ISSUE OF GROWTH

As rapidly developing countries grow, they will consume a larger share of global resources and could produce damaging levels of emissions. In many countries, these problems are compounded by the concentration of the population in large cities. Densely populated areas accelerate the depletion of land and local resources. Figure 1 shows one estimate of the world consumption of energy and the projected consumption one century hence. Currently, a large portion of the world’s energy is consumed by the relatively modest population in Western Europe, North America, and the Pacific Rim. If present trends continue, China and India will consume a preponderance of the world’s energy by the end of this century. One study projects total energy consumption of the world will increase from approximately 350 EJ (350 x 10^18 J) in 1990 to 1300 EJ in 2095. China (China, North Korea, Mongolia, Vietnam, Laos, and Kampuchea) alone is projected to consume approximately 500 EJ by 2095, more than the entire current world energy consumption (Edmonds, Wise and Barns 1995). For this reason, it is vital to ensure that new residential buildings in China’s rapidly growing cities are built in a sustainable fashion.

Measures to improve environmental sustainability in China should not and need not impede the improvement of standards of living. Although at present a majority of
energy in developing countries is devoted to industry, a rising standard of living will increase the proportion of energy consumed by buildings, as in the Western world. China’s residential and commercial energy consumption is consuming a growing fraction of total energy. As the per capita income and standard of living improves, this fraction should approach a value between the twenty-fifth percentile of Japan and the upper thirtieth percentiles of Western Europe and the United States.

In 1990, only about seven percent of China’s energy consumption was in the transportation sector. This is due to the concentration of heavy industry in China. In addition, the work unit, located close to the workplace, has traditionally met the housing needs of much of the population. As new residential projects are developed in urban areas far removed from employment centers, this new urban development will raise the proportion of energy usage due to transportation. Effective planning of sustainable residential development, then, must address the urban scale as well as the individual building.

The development of the Chinese economy encourages the demand for higher living standards in China. At present, air-conditioning is a key symbol of improvement of living standards. In 2001, 14.8 million air-conditioning units were sold, a rise of 41 percent compared to the previous year. The State Statistics Bureau reported that for every 100 urban households, there were 35.7 air-conditioning units in 2001. In eastern China, the average ownership was much higher at 52.5 percent (FriedlNet 2002). Other statistics report that Chinese consumers account for 35 percent of all air conditioners sold worldwide (Smith 2005). In 2006 it is predicted that total domestic market sales would be between 24 and 27 million units (China Daily 2005). The air-conditioning industry has increased 13 times since 1985. Energy consumption by air conditioners in the summer has become a main cause of severe electrical power shortage.

The electricity consumed by air conditioners in the basin of the Yangtze River is more than one-third of the total power supply during peak summer demand. If the trend continues and all 1.3 billion Chinese approach a living style and consumption level of North Americans, the world’s fossil energy reserves will be more rapidly exhausted.

Economic development has fostered a demand for larger living space (Figure 2). In urban residential units constructed in 2003, the average floor space rose to 23.7 m² per capita (China Statistical Yearbook 2004). The artificial control of the indoor environment using air-conditioning makes it possible to build a building without paying attention to the outdoor climate conditions. As a result, most recent buildings are built without traditional technologies but with mechanical systems. Although many will not accept the comfort levels of the past buildings based on Soviet designs, it is still possible to apply excellent traditional technologies to modern designs. Shading devices, natural ventilation, passive and evaporative cooling, steep roofs, passive heating, and massive walls are useful to improve thermal comfort, reduce the energy demand, and significantly protect the environment.

The trend of massive energy use in China has raised global concerns. Fossil energy consumed by power plants and by building heating plants results in an increase in carbon dioxide and sulfur dioxide emissions. Greenhouse gases such as carbon dioxide lead to global warming. The sulfur dioxide emissions in China bring acid rains to the entire far-east region. Therefore, conservation of energy, protection of the environment, and improvement of indoor air quality and thermal comfort are challenges designers and developers are facing.

Many old Chinese buildings can provide reasonable comfort and indoor air quality without using air-conditioning systems. In the past, in the countryside in...