaboration has extended to the development of compliance tools or to the training to the building industry to effectively use and comply with the standards. Also, we do not know the infrastructure available in Malaysia specifically available for checking compliance with energy standards or for conducting inspections of energy features of buildings. We do not know if similar estimates have been conducted of potential savings from application of the 2001 and 2006 revisions to the building energy standards when applied to current typical building practice in Malaysia We have not seen information about the use of the building energy standard over the past 15 years, or about how many buildings might have complied with part or all of it on a voluntary basis

[6] Get proper citation for this study.

Compact fluorescent lamps such as PL lamps, SL lamps, and 2-D lamps have been widely used in places of the less efficient tungsten filament lamp.

Low voltage quartz halogen lamps with glass mirror reflector and dichroic reflector coating are fast replacing the more energy consuming PAR lamps as flood lights and downlighters.

Fluorescent tubes with efficacy as high as 90 to 95 lumens/watt are widely used in commercial complexes and government buildings

Fluorescent ballasts sold in the market are with losses ranging from 6.5 W to 12 W instead of those with losses ranging from 15 W to 20 W

Fluorescent fittings with parabolic reflector to improved lighting efficiency are commonly used in commercial complexes and government buildings

- ***Air-conditioning***

More efficient air-conditioning plants are used such as multi-compressors chillers, variable air volumes systems, etc.

"Ice storage" technique is used in air-conditioning systems to reduce peak power demand

- ***Other***

Power factor correction capacitors are installed to reduced demand in reactive power

Building service management systems are installed in big complexes to optimize energy consumption

Co-generation is used in industrial and commercial sectors to increase fuel efficiency

7. Status of Voluntary Non-Regulatory Programs in Malaysia

Regional Energy Efficiency Activities:

Malaysia actively participates in ASEAN regional energy efficiency activities. Such activities include (1) participation in the development of regional energy benchmarking of buildings, and (2) regional energy efficient building award programs.

Award and Recognition Programs:

Building energy efficiency policy in the Philippines

Energy consumption data of the Philippines

- Sectoral Share of Energy Consumption (1998): Industrial (49.8%), Residential (24.9%), Transportation (16.7%), Commercial (8.6%);

- Sectoral Share of Carbon Emissions (1998): Industrial (55.0%), Transportation (22.2%), Residential (16.1%), Commercial (6.7%)

- The total energy consumption of the country increased 6.9% from 2002 to 2003.

- Consistent with the 6.6% average annual GDP growth target, it is projected that the national aggregate demand will experience a ten-year average increase of 4.7% from 2005 to 2014. Households, transport, industry, commercial entities and agriculture will be the main driver of the energy demand rise.

- The period of 2001-2003 was characterized by the increase in the utilization of indigenous energy resources that raised the country's energy self-sufficiency level from 45.1% in 2001 to 51.1% in 2002 and 53.9% in 2003. The 2003 level exceeded the 2004 MTPDP target of 52%. This growth is attributed mainly to the continued implementation of the stringent policy on lessening the country's dependence on imported energy through the utilization of indigenous fuels for new power plants and the retirement of aging oil-based power plants. The total indigenous energy production in 2003 increased by 8.6% compared with 2002.

- Renewable energy such as biomass, solar and wind continue to play a major role in the gross energy requirements of the sector. From 38% in 2002, the renewable power share in the power generation mix swelled to 42% in 2003.

- Imported energy supply will account for about 42.9% of the total energy mix in 2005. The country's dependence on energy imports will continue on a more restrained level at an average annual growth rate of 3.9% over the ten-year planning period.

- With the implementation of the various sectoral plans and programs in the 2005 Energy Plan, CO2 emission levels will increase at a lower average annual growth rate of 5.7 percent, from 77.1 MMMT in 2005 to 99 MMMT in 2010, and finally reaching 124.2 MMMT in 2014. The CBRED project commits to a 29.6 MMMT reduction within the planning period.

Evolution of energy policy in the Philippines

- During the 1970s and 1980s, the main theme of national energy policy of Philippines was to seek growth and self-sufficiency in energy production.

- In the past decade, these have been some change in the priority of national energy policy.

- The Philippine Energy Sector is currently governed by the Medium-Term Philippine Development Plan (MTPDP) which covers three major priority areas:

    1. sustained economic growth;
    2. social equity and poverty reduction; and
    3. Market-based industry.

- In line with these, the following goals were identified for the energy sector:

    1. Supply security and reliability
    2. Energy affordability and accessibility
    3. Environmental quality
    4. Consumer protection

- According to the Philippine Energy Plan (PEP) 2005 the attainment of energy independence is the over-arching objective of the energy sector. This over-arching objective is further specified into two-fold energy sector agenda:

    1. pursuit of energy independence; and
    2. Implementation of power market reforms.

- The Department of Energy (DOE) has set forth a goal of 60% self-sufficiency level in 2010, and hopes to achieve this by:

    1. Increasing indigenous oil and gas reserves
    2. Aggressively developing renewable energy resources
    3. Increasing the use of alternative fuels
    4. Forging strategic alliances with other countries
    5. Promoting a strong energy efficiency and conservation program

- On the other hand, the implementation of power market reforms includes a transparent privatization process of the generating assets of the National Power Corporation (NPC) and the transmission assets of the National Transmission Corporation (TransCo). The planned operationalization of the Wholesale Electricity Spot Market (WESM), the electricity trading mechanism among generators, suppliers and wholesale consumers, will be implemented in phases, starting in 2006.

Energy Efficiency policies

- In line with its mandate to promote the efficient and judicious utilization and conservation of energy and make it a way of life for every Filipino, the DOE will vigorously pursue programs and projects which cover two areas, namely: fuel efficiency and conservation as well as power conservation and demand-side management.

- With an invigorated energy efficiency and conservation program dubbed as the "EC way of life", a cumulative aggregate savings of 240.8 MMBFOE, to include the use of alternative fuels will be attained within the planning period.

- This energy management program is expected to redound not only to the total reduction in oil importation but also to the avoidance of greenhouse gas (GHG) emissions of approximately 61,977 gigagram carbon dioxide (GgCO2) during the ten-year period.

- **Primary Objective:** The primary objective of the government's energy efficiency program is to make the consumers realize that the way to compensate for and lessen the impact of the high costs of energy and electricity is by using it efficiently, judiciously, and wisely. Hence, energy efficiency promotions are aimed at encouraging efficient use of all energy forms by all users.

- **Goals:** The government's plan on energy efficiency is anchored on the following goals:

    1. Enhance consumer understanding of energy use

    2. Lower consumer energy expenditures without constraint on productivity

    3. Reduce capacity/ transmission expansion requirements

    4. Reduce greenhouse gas emissions

- **Policies and Strategies**

    1. Promotion of energy efficiency measures through the existing specific programs to sustain the economic, environmental and social benefits.

    2. Enhancement of private sector involvement in energy efficiency program through the development of an Energy Service Industry and the promotion of energy efficient technologies, goods, and services at the lowest possible price, with the highest possible quality.

    3. Promotion of voluntary agreements with energy intensive industries.

    4. Continues implementation and expansion of the appliance energy standards and labeling program.

    5. Encouragement of consumer purchase of more energy efficient technologies by providing accurate information on these products.

6. Integration of energy efficiency concepts in the procurement practices of the government.

7. Integration of energy efficiency policies in all sectors of the economy.

8. Periodic program monitoring and evaluation to assess the effectiveness of the energy efficiency program.

9. Intensification of collaboration efforts with the private sector, trade allies and industry associations.

10. Development of energy efficiency intensity indicators for each sub-sector.

11. Expansion of opportunities for energy efficiency and load management through competitive bidding vis-à-vis other resources.

12. Promotion of international cooperation on energy technology application.

Programs and Projects

- The process of reforms in both the energy markets and trade has already started in the country. In view of these changes, the framework of energy efficiency programs in a competitive environment is designed to ensure that the market works effectively. The government expects that its role as a provider of direct services will be reduced to give way to market based practices once the market is in full operation. Providing information (i.e., energy efficiency indicators, benchmark data on energy performance, new energy efficiency technology and products and labeling and standards) to the market will ensure its optimal operation.

- The energy efficiency programs will be implemented through the government and private sector initiatives. Government effort is geared on the provision of direct type services and regulatory measures, while the private sector will focus on market-driven types of services. Market transformation activities, such as in appliances and lighting, will be undertaken by both government and private sectors.

- During the market's transition to a competitive environment, the government will still pursue its existing programs and introduce appropriate new programs to ensure the continuity of gains in energy efficiency. The government will implement effective evaluation and monitoring system to assess the effectiveness of the program in the new market structure.

- For the **residential sector,** government initiatives will center on the information and education campaign, such as the Power Patrol Program and the market transformation program on labeling of room air-conditioners, refrigerators and freezers, fluorescent lamps and ballasts as well as fans and blowers. Likewise, the private sector will provide similar initiatives in the market transformation program, particularly on lamps and ballasts.

- **Industrial and commercial/institutional sectors** have a wide range of energy efficiency programs. These cover the information and education campaign, market transformation, recognition program, energy management services, voluntary agreement and the government's energy conservation program.

- In the **power sub-sector**, the regulatory requirements in the field of energy efficiency will be in the form of utility demand-side management (DSM) and system loss cap, which will be determined by the ERC.

Drivers of Change

- **Energy security and self-sufficiency**: The Philippines's dependence on imported oil makes the Philippine economy vulnerable to sudden spikes in world oil prices. Against the specter of the continually increasing oil price in the world market and power shortage on the domestic front, the main objective of PEP 2005 is to provide adequate supply to the increasing energy demand. With energy independence as its theme, the PEP 2005 calls for the development of the country's indigenous energy resources that will eventually lead to increased self-reliance and provide the much-needed boost to the country's economic front. At the same time, promoting energy efficiency is another effective approach towards achieving the DOE's energy security and self-sufficiency objectives. By managing energy demand through the efficient and judicious use of energy, available energy supply is maximized without jeopardizing economic growth targets.

- **Rising energy demand**: Energy-to-GDP ratios in the different sectors indicate increasing proportions except for the latter years of 1997 and 1998 due to the decline in the industrial and transport sectors. This decline could be attributed to the economic slowdown and partly to some improvements in energy efficiency. Overall, the trends signify that energy consumption has grown more rapidly than the economic output. These trends reveal the necessity of providing an effective energy efficiency and conservation program.

- **Power market reforms**: The Philippines had a wealth of potential energy resources. However, indigenous energy sources are underdeveloped and hampered the Philippines' progress in energy self-reliance. According to PEP 2005, power market reform will create an investment climate attractive to private domestic and foreign investments, which might help indigenous energy sources development. Also, industries and consumer groups will benefit from the open access scheme in the competitive generation market, and be provided with the flexibility to choose their electricity suppliers at the least possible cost.

- **Caring for the Society and the Environment:** The rate of growth in GHG emissions is a critical issue in the Philippines. Over half of the Philippines' GHG emissions are attributed to the energy sector. The Philippines government has committed to reducing GHG emissions through improving the performance of the energy sector. Promotion of new and renewable energy sources, energy efficiency and conservation is seen as both an alternative source of energy that might increase national energy security and self-reliance and an effective measure to keep GHG emission levels at a lower growth rate. Meanwhile, the NPC and TransCo are both guided by the Corporate Social Responsibility and

Environmental Stewardship Program policy on environmental management which subscribes to the precepts of sustainable development.

Policy makers in the energy sector

Policy making in general, resides with the Philippine Congress. For the energy sector, Congress has assigned specific energy policy functions to the Department of Energy. This includes the execution of the electric power industry reform, the privatization of the National Power Corporation, and the rationalization of rural electrification development.

The Department of Energy sets the policy directions for the energy industry while the National Electrification Administration provides financial and technical assistance to electric cooperatives.

The National Power Corporation and the National Electrification Administration are attached agencies of the Department of Energy.

The Energy Regulatory Commission (ERC) is tasked with regulatory functions relevant to setting tariffs and ensuring consumer protection. An important function of the ERC is the issuance of operating permits of power generation facilities including cogeneration units.

The Department of Energy is the central planning and policy-making body in the energy sector. It is headed by a Secretary, who is a member of the Cabinet with the following government agencies attached to it: National Power Corporation, National Electrification Administration and the Philippine National Oil Company.

The Department of Energy was created to prepare, integrate, coordinate, supervise and control all plans, programs, projects and activities of the Government relative to energy exploration, development, utilization, distribution and conservation.

APPENDIX

The energy efficiency programs of the government for the planning period include:

- **Energy Management Services.**

  1. This is a comprehensive energy management approach to promote energy efficiency. This is designed to assist the commercial and industrial establishments in identifying effective measures towards wiser and efficient use of energy. These services, most of which are presently being provided by the government, include energy audit, financing, information on energy utilisation performance of the different industrial firms, technology promotions, recognition program and the Partnership for Energy Responsive Eco-Zone (PEREZ) program.

  2. The PEREZ program will cover an agreement between DOE and Philippine Economic Zone Authority (PEZA) to facilitate voluntary action with regard to the monitoring and reporting of energy consumption and adoption of energy efficient technologies of individual locators within the ecozone.

  3. The cumulative energy savings potential for the commercial and industrial sectors is projected to increase from 3.6 MMBFOE in 2002 to 48.8 MMBFOE by 2011. Given the potentially large savings involved, it is envisioned that the private sector will be a major player in this area through the engineering companies and/or ESCOs. An expanded ESCO could provide a wide range of services including auditing facilities, identifying and engineering energy saving measures, guaranteeing the savings from these measures and in some cases, providing project financing.

- **Information and Education Campaign.**

  1. The government has two major programs under this area: the Power Conservation and Demand Management (Power Patrol) and the Fuel Conservation and Efficiency in Road Transport (Road Transport Patrol).

  2. The Power Patrol program directs its information and education efforts to the residential, commercial, and industrial sectors mainly through seminars and workshops. Efforts will be focused on the commercial and industrial sectors and will jumpstart the program in economic zones. It is expected that this program will be self-sustaining by 2007.

  3. On the other hand, the Road Transport Patrol program focuses on the drivers, operators, vehicle and fleet owners, transport groups and associations. Various mechanisms to implement the transport policies involving regulations and control, use of market-based incentives, institutional measures, investment policies, research and development, and intensified information campaign and education programs were developed. Ultimately, the program is expected to contribute in reducing oil imports and environmental emissions as a result of lower fuel consumption in the transport sector. Aggregate savings from this program will stand at 0.7 MMBFOE by 2011.

- **Government Enercon Program.**

    1. This program mandates that all government offices have to reduce their electricity and fuel consumption by 10 percent and submit monthly reports to the DOE. To support this program, a recognition system called the "Energy Efficient Best Practices Awards in Government" was created. This award will form part of the Don Emilio Abello Energy Efficiency Award given during the annual National Energy Week.

    2. To institute efficient energy management in the government sector, the DOE will establish a Government Energy Management Program (GEMP) in 2002. The aim is to reduce the use and cost of energy in government agencies by adapting energy efficiency technologies and practices in all government facilities.

    3. Collaboration efforts with other government agencies will be undertaken to reflect the integration of energy efficiency objectives in the policies of these agencies. The initial focus are mass housing and public school buildings.

    4. As a means of leading by example and disseminating the information on the benefits of the program, the DOE will stimulate energy efficiency improvements by adopting energy efficient technology in its buildings. It will endeavor to make its buildings a showcase of energy efficiency.

    5. The potential cumulative energy savings of this program is estimated at 1.9 MMBFOE for the 10-year planning horizon.

- **System Loss Reduction for Utilities.**

    1. This program supports Republic Act 7832, which seeks to address electricity waste due to system losses in electricity distribution. The EIRA has amended the ceiling on the recoverable rate of system losses as prescribed in RA 7832. The ceiling, to be determined by the ERC, shall be based on load density, sales mix, services cost, delivery voltage and other technical considerations.

    2. The estimated cumulative potential savings from this program is projected at about 0.6 MMBFOE in year 2002 to 4.4 MMBFOE by 2011.

- **Heat Rate Improvement of Power Plants.**

    1. Improvement in the operational capability of old thermal, coal and diesel power plants is a continuing endeavor to increase plant availability, increase plant output, improve operational efficiency, extend plant life, and reduce operating costs. The main objective is to bring the actual performance of all generating units close to their optimum levels.

    2. Competitive markets will quickly evolve in a restructured power sector. This will put pressure on power plant operators to reduce cost through operational efficiency programs.

3. The aggregate potential energy savings of this program is estimated at 1.9 MMBFOE during the planning horizon.

- **Efficiency/ Energy Labeling & Standard.**

1. The energy-labeling program aims to improve the efficiency/performance of appliances, equipment and other energy consuming devices. There are four sub-programs under this: Efficiency Standard and Labeling for Room Air-conditioners; Energy Labeling for Refrigerators and Freezers; Fluorescent Lamp Ballast Energy Efficiency Standard; and Performance Certification of Fans and Blowers. The program can contribute an estimated cumulative potential energy savings of 0.9 MMBFOE in 2002 to 9.7 MMBFOE in 2011.

- **Demand-Side Management (DSM) Program.**

1. There is an ongoing initiative to review, amend and improve the 1996 DSM Regulatory Framework. This is due to the uncertainties, challenges and opportunities with the liberalization of the power industry. To date, the national DSM program has remained in the pre-implementation stage.

2. By 2011, an estimated cumulative potential energy savings of 1.2 MMBFOE will be generated from the DSM program.

3. All the energy efficiency programs in the power sector will defer the construction of 450 MW of additional plant capacity.

7. Energy efficiency building standards in Singapore

Singapore Summary

Singapore's energy code program is a key element of its exemplary set of energy efficiency and green building programs. The first energy code, implemented as a mandatory code in 1979, has been revised and refined several times since. Today a range of mandatory and voluntary programs is available. These programs are coordinated via an energy master plan maintained by the Building & Construction Authority (BCA). Two new financial incentive programs encourage green buildings and R&D in building energy efficiency. These new programs complement the extensive set of existing programs. Several websites contain a wealth of information about the energy efficiency programs, including copies of the energy code provisions, compliance forms and tools, plus information and application forms for various related programs. These websites, form a major resources, especially in comparison to some other countries in the region, where information about building energy code and energy efficiency programs not so easily available to review and use. It is interesting to note that the main responsibility of the key energy code administrative authority in Singapore (BCA) is administering buildings rather than engaging in energy R&D. The BCA does have an excellent and long-standing collaboration with the National University of Singapore (NUS), which provides technical and R&D input to various building energy efficiency programs.

First Version of the standards

- **First Version:** Singapore developed its first energy code developed in 1979. Singapore was the one of the first countries in the region to develop and implement an energy code. The scope of the standard included: (1) building envelope, (2) air-conditioning, (3) lighting, (4) electrical, and (5) service water heating. This first version of the standard drew much of its overall approach and considerable material from (1) the 1975 version of the ASHRAE energy standard in the US. For example, Singapore expanded upon the envelope OTTV requirements and approach contained in the 1975 ASHRAE standard.

- **Mandatory enforcement:** Singapore's energy code has been mandatory since the first version, and Singapore has gained a reputation for strong and effective enforcement of the energy code. Administration of the energy code is by the Building and Construction Authority (BCA) of Singapore.

- **Compliance guidelines:** By 1983, Singapore had developed a comprehensive guidebook for the enforcement of its energy code.

- **Compliance tools:** Until 2000, the Singapore energy code contained just a prescriptive compliance option. In 2000, anew system analysis compliance option became available to allow tradeoffs during compliance. This new method uses a software-based set of tools developed and made available by the National University of Singapore (NUS). For more information about this program see below in the Implementation and Impacts section.

Revisions to the standards

- **Revisions**: The Singapore energy code requirements have been revised several times since the 1st version was adopted in 1979.
  - In 1989, a revision to the energy code was made. According to a review of that code[7] contained requirements for roof and wall insulation, air leakage, location of entry doors, zoning for temperature control, sufficient electric power metering, switching off the air-conditioning automatically in hotel guess rooms when the rooms are unoccupied, data-logging facilities for collecting data for energy audits.
  - In 1999, three codes of practice for buildings were updated:
    1. (1) *Code of Practice for Energy Efficiency Standard for Building Services and Equipment*, Singapore Standard CP24, The new ETTV requirement was pegged to a model building with a window-to-wall ratio (WWR) or 0.33 and a glass shading coefficient of 0.40, while the requirement prior to 1999 pegged to a model building with a window-to-wall ratio (WWR) or 0.33 and a glass shading coefficient of 0.60. (See http://www.bdg.nus.edu.sg/buildingEnergy/publication/papers/paper1.htm)
    2. (2) Code of Practice for Mechanical Ventilation and Air-conditioning in Buildings, CP13. The BCA-NUS website indicates that as to the revised CP 24:1999, it "…sets the minimum energy efficiency standards for four major energy consuming equipment and system, viz. air-conditioning equipment, water heaters, electric motors and artificial lighting system. However, only the lighting power budget section of CP 24 is implemented."
    3. (3) Code of Practice for Artificial Lighting in Buildings, CP38.
  - The 1999 revisions, made effective in mid-2000, also included a new system-analysis tradeoff compliance option in addition to the prescriptive compliance that had been in effect since 1979.

Jurisdiction

Administration: The Building and Construction Authority (BCA) has been the government entity responsible for developing and enforcing the energy efficiency building codes of practice.

Infrastructure: In Singapore, there has evidently been a very effective, sustained, long-term collaboration between government (BCA) and academia (NUS).

Implementation and Impacts

Software Tools for Compliance: The following has been extracted from the BCA-NUS joint "Building Energy & Research information Centre" website, from *http://www.bdg.nus.edu.sg/buildingEnergy/software&tools/index.html*:

"Building Energy Standards (BEST) is window based software developed by the National University of Singapore. It is a design tool which can be used by engineers, architects and

[7] International Survey of Building Energy Codes, by the Australian Greenhouse Office, published in 2000.

building services professionals to demonstrate compliance with prescriptive and energy performance standards relating to air-conditioned buildings."

"BEST is capable of calculating the annual heat gain through the building envelope as characterized by the envelope thermal transfer value (ETTV). It also evaluates the annual heat gain through the roof as the roof thermal transfer value (RTTV). Finally, it allows the user to estimate the following based on a set of prescriptive criteria and user-defined design values:

- *envelope thermal transfer value (ETTV)*
- *roof thermal transfer value (RTTV)*
- *lighting power allowance*
- *receptacle power density*
- *peak system cooling load*
- *sensible heat removal rate*
- *annual cooling energy consumption*
- *annual total energy consumption"*

- **Showcase Buildings:** the BCA-NUS joint "Building Energy & Research information Centre" website includes a description of a current "showcase" building. The Revenue House is owned by the Inland Revenue Authority of Singapore. It is a 24 storey building with a gross floor area of 108,000 m^2, a 20,000 m^2 car park, and 83,000 m^2 of air-conditioned area. It has 80% office space and 20% retail.

- The 4-year old Revenue House has an Energy Efficiency Index of 147.5 $kWh/m^2/yr$, which is 36% more energy efficient than the typical office building in Singapore. The BCA-NUS website provides a good summary of the features of this energy-efficient building.

Strong Collaboration between Government Code Enforcement and Academia: The Building and Construction Administration and the National University of Singapore have had a long-standing and effective collaboration. Example collaborative activities include such activities as:

Analysis of energy code impacts and improvements

Development of Energy Efficiency Indices and Benchmarking of building performance

Compliance tool and software development

Joint website that serves education and outreach objectives, that makes available a wide range of data, tools, and information about the energy code and energy efficiency.

Building Energy Website: Energy Code Documents are Publicly Available on the Web: An innovative aspect of the Singapore energy code within the region is that the code and supporting documentation is available on the web.

7. Status of Voluntary Non-Regulatory Programs in Singapore

$50 Million Green Building Research Fund: A new program was announced on 14 Dec 2006 to set aside $50 million over the next five years for the new "MND Research Fund for the Built Environment". The purpose is to intensify R&D efforts in green building technologies and energy efficiency. This is the 1st dedicated fund in Singapore for the construction and real estate sectors, and is an integral part of the BCA's Green Building Masterplan. (See: http://www.bca.gov.sg/ResearchInnovation/mndrf.html)

Green Mark Incentive Scheme (GMIS): In January 2005 BCA launched the BCA Green Mark Scheme in order to promote environmental awareness in the construction and real estate sectors. The "Green Mark" is used to rate the environmental friendliness of a building ('green building'). It encourages the adoption of various Green Building Technologies (GBTs) to achieve a sustainable built environment of the building by improving :

Energy efficiency
Water efficiency
Indoor environment quality and environmental management.

The Singapore government has set aside $20 Million over 3 years, effective 15 December 2006, and will offer cash incentives to developers and building owners who try to achieve a BCA Green Mark Gold rating or higher through the design and construction of new buildings or the retrofitting of existing buildings. There are 3 levels of financial incentives (Gold, Gold Plus, and Platinum), corresponding to increasing levels of green technologies and energy savings obtained. The incentives range from $\$3.0/m^2$ to $\$6.0/m^2$ of gross floor area (GFA) for new building; retrofit of existing buildings is eligible for about 40% of the incentive for new buildings per m^2. (More detail and application forms are available at: http://www.bca.gov.sg/GreenMark/GMIS.html)

***Energy Management Of Public Sector Buildings*: **The BCA-N US website indicates that " The public sector by virtue of its size is well positioned to be a role model as well as a showpiece of energy efficiency measures that are viable. Any improvement in building energy efficiency in the public sector will make a significant contribution to the performance at national level besides creating the necessary public awareness. Banding of public sector buildings based on energy performance would provide landlord government agencies a rough indication of how they fare in comparison with other buildings of the same type. The buildings could be banded by type into three groups i.e. top 25%, middle 50% and bottom 25%. Banding is preferred to ranking as the present data does not allow a precise evaluation. Over time, as evaluation of buildings is improved under the EEI scheme, ranking can be considered at a later stage. The BCA will undertake to band all public sector buildings by type based on energy performance into three groups i.e. top 25%, middle 50% and bottom 25%. An initial banding of all large public office buildings has been completed." (See http://www.bdg.nus.edu.sg/buildingEnergy/energy_masterplan/index.html#ENERGY%20MANAGEMENT%20OF%20PUBLIC%20SECTOR%20BUILDINGS)

Energy Efficiency Indices (EEI) & Performance Benchmarks: For the buildings industry to be more efficient, both government policy makers and building owners need access to good information about building energy performance and related building energy features in order to help them estimate the cost-effective potentials for building energy savings. The BCA plans as a 1st step to derive an Energy Efficiency Index for every building with a sizeable air-conditioning load. When such indices have been established, then the government can set performance benchmarks for various types of buildings. Then, building owners will know how their buildings compare to the performance benchmark. The BCA indicates it intends to accomplish this indexing and benchmarking effort by building type over s period of several years. To date, a study of 104 office buildings has been accomplished and is reported on the BCA-NUS website. See: http://www.bdg.nus.edu.sg/buildingEnergy/publication/papers/BCABEAud.pdf

Performance Contracting: The BCA plans to encourage performance contracting, based upon its successful application in the US and elsewhere, and BCA plans work with the Ministry of Finance on a standard form of performance contract for public buildings. (See http://www.bdg.nus.edu.sg/buildingEnergy/energy_masterplan/index.html#ENERGY%20MANAGEMENT%20OF%20PUBLIC%20SECTOR%20BUILDINGS)

Building Energy Audit Process: Over the years a lot of information on building energy use has been collected, which forms a firm base for detailed analysis of potential energy savings. This database has been used in educational programs aimed at various professional groups. The National University of Singapore is very active in this program. The joint BCA-NUS website includes a paper providing guidance on conducting energy audits. See: http://www.bdg.nus.edu.sg/buildingEnergy/publication/papers/BCABEAud.pdf.

Tax incentives: The Singapore government offers an Approved Accelerated tax Depreciation Scheme, within 2 categories:

Category A: For Replacement Machines & Equipment

- any air conditioning system
- any boiler
- any water pumping system
- any washing or dry-cleaning machine system
- any refrigeration system
- any life or escalator
- any instant hot water system

Category B: For Energy-Saving Equipment & Devices

- any solar heating or cooling system
- any solar energy collection system
- any heat recovery system
- any power factor controller
- any high efficiency electric motor
- any variable speed drive motor control system
- and high frequency lighting system
- any computerised energy management system

Other Financial Incentives are also offered including

- Investment Allowance Scheme (IAS)
- Local Enterprise Technical Assistance Scheme (LETAS)

Energy efficiency building standards in Thailand

First Version of the standards

- **First Version:** In the late 1980s, a first-draft energy efficiency building standard was developed as a collaborative effort between researchers at AIT and international consultants under an ASEAN-USAID project.

- **Scope:** The scope of the 1st-generation standard has included: (1) building envelope, (2) air-conditioning, and (3) lighting. This standard drew its overall approach and considerable material from the 1983 Singapore standard, from early drafts of the emerging 1989 ASHRAE standard in the US, and from the draft from the draft standard that had been recently developed in Malaysia.

- This first Thai standard developed its on approach to formulating the OTTV requirements for the building envelope, and did not simply copy the formulae or requirements from Malaysia, Singapore, or ASHRAE. Nonetheless, the overall Thai envelope methodology was not radically different from the others. Formats and requirements for the other building systems were also similar to the other standards.

- The primary input to this first Thai standard was provided by AIT and other Thai universities in Bangkok and Chang Mai, with input from an international consultant (IC) team from Lawrence Berkeley Laboratory working under an ASEAN-USAID project. An in-country technical committee was assembled that represented the building industry, academia and government; this committee reviewed the standard.

- **Early International technical and funding support:** The USAID funded ASEAN-USAID collaborative program supported the development of the first version of the Thai energy efficiency building standard, and also support several related university-based research efforts, but did not continue to provide funding or technical support into subsequent implementation phases of the standard.

- **Compliance tools:** The draft compliance guideline that had been developed for the Malaysian standard in the late 1980s by the IC team was provided to researchers in Thailand for their use.

- **Adoption:** The first generation Thai standard was first endorsed in 1995 as a set of building energy codes for "designated buildings" and government buildings and later in 1995 was further defined as a Ministerial Regulation. Compliance was required for "designate buildings," which are larger buildings that meet either of the following:

  (1) A building or buildings under same address which are allowed by any energy distributor to install electricity metering device, or to install one or more transformers whose combined capacity is 1,000 kilowatts or 1,175 kVA and up.

  (2) A building or buildings under same address which consume commercial energy including electricity and steam as from January 1, to December 31 of the past year in total volume of energy of twenty million megajoules or more of electrical energy equivalent.

These capacity and consumption limits indicate that most "designated" buildings have air-conditioned floor areas greater than about 10,000 m^2.[8]

- **Enforcement:** The energy code has evidently been mandatory since 1995 for both existing and new buildings.[9] A primary focus has been on mandatory enforcement for existing "designated" buildings. Energy audits were required for existing designated buildings, and several thousand reasonably detailed audits of existing buildings have been done. This has spawned the development of an energy auditing industry, and has also produced a valuable database of energy characteristics of larger Thai buildings.

- While we have seen summary data that, based on audits conducted, that substantial numbers of existing buildings did not comply with the building energy code requirements (about 40% for envelope, 25% for lighting, and over 50% for aair-conditioning). However, we have not seen any systematic data to indicate that substantial retrofits occurred via retrofits of existing Thai buildings as a result of these audits or that any significant energy was saved as a result of the audits and related activities. [10]

- A primary focus on compliance for existing buildings is unusual for building energy codes and standards. For existing buildings, significant energy efficiency improvements are usually cost-effective mainly as part of major additions or renovations encompassing major equipment or system replacements. And then, lighting and air-conditioning are most likely to be cost effective, while envelope improvements are less likely to be cost-effective. For this reason, most building energy codes have focused on new buildings, and for existing buildings have focused on requirements specifically for those portions of buildings being added or undergoing major retrofit.[11]

- For new buildings, additions, or renovations, currently the persons that are responsible for checking the energy code compliance are the staff of the technical departments in local building department administrations that issue building permits. However, there are few if any staff skilled or trained in evaluating the energy issues or energy compliance. Also, apparently, there are no detailed compliance forms or requirements to submit. Evidently, people are knowledgeable of the general energy requirements, but when an application for build permit is submitted, it includes a general statement that the building complies with the energy code, but no detailed justification is submitted, because it is not required.

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[8] Indeed, the Macro-economic study recently conducted as part of the building energy code revision process has recommended that, for a number of reasons, the specification of "designated" buildings be changed to buildings with air-conditioned floor area greater than 10,000 m^2. See section 3 of the macro-economic report, specifically section3.4

[9] Confirm

[10] Need to confirm this. However, see below the example of Mike Shopping Mall, which won the ASEAN Energy Award in 2001 for an ESCO-based retrofit and energy improvement.

[11] This is summarized succinctly in Section 4.2.1 of ASHRAE 90.1-2004.

- **Training:** The DANIDA/DEDE team made a survey of the professionals in the building industry field, and identified a strong need as well as a desire for further training in energy efficiency in buildings.[12] However, there is apparently not a program to provide such training.[13]

Revisions to the standards

- **Revisions**: In the past several years[14], a major assessment has been made of the first-generation Thai building energy code, a major revision of the code has been accomplished, and a macro-economic impact assessment has been conducted. The revised format and requirements are discussed in detail in a joint DEDE/DANIDA report prepared with the assistance of Dansk Energi Management A/S.[15]

- **International technical and funding support for the revision process:** This work has been done as a collaboration between the Thai Department of Alternative Energy Development and Efficiency (DEDE) and Danish International Development Assistance (DANIDA). DANIDA has also provided funding support.

- A detailed analysis was conducted of some 200 audited "designated" buildings[16] from an available database of about 2000 audited buildings.[17]

- Also, a macro-economic survey, a revised energy code has been developed based on substantial revisions made to the first-generation energy code.[18] This well-defined study, prepared for DEDE with the assistance of Dansk Energi Management A/S, determined that the requirements of the new code would produce an estimated energy savings of 8-9% relative to current Thai energy-related construction practice.[19] The report actually used

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12 Personal communication from Karsten Holm.

13 Confirm.

14 None of the reports are dated. Need to get general dates.

15 **Report on Energy Code Development,** Energy Performance Requirements of Commercial Buildings: Technical and Economic Analyzes, Adjustments to the Building Energy Code, a Government-to-Government agreement between Thailand and Denmark

16 Review of existing building design traditions and conventional technologies, extracts from a joint DEDE/DANIDA report prepared with the assistance of Dansk Energi Management A/S.

17 Personal communication from Karsten Holm.

18 Report on Energy Code Development, Energy Performance Requirements of Commercial Buildings: Technical and Economic Analyzes, "Adjustments to the Building Energy Code," A Government to Government agreement between Thailand and Denmark, [date?].

19 The report did not detail the specific measures that are estimated to produce savings and the comparable energy features of current Thai building construction for offices, retail, hotels, hospitals, and educational buildings. Since the comparative energy analyses of these buildings were done by DOE-2, the specific measures were most likely identified in some detail. However, this information was not cited in the published report.

savings projects of about ½ of this, assuming imperfect penetration and compliance, Even based on the more conservative savings estimates, the report concluded that 3 types of positive benefits would occur from compliance with the revised energy code:

"1. Energy savings on a national scale prompted by the proposed building code amendments (and its value given electricity prices)

2. Peak power demand reduction prompted by the proposed building code amendments (and its value given reduced power generation requirements)

3. CO_2 emissions reduction prompted by the proposed building code amendments."[20]

Another estimate of projects savings has evidently been done at AIT with results presented by Dr. Surapong. We do not have the details or assumptions underlying those estimates.

Jurisdiction

The Department of Alternative Energy Development and Efficiency (DEDE) has been the responsible Ministry for developing and enforcing the energy efficiency building codes.

Infrastructure: There has evidently been an effective, sustained, long-term collaboration between government and academia in Thailand that has contributed to the development and refinement of the building energy standards. [However, we do not know if this collaboration has extended to the development of compliance tools or to the training to the building industry to effectively use and comply with the codes.].Very recently, a handbook has been written to assist building professionals in energy efficient building design and in LCC analysis of design options. Also, a computer program has been written to assist designers to comply with the code. However, we have not seen information about energy code implementation programs in Thailand such as

- Compliance forms and instructions,
- Other types of energy efficiency and code compliance training for the building industry such as workshops,
- Outreach and information programs

Implementation and Impacts

We are not aware of any estimates made in the late 1980s for the potential savings for Thai buildings from building energy standard that had been developed. However, one might reasonably assume that the level of projected savings for Thai buildings would be similar to the savings estimated for similar standards and codes developed at that time for Malaysia, the Philippines, and Indonesia.

A macro-economic analysis has been conducted of the potential savings that might result from the new revisions to the Thai energy code; see above.[21]

[20] Benefits extracted from page 3 of the report.

As to market transformation to date, professional judgment estimates of recent market changes in Thailand indicate that there have been improvements in the efficiency of lighting and air conditioning systems, but that there have not been significant improvements in the use of energy efficient windows or envelope insulation.

7. Status of Voluntary Non-Regulatory Programs in Thailand

Regional Energy Efficiency Activities:

Thailand actively participates in ASEAN regional energy efficiency activities. Such activities include (1) participation in the development of regional energy benchmarking of buildings, and (2) regional energy efficient building award programs**.**

Regional Energy Awards:

- ASEAN Energy Awards 2003 For Energy Efficient Buildings:

  The Central Academic Shinawatra University Building of Thailand won the main prize in 2003 in the new and existing building category.

- ASEAN Energy Awards 2001 For Energy Efficient Buildings:

  The Mike Shopping Mall of Thailand won the main prize in 2001 in the retrofitted building category.

Thai Award and Recognition Programs:

- The Department of Energy in Thailand has recently begun to provide awards to energy efficient buildings, but no awards have apparently been given yet.

Green building programs:

- There does not appear to be significant activity within the Thai private sector toward green buildings.

- The Thai electricity authority (EGAT) has had a green building program, but it evidently targeted a limited number of buildings and its effectiveness is not known.

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[21] Adjustments to the Building Energy Code, **Macro-economic Analysis,** Impact of proposed new draft building energy code, Department of Alternative Energy Development and Efficiency, Thailand, February 2004

RETROFITTED BUILDING CATEGORY

Extracted from the ASEAN Energy Awards web-page:
http://www.aseanenergy.org/energy_sector/energy_efficiency/aea/2001/summary.htm

WINNER:
MIKE SHOPPING MALL OF THAILAND

Building Information

Name of Building	Mike Shopping Mall
Ownernership	Both owner and tenants
Total Number of Storeys	9 Floors
Total Gross Floor Area	42,100 m^2

Efficiency Chart

Energy Efficiency Index	169 $kWh/m^2/yr$
Temperature	25^oC
Relative Humidity	50-55%
Lighting Load	12 W/m^2
OTTV	38.03 W/m^2

Mike Shopping Mall is the largest shopping mall in Pattaya City, Thailand. It has 9 floors and one basement, with the building façade oriented towards a beautiful sea beach. It is a multi-function complex consisting of a department store, a shopping plaza, and an office. The mall is a favorite shopping destination of both Thai and non-Thai tourists.

In 1996, Mike Shopping Mall was designated for energy retrofit under the Energy Conservation and Promotion Act B.E.2535 of Thailand. An energy service company (ESCO) conducted an energy audit. To eliminate the risks on investment, the services of an ESCO was engaged to deliver a level of guaranteed savings without compromising the building design and comfort. If the projected savings fall short of a guaranteed amount, the ESCO pays the difference.

Highlights of the Energy Retrofitting

1. The energy performance indicators are better than existing standards. Energy savings were about 31%. Investments were paid back in 1.3 years.
2. Energy savings is 7 percent in 1997 and 1998; 13 percent in 1999; and 10 percent in 2000. Energy audit is conducted every 6 months to further highlight efficiency improvement.
3. More than 20 energy-retrofitting measures have been implemented for both passive and active concepts. They range from no cost, low-cost to easy-to-do measures.
4. It is an excellent showcase of a Government-initiated project. The Thai Government provided technical guidance and financial assistance to realise the energy retrofit programme of Mike Shopping Mall.
5. The building adopted low cost, efficient, and locally developed energy technologies.
6. It pioneered in the promotion of a performance guarantee business concept between building owners and an ESCO. The concept is critical for a project that requires significant amount of investments to convince building owners to undertake energy retrofit.
7. The project is a living testimony of the effective and serious policy of the Thai Government towards energy efficiency and environmental improvement.

Energy efficiency building standards for India
Summary

- India is the world's sixth greatest energy consumer. Its ongoing population explosion and rapid economic growth, along with a move toward urbanization and industrialization, has placed great strain on the country's energy resources and environment.
- Lowering energy intensity of GDP growth through higher energy efficiency is key to meeting India's energy challenge and ensuring its energy security.
- With a near consistent 8% rise in annual growth, building energy consumption has seen an increase from 14% in the 1970s to nearly 33% in 2004-2005.
- India has just developed a first-generation energy code applicable to all buildings except low-rise residences (3 stories or less) and is still in very early stages of implementing the new energy code. Effective implementation of the energy code is hindered by factors like lack of (1) clear implementation guidelines, (2) effective local implementation infrastructure for energy code administration and enforcement including code checking and inspections, (3) incentives from the government, (4) technical expertise, (5) appropriate materials and equipments to meet requirement of codes, etc.
- Non-government initiatives from industry associations and private companies have played an important role in promoting the Green Building concept in India, which uses energy code requirements as an important base case.

Data Profile

Despite its large annual energy production, India is a net energy importer due to the large imbalance between production and consumption. It currently ranks as the world's sixth greatest energy consumer, accounting for about 3.3% of the world's total annual energy consumption, and as the world's eleventh greatest energy producer, accounting for about 2.4% of the world's total annual energy production[22]. More than 70% of its crude oil consumption is met via imports.

In terms of per capita energy consumption, India is well below most of the rest of Asia and is one of the lowest in the world[23]. But to a great extent this low figure is a result of India's large rural population (70% of total population, close to 700 million,) who have very limited access to electricity yet[24]. It is projected that India's urban population would grow to about 473 million in 2021 and 820 million by 2051, as against only 285 million in 2001. Its booming metropolises, with 35 cities with populations in excess of 1 million and more joining the list, are straining the limits of its energy supply and causing serious air pollution problems. From 1980 to 2001, total energy

[22] Carbon Sequestration Leadership Forum, http://www.cslforum.org/index.htm

[23] At 0.16 kgoe/$GDP (PPP) it is lower that that of China's and the United States of America's, which are at 0.23 kgoe/$GDP (PPP) and 0.22 kgoe/$GDP (PPP) respectively, but fares higher than the intensities of the United Kingdom's at 0.14 kgoe/$GDP (PPP) and Brazil & Japan's at 0.15 kgoe/$GDP (PPP).

[24] Even though 85% of villages are considered electrified, around 57% of the rural households and 12 percent of the urban households i.e. 84 million households (over 44.2% of total) in the country did not have electricity in 2000.

consumption in India increased 208%, while per capita consumption rose 103%. Higher energy consumption in the industrial, transportation, and building sectors continues to drive India's energy usage upwards at a faster rate even than China.

An analysis of consumption by sectors shows that industry accounts for nearly half of final commercial energy consumption, followed by transport and building sectors. With a near consistent 8% rise in annual growth, building energy consumption has seen an increase from a low 14% in the 1970s to nearly 33% in 2004-2005. The gross built-up area added to commercial and residential spaces was about 40.8 million square meters in 2004-05, which is about 1% of annual average constructed floor area around the world and the trends show a sustained growth of 10% over the coming years[25], highlighting the peace at which the energy demand in the building sector is expected rise in India.

In 2001, India ranked fifth in the world in carbon emissions, behind the United States, China, Russia and Japan. Between 1990 and 2001, India's carbon emissions increased by an astonishing 61%, a rate surpassed only by China's 111% increase during the same time period. For the coming decade, carbon emissions in India are expected to continue to increase because of low energy efficiency and stiff population growth and urbanization.

National Energy Policy

Energy is poised to be one of the biggest constraints to India's growth. As of date, problems such as shortages of fuels, an increasing dependency on imported oil, and poor health of the power sector are discouraging growth in India.

Energy policy in India focuses on "energy for all" and intends to build an environment friendly sustainable energy supply industry. With these primary objectives the planning commission has prepared an *Integrated Energy Policy* linked with sustainable development that covers all sources of energy and addresses all aspects of energy use and supply including energy security, access and availability, affordability and pricing, as well as efficiency and environmental concerns. The Integrated Energy Policy has laid a lot of stress on energy efficiency and conservation, with particular emphasis on efficiency of electricity generation, transmission, distribution and end-use. It is pointed out that over the next 25 years energy efficiency and conservation would be very critical to ensure energy security and economic growth.

In June 2003, the *Electricity Act 2003 (EA2003)* was enacted to consolidate the laws relating to generation, transmission, distribution, trading and use of electricity. It also called for promotion of efficient and environmentally benign policies. In compliance with the provisions of the act, the *National Electricity Policy* was notified in 2005 by the central government. The prime objectives are

- to provide access to electricity for all households by next five years, meet full demand by 2012, increase per capita availability of electricity to over 1000 units by 2012; and

[25] India-Country Report 2005-2006 - Construction Industry Development Council, India

- to ensure financial turnaround and commercial viability of electricity sector and protection of consumers' interest.

According to the *National Electricity Policy,* energy conservation and utilization of alternative forms of energy form two core issues that are to be addressed in order to achieve the desired objectives.

Energy Efficiency Policy

The first government initiative towards energy efficiency was when the Indian parliament passed the *Energy Conservation Act, 2001* that led to the establishment of the Bureau of Energy Efficiency (BEE) under Ministry of Power to implement the Act. According to the Act, the target for energy saving in 10th plan period is 13% of estimated demand. This Act requires large energy consumers to adhere to energy consumption norms; new buildings to follow the Energy Conservation Building Code; and appliances to meet energy performance standards and to display energy consumption labels.

The Integrated Energy Policy unveiled in 2006 identified the following 10 foremost areas where significant savings can make a substantial impact[26], half being related to building:

- Mining
- Electricity Generation, transmission and distribution
- Water Pumping
- Industrial production, processes, hauling
- Mass transport
- Building design
- Construction
- Heating, Ventilation and Air-Conditioning
- Lighting &
- Household Appliances

Building energy efficiency policy

Building EE Codes

India has many central and local authorities and bodies that help compile building codes and standards that are applicable at local and national levels. As of now, there are 2 different codes that have been developed by bodies at national level:

- The Bureau of Indian Standards – National Building Code (NBC) which cover all aspect of building design and construction; and

[26] Page XXI, Integrated Energy Policy – Report of the Expert Committee, Government of India, Planning Commission, New Delhi – August 2006.

- The Bureau of Energy Efficiency – Energy Conservation Building Codes (ECBC) which targets specially at building energy efficiency;

NBC

Building byelaws in India are under the purview of state governments and vary with administrative regions within the state. However, the central government realized the need to develop a unified building code to reflect latest trends in construction. The Bureau of Indian Standards (the national body for development of codes and standards) has developed the NBC as a guiding code to be followed by municipalities and development authorities in formulation and adoption of building byelaws. The code is meant to be a guide to all governmental and private agencies controlling building activities. It covers nearly all aspects of building design and construction, including energy efficiency.

The NBC has was first published in 1970 and then revised in 1983, 1987, 1997, and most recently in 2005 (see Bureau of Indian Standards website at http://www.bis.org.in/sf/nbc.htm). In the latest edition of the code, guidance on aspects of energy conservation and sustainable development have been addressed concerning appropriate design, usage and practices with regard to building materials, construction technologies, and building and plumbing services. The document provides general guidance on potential energy efficiency aspects of such factors as Daylight Integration, Artificial lighting requirements, Select HVAC design norms, etc. It is not clear whether the NBC is mandatory or voluntary, since in the 3 sections of the NBC on the Building Services(ventilation, lighting, daylighting, AC, etc), there is very little that is specifically required, i.e., while it provides excellent "guidance" on these topics, the NBC sets almost no limits.

ECBC

The first 'stand-alone' national building energy standard/code is ECBC developed after the implementation of the Energy Conservation Act, 2001. It is India's first effort towards energy efficiency in buildings.

The ECBC program's objective is to reduce the baseline energy consumption by supporting adoption and implementation of building energy codes. It takes into account location and occupancy of the buildings and provides minimum standards to be followed to reduce energy demand of the buildings through design and construction practices while enhancing occupant comfort.

Unlike the NBC, which mainly provides general guidance relative to energy, the ECBC lists specific maximum and minimum limitations on a number of key building features that affect building energy use. While the NBC sections only provide guidance, the essence of the ECBC is to set such limits with great care, in language that hopefully can be checked, inspected, and enforced.

The ECBC is mandatory for big commercial buildings [27] and applicable to all buildings with a conditioned floor area larger than 1,000m^2, except low-rise residential buildings. [28]. The code is recommended for all other buildings.

Approach: ECBC has both prescriptive and performance based compliance paths. The prescriptive path calls for adoption of minimum requirements for the building envelope and energy systems (lighting, HVAC, service water heating and electrical). The performance-based compliance path requires whole building simulation approach to prove efficiency over base building as defined by the code. There is also a system-level performance compliance option for the building envelope. This leaves the code inherently flexible and easy to adopt.

Jurisdiction: The BEE is the primary body responsible for implementing the ECBC and works towards policy formulation as well as technical support for the development of the codes and standards and their supporting compliance tools, procedures, and forms. . In developing the ECBC, the BEE has orchestrated a diverse group of in-country and international technical experts. BEE will also work closely with national and state-level government entities to administer and enforce the ECBC and other energy-related codes and standards.

Implementation of NBC and ECBC

India has just developed a first-generation energy code (the ECBC) applicable to all buildings except low-rise residences (3 stories or less) and is still in very early stages of implementing the new energy code. Effective implementation of the ECBC energy code is hindered by the lack of:

- Clear implementation guidelines,
- Local infrastructure for energy code administration and enforcement including code checking and inspections,
- Incentives from the government,
- Widespread technical expertise,
- Appropriate materials and equipments to meet requirement of codes, etc.

Appliance/Equipment Labeling and Standards:

The Bureau of Energy Efficiency's standards and labeling program which is under development, aims to ensure the availability of only energy efficient equipment and appliances to the people. Up to now, this program has covered 9 types of equipments/appliances for labeling and 3 types for minimum performance standards. As of now it is a voluntary scheme and offers no direct financial incentive for industry to participate.

[27] Big commercial buildings means those have a connected load of 500 kW or greater or a contract demand of 600 kVA or greater.

[28] This means buildings with a conditioned floor area of 1,000 m^2 (10,000 ft2) or greater.

Status of Voluntary Non-Regulatory Programs

India has a number of voluntary green building standards and certification systems, as listed and described below:

The Indian Green Building Centre (IGBC): Industry associations in India have played an important role in promoting energy efficiency. The IGBC is an example of an institution created by an industry association. The IGBC is facilitating the LEED rating of the United States Green Building Council. There are about 5 buildings that have been rated and 25 projects are registered for rating under the LEED system. Actually, the IGBC building in Hyderabad was the first platinum rated building to be built outside of the USA.

GRIHA (Green Rating for Integrated Habitat Assessment): The LEED rating systems are developed around the premise that the buildings are air conditioned, whereas in India, a large number of buildings built to date are non-air-conditioned or partially air-conditioned. To bridge the demand for a rating system for non-air conditioned buildings while taking into account the possibility of a partially air conditioned building as well, TERI developed its own system known as GRIHA for the new large energy consuming segment, i.e. commercial, institutional and residential buildings (new construction). This system responded specifically to India's prioritized national concerns such as extreme resource crunches in the Power and water sectors and a fast eroding biodiversity. It attempted to stress on solar passive techniques for optimizing indoor visual and thermal comfort and relying on refrigeration based air-conditioning systems only in cases of extreme discomfort. There are 8 registered projects under GRIHA that are under construction. TERI is in the course of developing a similar standard to address the needs of other building typologies such as existing buildings.

***Planned national green building rating system*:** Now, in consultation with the experts from various related fields in India, the Ministry of New and Renewable Energy Sources (MN&RE) is planning developing a national rating system for green buildings. This shall be a voluntary system to be adopted by builders and individuals alike. The MN&RE is trying to develop an incentive mechanism for the same as well.

***Planned energy audit program*:** The BEE has planned to mandate energy audits (by early 2007) for all existing commercial buildings above a certain threshold of connected load and would develop mechanisms to ensure that the recommendations of the audit are implemented in a stipulated time. There would thus be a large demand for Energy Service Companies (ESCOs), and those establishing themselves faster would reap maximum benefits of the mandate[29].

Demand Side Management (DSM): It would be fair to say that DSM is viewed by the government as the primary strategy for energy conservation in residential buildings. Studies show that implementation of DSM options to reduce demand for electricity through energy efficient processes, equipment, lighting and buildings can help reduce the demand by an estimated 15% by

[29] Interview with Dr Ajay Mathur, DG , BEE.

2031-32 in India[30]. Around September 2002, DSM cells were set-up in utilities in five states and pilot projects had been designed for Karnataka and Mahrashtra. Through 2002-03, capacity building exercises were initiated and completed in MEDA (Maharashtra Energy Development Agency) and BESCOM (Bangalore Electricity Supply Company). Ever since, additional capacity building exercises for the electric utility regulators as well as the preparation of investment grade feasibility reports for implementing DSM projects have been under way[31].

***Renewable energy sources in buildings*:** India is the only country that has a separate government ministry exclusively for non-conventional energy sources, i.e. MN&RE, and it has one of the largest national programs to promote the use of solar energy. MN&RE have initiated several programs focusing on utilization of renewable energy sources in buildings. For example, the Solar Buildings program provides assistance for several dissemination related activities and provides financial support for the design and construction of energy efficient and solar passive buildings. The solar buildings have been tried out in a few States. The government of Himachal Pradesh has made it mandatory to construct all its future buildings using passive design features.

Information distribution: The BEE website is a comprehensive information base on energy conservation related developments and issues. It provides an update on the related policy framework especially in the context of EC Act 2001 beside topical write ups, news and highlights on happenings in India.

[30] Page 49, Integrated Energy Policy – Report of the Expert Committee, Government of India, Planning Commission, New Delhi – August 2006.

[31] Action taken Report, Bureau of Energy Efficiency, 2004