

Energy efficiency building standards in China

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. Finally, a revised national energy design standard for residential buildings that combines the three previous regional standards has been under development since 2005 and was 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, Tianjin, Shanghai, and Chongqing.

Enforcement of building energy standards was problematic, particularly in the early years, in part because programs were introduced and led by the Ministry of Construction, but were implemented locally. As a result, compliance to the energy standards is now good in such leading cities as 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 (residential 2001, Green Olympic Building Assessment System 2004, Evaluation Standard for 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.

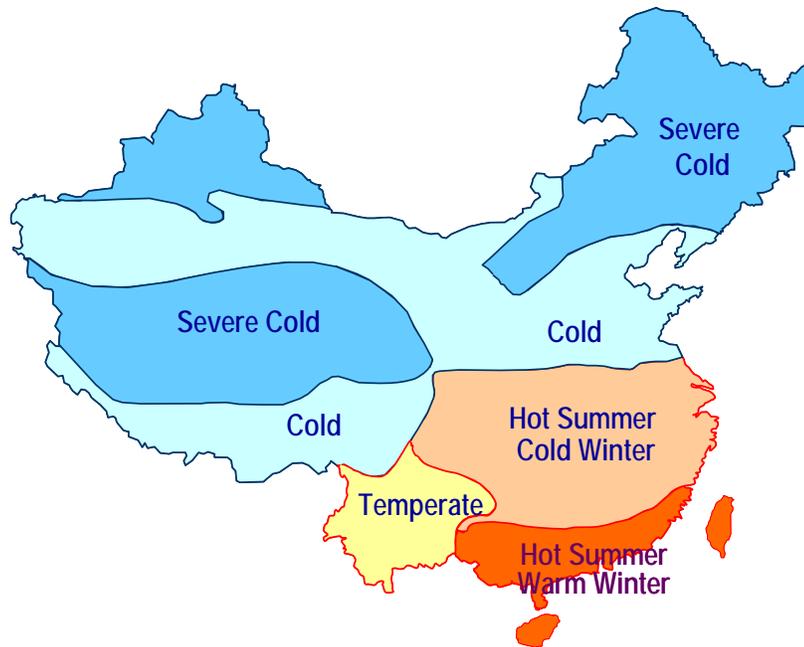
Status of Building Energy Efficiency Standards

From an institutional point of view, China has the 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, developed in 1986, was solely for residential buildings in the Heating Zone in north China. It was 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 1990s, 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 percent in the 1986 version, and by 50

percent in the 1995 version of the standard. The 1986 aimed at reducing the heat losses of the building envelope by 30 percent, while the 1995 revision also added a 20 percent 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 have not been 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 1980s 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 is thought to be fairly uneven, given its early adoption.

With China’s rapid economic growth in the 1990s, 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 percent compared to pre-existing buildings. These two standards marked the first efforts in China to evaluate cooling, in addition to heating energy use, and to use computer simulations to define energy budgets. 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; with this designation as a national standard, the MOC indicated an increased importance attached to building energy efficiency. Completed and adopted by the MOC in 2004, it also set a target of 50 percent energy reductions compared to pre-existing buildings, but this 50 percent savings was to be achieved through improvements to both the building envelope (22 percent) as well as the HVAC system (28 percent).

In 2005 the MOC decided to update the three regional residential building energy standards (Heating Zone, HSCW, and HSWW), and combined 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 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 in residential buildings, air-conditioning is installed by the apartment owner, making any requirements in the building standard difficult to enforce and largely advisory in 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 lower U-values (in the heating-dominant locations) or shading coefficients (in the cooling-dominant locations) the larger the windows. Tables 6 through 10 lists the prescriptive envelope requirements of the 2004 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 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.

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/(m ² ·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.transpar ent 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

| Bldg envelope component | | Heat Transfer Coefficient (W/(m ² ·K)) | | |
|---|---------------------|---|--|--------------|
| | | 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/(m ² ·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.transpa rent 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/(m ² ·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.transpa rent 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/(m ² ·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 Coefficient (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 ·K) | 0.3 < Shape Coefficient ≤ 0.4 Heat Transfer Coefficient (W/m ² ·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 |
| | $0.2 < \text{WWR} \leq 0.3$ | ≤ 2.8 | ≤ 2.5 |
| | $0.3 < \text{WWR} \leq 0.4$ | ≤ 2.5 | ≤ 2.2 |
| | $0.4 < \text{WWR} \leq 0.5$ | ≤ 2.0 | ≤ 1.7 |
| | $0.5 < \text{WWR} \leq 0.7$ | ≤ 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 ·K) | 0.3 < Shape Coefficient ≤ 0.4 Heat Transfer Coefficient (W/m ² ·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 |
| | $0.2 < \text{WWR} \leq 0.3$ | ≤ 2.9 | ≤ 2.5 |
| | $0.3 < \text{WWR} \leq 0.4$ | ≤ 2.6 | ≤ 2.2 |
| | $0.4 < \text{WWR} \leq 0.5$ | ≤ 2.1 | ≤ 1.8 |
| | $0.5 < \text{WWR} \leq 0.7$ | ≤ 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 | — |
| | $0.2 < \text{WWR} \leq 0.3$ | ≤ 3.0 | — | ≤ 2.5 | — |
| | $0.3 < \text{WWR} \leq 0.4$ | ≤ 2.7 | $\leq 0.70/—$ | ≤ 2.3 | $\leq 0.70/—$ |
| | $0.4 < \text{WWR} \leq 0.5$ | ≤ 2.3 | $\leq 0.60/—$ | ≤ 2.0 | $\leq 0.60/—$ |
| | $0.5 < \text{WWR} \leq 0.7$ | ≤ 2.0 | $\leq 0.50/—$ | ≤ 1.8 | $\leq 0.50/—$ |
| 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 | — |
| | $0.2 < \text{WWR} \leq 0.3$ | ≤ 3.5 | $\leq 0.55/—$ |
| | $0.3 < \text{WWR} \leq 0.4$ | ≤ 3.0 | $\leq 0.50/0.60$ |
| | $0.4 < \text{WWR} \leq 0.5$ | ≤ 2.8 | $\leq 0.45/0.55$ |
| | $0.5 < \text{WWR} \leq 0.7$ | ≤ 2.5 | $\leq 0.40/0.50$ |
| 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 |

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 with a large hot water 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 very important aspect of energy efficiency in large buildings,

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

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 revised its building energy standards to be more stringent (with a 65 percent 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 1990s, 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, four 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 percent) in the major cities, and fair (50 to 80 percent) in the smaller cities. A survey conducted by the MOC in 2005 of code enforcement in northern China identified another problem: while over 70 percent of the buildings complied with the energy standard on paper, less than 30 percent 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 an "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 establishing 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. 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 (in 2002).

Sources and References

Lang Siwei, Chief Engineer, former director of the Air-Conditioning Institute, China Academy of Building Research, Beijing China.

Ministry of Construction 2006. *Design standard for energy efficiency of residential buildings*, (public comment draft in Chinese).

Ministry of Construction 2005. *Design standard for energy efficiency of public buildings*, GB 50189-2005 (in Chinese), China Architectural Engineering Press, Beijing China.

Ministry of Construction 2001. *Design standard for energy efficiency of residential buildings in the hot summer and cold winter zone*, JGJ 134-2001 (in Chinese), China Architectural Engineering Press, Beijing China.

Ministry of Construction 2003. *Design standard for energy efficiency of residential buildings in the hot summer and warm winter zone*, JGJ 75-2003 (in Chinese), China Architectural Engineering Press, Beijing China.

Ministry of Construction 2006. *Evaluation standard for green building*, GB/T 50378-2006 (in Chinese), China Architectural Engineering Press, Beijing China.

Nie, M.S., Qin, Y.G., Jiang, Y., Zhang, Q.F. 2002. *China Ecological Housing Technology Rating System* (in Chinese), China Architectural Engineering Press, Beijing China.

Green Olympic Buildings Research Group 2004. *Implementation Manual of Green Buildings for Beijing Olympics* (in Chinese), China Architectural Engineering Press, Beijing China.

Beijing City Construction Engineering Standard 2005. *The Standard of Energy Efficiency Rating System for Commercial Buildings*, DBJ/T01-100-2005 (in Chinese), Beijing Construction Commission.

Lin, J. 2002. "Made for China: Energy Efficiency Standards and Labels for Household Appliances", *Sinosphere*, Nov. 2002.

EU-China Energy and Environment Programme and China Academy of Building Research 2006, *International workshop on Building Energy Performance Evaluation and Energy Labeling*, proceedings, June 16, 2006, Beijing China.

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