CHAPTER 14

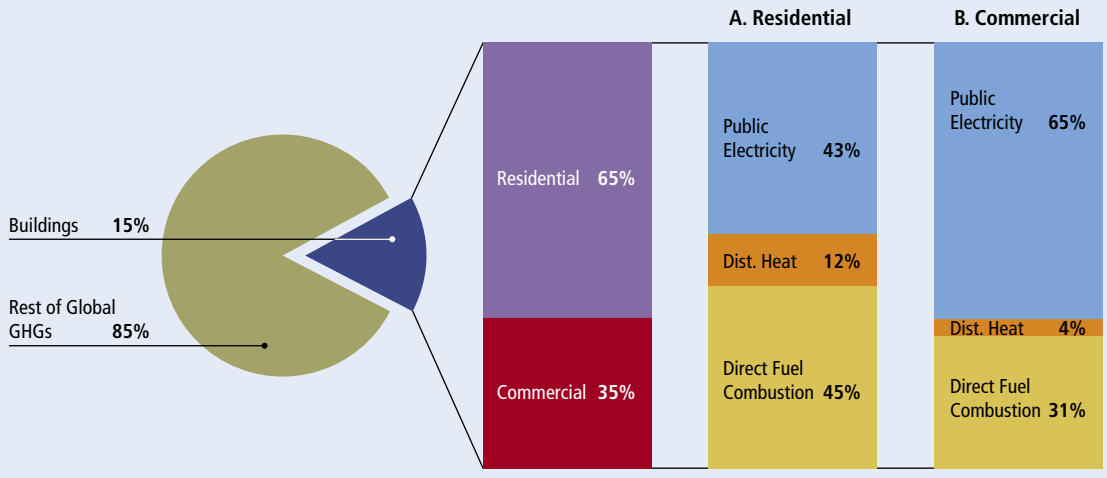
Buildings

Emissions

The buildings sector[169] encompasses both residential and commercial (including institutional) buildings. The sector accounts for 15.3 percent of global GHG emissions, including 9.9 percent for commercial buildings and 5.4 percent for residential; CO_2 accounts for nearly all emissions (Figure 14.1). Emissions from the building sector are predominantly a function of energy consumption for diverse purposes that can be organized into three broad categories: public electricity use, direct fuel combustion, and district heating.

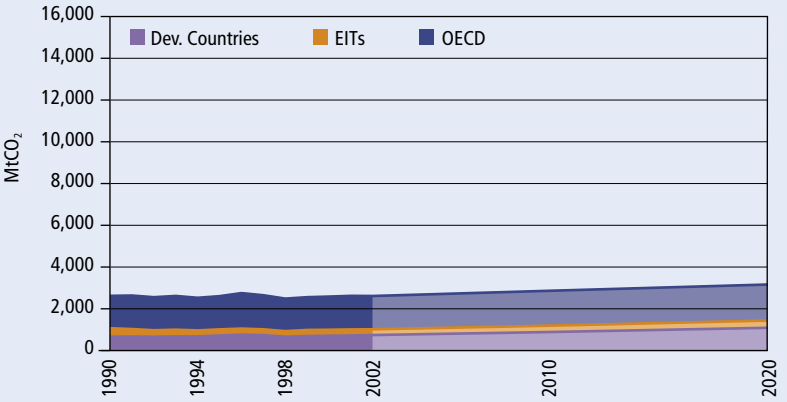
Public electricity use includes lighting, appliance use, refrigeration, air conditioning, and to some

Figure 14.1. CO_2 from Building Use



Sources & Notes: IEA, 2004a. See Appendix 2.A for data sources Appendix 2.B for sector definition. Absolute emissions in this sector, estimated here for 2000, are 6,418 $MtCO_2$.

Figure 14.2. CO_2 from Building Use, Trends and Projections



Source: IEA, 2004b,c.

extent space heating and cooking. These activities account for 65 percent of commercial building emissions and 43 percent of residential building emissions. Globally, the building sector is responsible for more electricity consumption than any other sector, 42 percent,[170] so to a significant extent, this sector implicates the electricity sector at large (see Chapter 11). Direct fuel consumption results primarily from space heating with modest contributions from food preparation (gas-driven cooking) as well as gas-driven air conditioning and refrigeration systems. This source accounts for 45 and 31 percent of emissions in residential and commercial buildings, respectively. District heating includes centrally operated heating (and sometimes cooling) systems that service entire cities or other large areas. Emissions arising from production of construction materials (e.g., steel, aluminum), including manufacture of appliances, are not included here.

Building sector emissions may be either *direct* (on-site), such as emissions from fuels combustion, or *indirect*, such as emissions from public electricity use and district heat consumption. Certain activities such as cooking, air conditioning, space heating and refrigeration may generate either direct or indirect emissions depending on the technology used.

The building sector encompasses a diverse set of end-use activities, which have different implications in terms of emissions reductions. Space heating, space cooling, and lighting, which together account for a majority of building energy use in industrialized countries, depend not only on the energy efficiency of temperature control and lighting systems, but also on the efficiency of the buildings in which they operate.[171] Building designs and materials have a significant effect on the energy consumed for a select set of end uses. On the other hand, building design does not affect the energy use of cooking or appliances, though these end uses are nonetheless attributed to the building sector. Appliance efficiency matters more for some end uses than for others. Water heating and refrigeration each account for significant shares of building energy use since they are in constant use. By contrast, cooking, and small appliances (including computers and televisions) generally account for only small percentages of building energy consumption, owing to their intermittent use.[172]

Emissions from the building sector vary widely by country in both absolute and per capita terms (Figure 14.3), and depend greatly on the degree of electrification, the level of urbanization, the amount of building area per capita, the prevailing climate, as well as national and local policies to promote efficiency. In addition, building sector emissions vary by composition (Figure 14.4), reflecting different space heating needs and carbon intensities in the electricity sector (Chapter 11). For example, building emissions in Australia and South Africa consist almost completely of electricity use due to the predominance of coal used for electricity production, while the electricity shares of emissions in France and Brazil are much lower, due to their reliance, respectively, on nuclear and hydropower. District heat use is concentrated in the transition economies of Russia, Ukraine, and Poland, as well as in Scandinavian countries.

There is an important correlation between building emissions and socioeconomic development levels (Chapter 7). In general, building emissions are higher in industrialized countries, both in per capita terms (Figure 14.3) and as a percentage of total country emissions (Figure 14.5) with variances due to climate, fuel mix and other factors. Thus, development has an

important effect on emissions from the building sector, implying that building efficiency becomes more significant as countries become more prosperous.

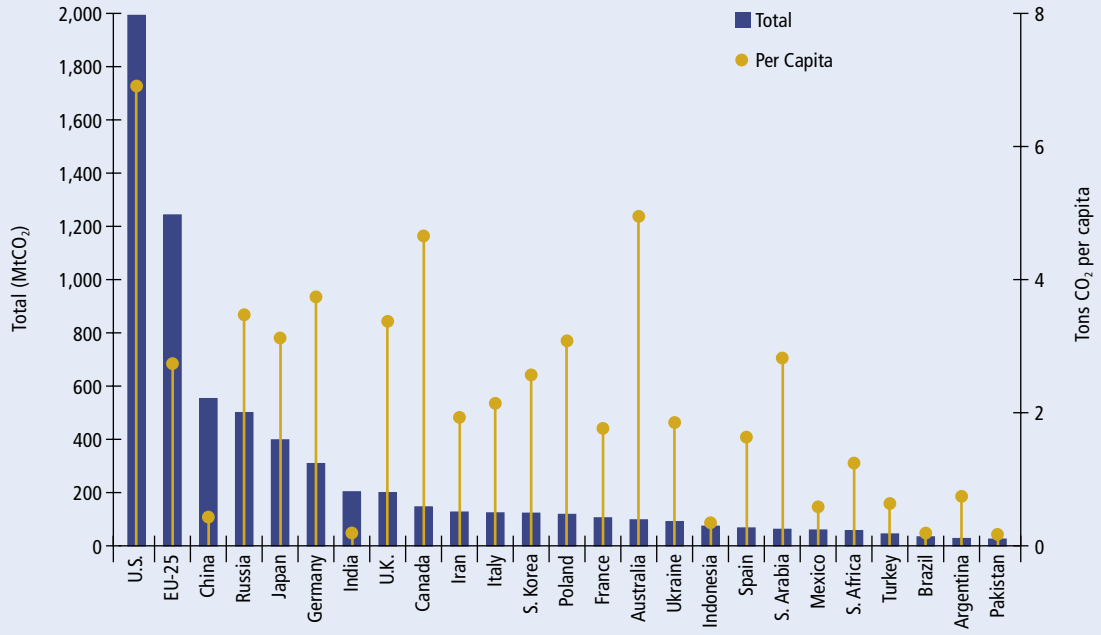
In the development context, it is important to distinguish between new building construction and existing building stock. New construction can more easily incorporate efficient materials and technologies, and owing to the long life cycle of buildings, is a strong indicator of future emissions trends.[173] New construction is projected to grow by 7 percent annually in China and 5 percent annually in India and Southeast Asia, compared to only 2 percent in the United States, Western Europe and Japan.[174] Building efficiency directly impacts at least half the emissions from end uses (space heating, cooling and light combined) in the building sector. Therefore, the importance of building sector emissions is especially significant in key developing countries, owing both to projected shifts in sectoral composition and rapid new construction with attending opportunities to employ efficient materials and best practices.

Sector Context

Analysis of the building sector produces mixed conclusions, owing to the diversity of influences and end uses that the sector embodies. International trade and a small number of multinational corporations play a significant role in the production and distribution of most building appliances, including cooking appliances, lighting, heating, and cooling systems. However, the opposite is true for building construction, which is dominated by small local firms. Many materials essential to building efficiency, such as cement and timber, are not heavily traded (aluminum and steel are notable exceptions), and building practices and materials vary widely depending on available resources, customs, and prevailing climate.

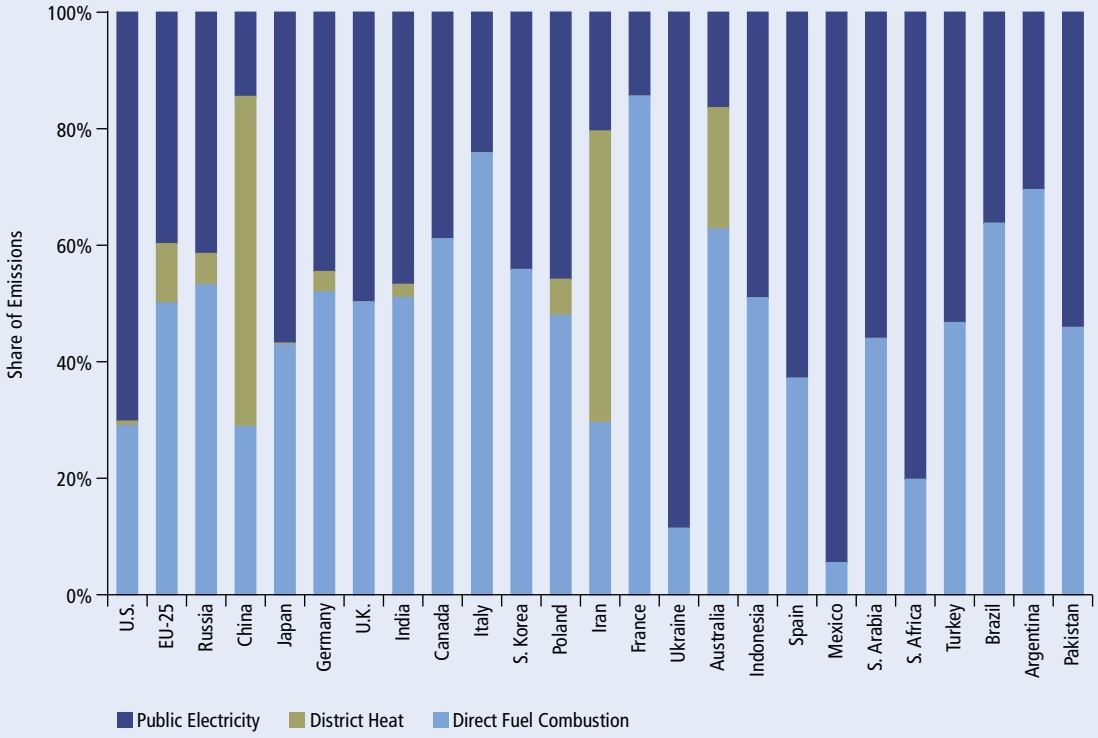
One consistent quality in the building sector is that it is subject to a high degree of regulation. Building codes often influence material use, and appliance standards, both mandatory and voluntary, have a significant effect on energy efficiency. Regulatory regimes, to the extent that they exist, may therefore provide a pathway to improve efficiency for both building construction and a variety of building appliances. Furthermore, government operations in commercial buildings often constitute a significant share of total building use, as government activity at all levels is building-dependent. By choosing energy efficient designs and materials for their own use, governments can thus exert significant influence over the building sector as a whole.

Figure 14.3. CO_2 from Building Use, Total and Per Capita, 2002
Top 25 GHG emitters



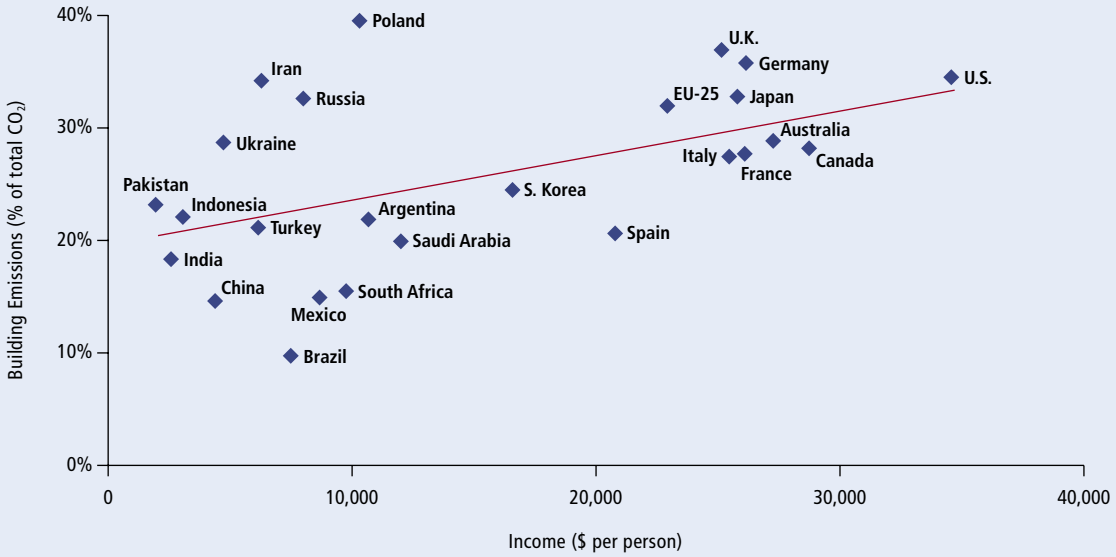
Sources: IEA, 2004a,b.

Figure 14.4. Relative Shares of CO_2 Emissions from Building Use, 2002
Top 25 GHG emitters



Source: IEA, 2004a,b.

Figure 14.5. Correlation of Socioeconomic Development and Building Sector Emissions, 2002
Top 25 GHG emitters



Sources & Notes: WRI, based on CAIT, IEA 2004b. The red trend line depicts the best fit correlation between per capita income and share of building emissions. Total CO_2 excludes emissions from land-use change and forestry and from international bunker fuels.