Greenhouse Gas Emissions: Baseline Inventory and Projections

Global and Regional Overview

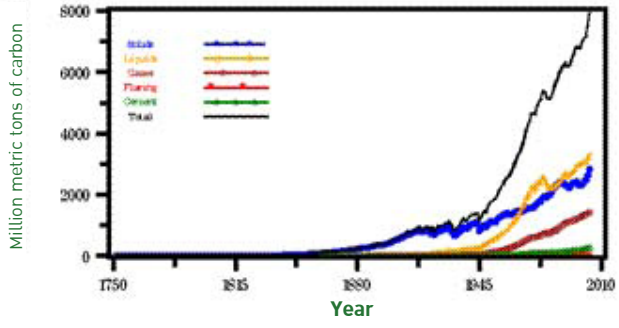
Past and present observations of climate change and its many impacts, and the collection of data from Thailand and other countries around the world form the basis for the scientific investigation of this phenomenon and the course it will likely take in the future.

While past and present data on the impacts of climate change are indispensable, equally important are data on its causes, especially on greenhouse gas emissions. Records that are kept around the world show that billions of tons of carbon in the form of carbon dioxide (CO_2) are absorbed by oceans and the living biomass every year. We also know that these systems emit massive quantities of carbon dioxide into the atmosphere annually through natural processes, and that changes in land use and forestry practices can both emit carbon dioxide and act as a carbon sink.

If maintained in equilibrium, the carbon fluxes, or continuously changing amounts of carbon, among these various reservoirs would be roughly in balance. However, since the start of the Industrial Revolution equilibrium has been destabilized and seems unlikely to be restored in the near future. Global atmospheric concentrations of carbon dioxide increased from about 280 ppm in the mid-1700s to 379 ppm in 2005 (IPCC -GW1, 2007), principally due to the combustion of fossil fuels.

This means that globally in 2004 alone approximately 27,044 million tons of carbon dioxide were added to the atmosphere as a result of the combustion of fossil fuels; boxes 3.1 and 3.2 show the data for global and per capita emission respectively. Of that enormous quantity of carbon dioxide, Thailand accounted for only about 1.0 per cent (Carbon Dioxide Information Analysis Center (CDIAC), 2007), but its contribution is by no means innocuous, as will be demonstrated by the data on those emissions contained in the section below on Bangkok.

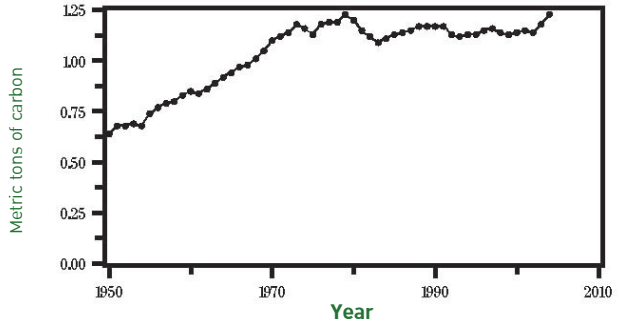
Box:3.1. Estimated emissions of carbon dioxide



Since 1751 roughly 315 billion tons of carbon have been released into the atmosphere owing to the combustion of fossil fuels and the production of cement. Half of the emissions have occurred since the mid-1970s. The 2004 global estimate of carbon dioxide resulting from fossil fuel combustion is 7,910 million metric tons* an all time high and a 5.4 per cent increase over that of 2003 (CDIAC, 2008).

Source: CDIAC 2008

Box:3.2. Global emissions of carbon dioxide per capita



Global carbon dioxide emissions per capita increased from 0.63 tons annually in 1950 to 1.23 tons in 2007, representing an average growth rate of 1.14 per cent annually.

Source: CDIAC 2008

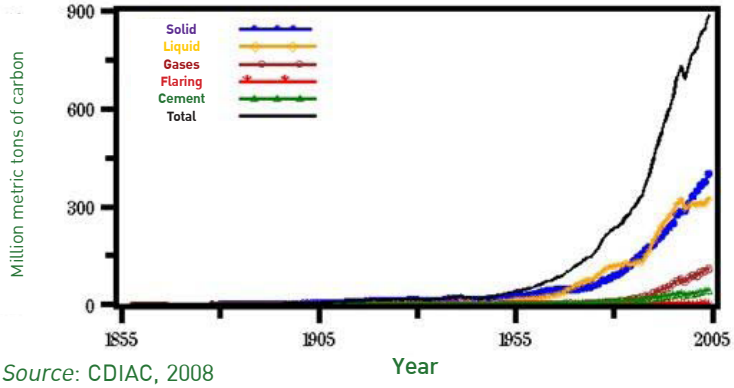
Emissions of carbon dioxide from the combustion of fossil fuels in 27 selected economies of Asia dropped in 1997 and 1998 for the first time since the post-Second World War level recorded in 1947 and 1948, ending a 50-year period of growth averaging approximately 7 per cent per year (CDIAC, 2008).

Such emissions rose to 885 million tons of carbon in 2004, a 31-fold increase over the levels in 1950. The increase in emissions of carbon dioxide since 1948 reflects not only the increased contributions of India, Indonesia and the Republic of Korea, but also of Malaysia, Pakistan, the Philippines, Singapore and Thailand, as well as that of other less populous economies in Asia (see figures 3.1 to 3.3).

India, Indonesia and the Republic of Korea were responsible for 64 per cent of the region's emissions of carbon dioxide from fossil fuel combustion in 2004. Per capita emissions in the region are as low as 0.01 tons of carbon per person per year in Afghanistan and Cambodia, and as high as 6.6 tons in Brunei Darussalam. Of the 22 economies in Asia selected for comparison, 15 have per capita emission levels below the global average of 1.23 tons of carbon per year (CDIAC,2008).

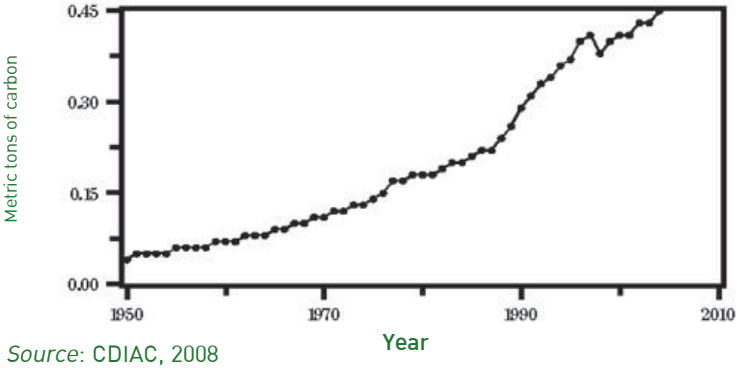
The burning of coal is the major source of carbon dioxide emissions from fossil fuel sources in the region. Over 63 per cent of the coal consumed in the region is burned in India; moreover, India, Indonesia and the Republic of Korea combined account for 61 per cent of the carbon dioxide emissions from the combustion of liquid fuel (CDIAC, 2008).

Figure 3.1. Emissions of carbon dioxide by 27 selected economies in Asia



Source: CDIAC, 2008

Figure 3.2. Emissions of carbon dioxide per capita of selected economies in Asia

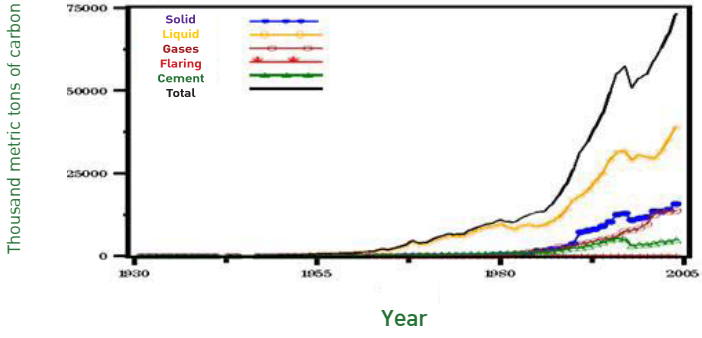


Source: CDIAC, 2008

Thailand

As in other parts of Asia, the emissions of carbon dioxide in Thailand have shown an increasing trend in recent decades, rising from 1.6 tons per year in 1990 to 4.3 tons per capita per year in 2004 (ESCAP, 2007). Although the emissions dropped following the 1997-1998 financial crisis, they started climbing again from 1999 through 2007 (see figure 3.3 and 3.4).

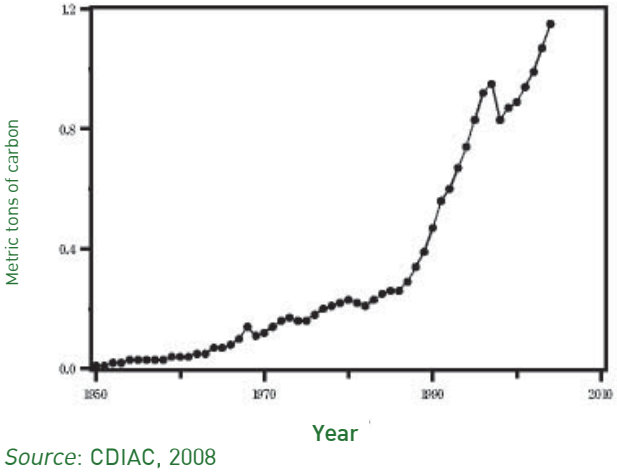
Figure 3.3. Emissions of carbon dioxide by Thailand



Source: CDIAC, 2008

In 2005, Thailand's Ministry of Energy indicated that energy end-use activities accounted for 56 per cent of the total emissions of carbon dioxide in 2003, while emissions resulting from agricultural activities accounted for 24 per cent. Changes in land use and forestry practices accounted for 7 per cent of Thailand's total carbon dioxide emissions, while industrial production accounted for 19 per cent of the total.

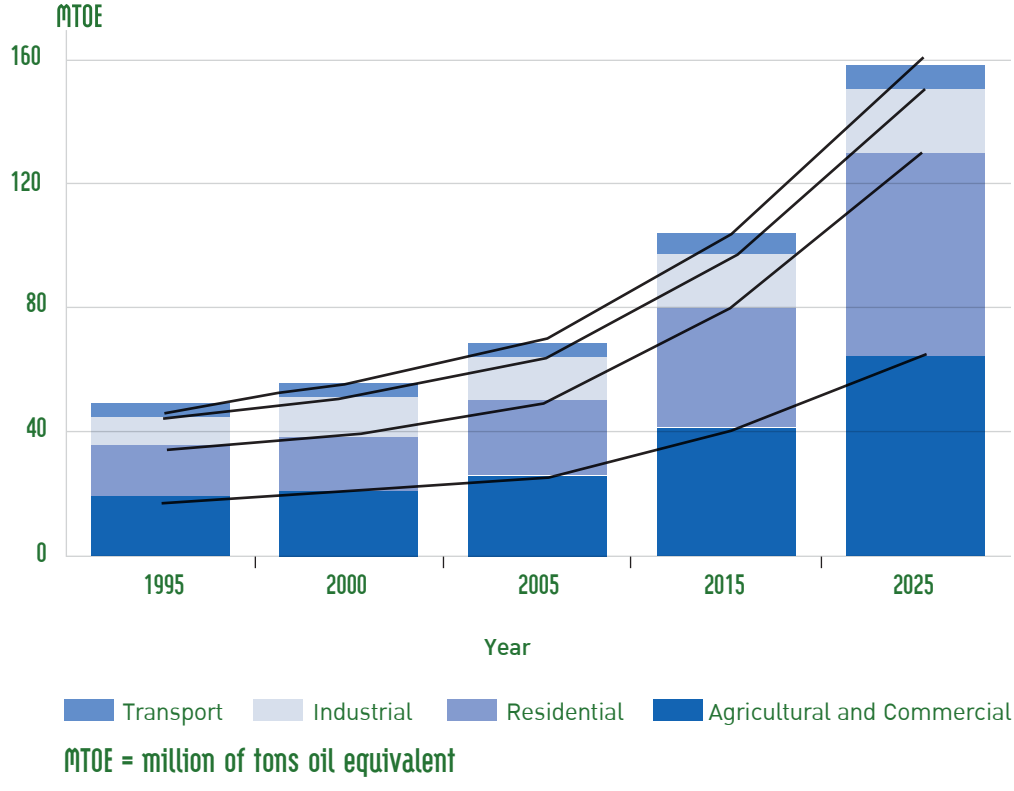
Figure 3.4. Emissions of carbon dioxide per capita by Thailand



Source: CDIAC, 2008

In Thailand, total energy consumption in 2003 was equivalent to 3.1 quadrillion British thermal units (BTUs), comprising oil (53 per cent), natural gas (33 per cent), coal (12 per cent), hydroelectricity (2 per cent), other renewables (1 per cent) (ADB-CAI-Asia 2006). Majority of the energy in Thailand is predominantly consumed in the transport sector which accounts for 79.4 per cent of all fuel consumption that year, or about 25.4 billion liters. Of this, total road based vehicles used more than 99 per cent of total fuel consumed. The main fuel types are gasoline, diesel oil, and jet fuel. In looking forward to 2025 (figure 3.5), the energy demand forecast shows that the demand of the transport sector is expected to reach 64.7 million tons of oil equivalent, nearly of 2.5 times increase from of that of 1995 (Srisurapanon, undated).

Figure 3.5 Final energy demand per sector in the business-as- usual case



Source: Energy Policy and Planning office, Ministry of Energy, 2006

Thailand is a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) and is listed under the non-Annex 1 countries, which includes developing countries that are especially vulnerable to the adverse impacts of climate change and includes countries with low-lying coastal areas, such as Thailand. Therefore, because the Convention emphasizes activities that take into account such countries'special needs and concerns, Thailand is not required to reduce its greenhouse gas emissions.

When compared with industrialized countries and developing economies, Thailand is not a major emitter; it is responsible for only a small fraction of total greenhouse gas emissions worldwide (about 1.0 per cent of the total). In addition, the average per capita emissions in Thailand are lower than the global average of 1.23 tons of carbon (CDIAC, 2008).

Nonetheless, Thailand will suffer the full impacts of climate change even though it contributes only a small amount of greenhouse gases. This is because the nature and severity of climate change impacts are dependent on a number of factors, including a country's geographic location, its local environment, its level of preparedness and the adaptive measures it undertakes.

Bangkok

Owing to Bangkok's preeminent position as Thailand's capital, communications hub, and administrative and business centre, the city accounts for much of the country's emissions of carbon dioxide estimated to be 61.23 million tons in 2007. In 2005, those emissions totaled 43 million tons-a much greater volume than that of Toronto (24 million tons). Although they were lower than the total carbon dioxide emissions of New York City (58 million tons), they were about the same as those of London (44 million tons).

Greenhouse gas emissions per capita reveals that the residents of Bangkok were responsible for producing 7.1 tons of carbon dioxide per annum in 2005, that is, the same level of emissions as produced by New Yorkers (7.1 tons per capita), and considerably higher than the annual emissions of Londoners (5.9 tons per capita) but lower than the levels produced by residents of Toronto (9.6 tons per capita) (see table 3.1).

Table 3.1. Comparison of carbon dioxide emissions of Bangkok and selected cities in developed countries (2005)

City	Millions of tons of carbon dioxide	Tons per capita of carbon dioxide emissions
Bangkok	43	7.1
Toronto	24	9.6
New York	58	7.1
London	44	5.9

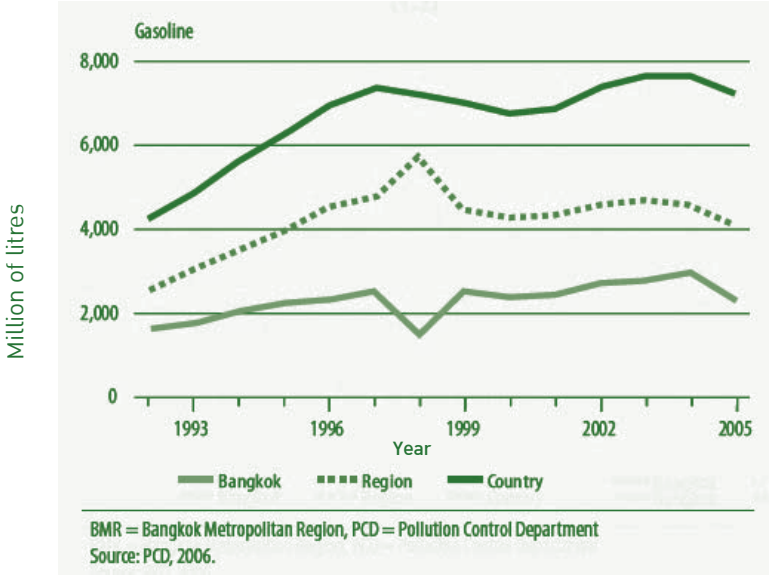
Source: Bangkok Metropolitan Administration, 2007

The principal sources of greenhouse gas emissions in Bangkok are transportation (37.68 per cent) and electricity generation (33.37 per cent) (see table 3.2). The Department of Energy Business, Ministry of Energy, indicated that, in 2007, the transport sector in Bangkok emited almost 23.07 million tons of carbon dioxide per annum from consuming 8,948,683 million litres of gasoline and diesel oil. Electricity used was as high as 29,180 GWh which caused 20.43 million tones of carbon dioxide emissions, accounting for 33.37 per cent of the annual total. Solid waste and waste water emitted 12.16 million tones of carbon dioxide, equivalent to 19.86 per cent of total annual carbon dioxide emission. These three sources contribute 90.91 per cent of the total emissions of greenhouse gases annually. The remaining 9.09 per cent comes from other sources, such as agriculture.

Table 3.2. Greenhouse Gases Emission Inventory of Bangkok City in 2007

Source	Emission (Million tones per year)	Percentage
Electricity	20.43	33.37
Transportation	23.07	37.68
Solid waste and waste water	12.16	19.86
Other	5.57	9.09
Total	**61.23**	**100**

Figure 3.6 Gasoline consumption by the transport sector in BMR and Bangkok



Source: Bangkok Metropolitan Administration

Figure 3.7 Gasohol consumption by the transport sector in BMR and Bangkok

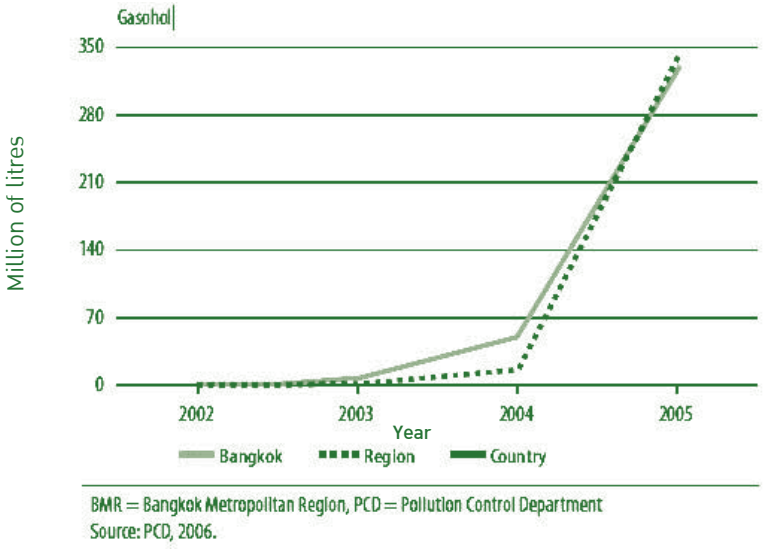
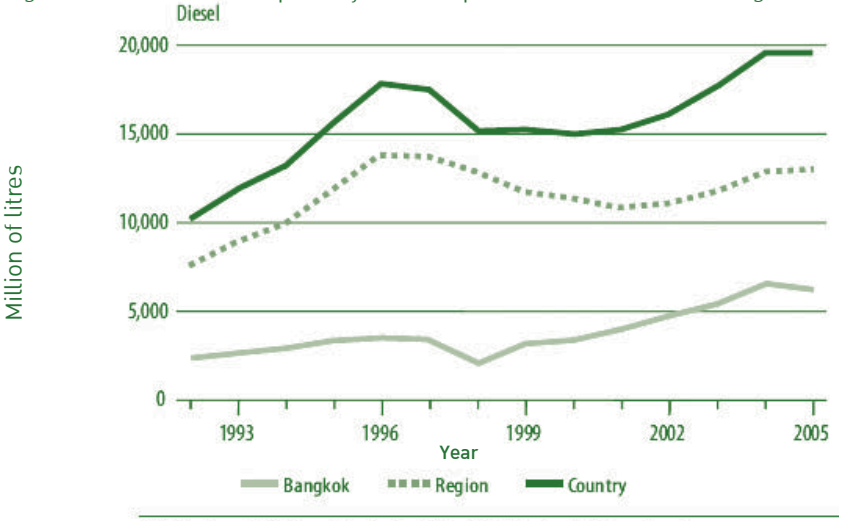
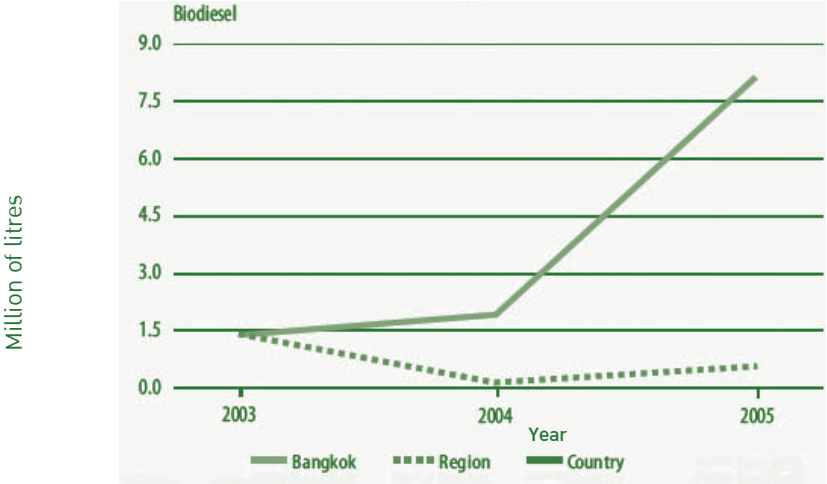


Figure 3.8 Diesel consumption by the transport sector in BMR and Bangkok



BMR = Bangkok Metropolitan Region, PCD = Pollution Control Department
Source: PCD, 2006.

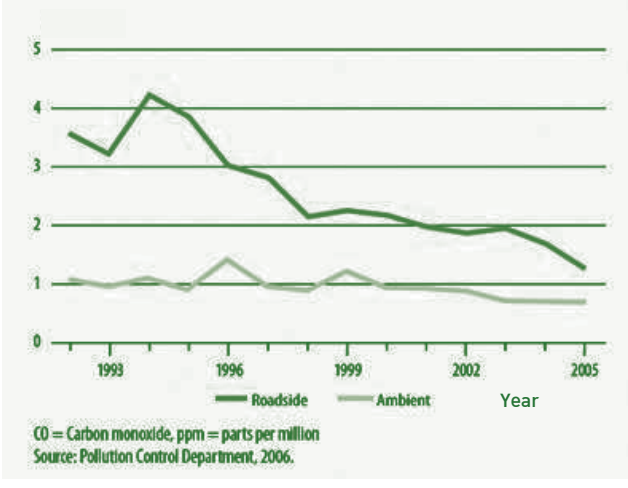
Figure 3.9 Biodiesel consumption by the transport sector in BMR and Bangkok



BMR = Bangkok Metropolitan Region, PCD = Pollution Control Department
Source: PCD, 2006.

Cars are major sources of carbon monoxide (CO), hydrocarbons, and nitrous oxide (NOx). Two-stroke motorcycles are a dominant source of hydrocarbon emission and contribute significantly to particulate matters (PM) and CO emissions but this type of motorcycle is decreasing in number. Diesel trucks (both heavy and light duty) are responsible for high emissions of PM, NOx, CO and hydrocarbon. Despite huge increases in the number of vehicles, CO levels have declined slightly over the last few years due to fleet modernization, enforcement of emission standards, reduced traffic congestion and improvements in fuel quality. Roadside measurements of CO levels in Bangkok from 1992 to 2005 show a steady reduction over a 14-year period (Figure 3.10). Annual ambient levels were not very different from those for 2003 and 2004, while annual roadside level decreased over the same period (ADB and CEI-Asia,2006) .

Figure 3.10 Annual roadside and ambient carbon monoxide (CO) levels in Bangkok 1992-2005

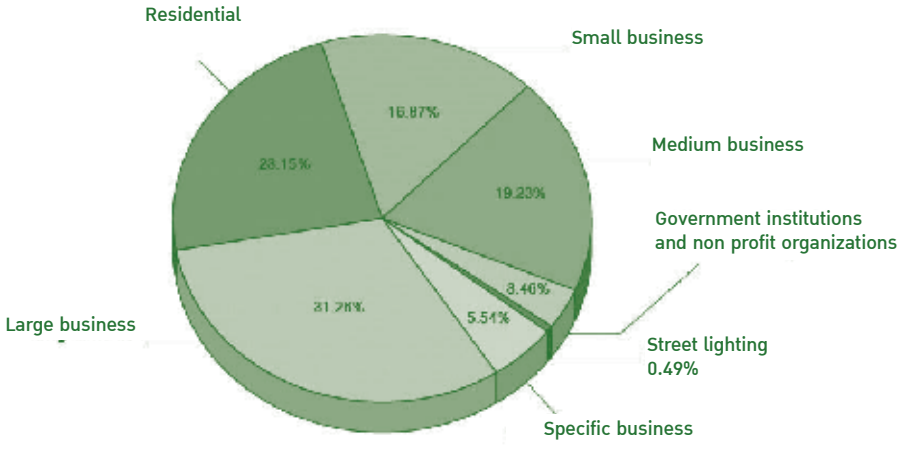


The Bangkok metropolitan urban area consumed approximately 29,200 Gigawatt hours (GWh) of electricity per annum in 2007. Producing this amount of electricity generated 14.86 million tons of carbon dioxide. Electricity consumption in Bangkok has risen from 20,129 GWh in 1998 to 29,180 GWh in 2007, or by an average annual increase of 4.2 per cent. The emission of carbon dioxide related to the consumption of electricity has also risen at the same rate (see table 3.3). Figure 3.11 dipicts the share of electricity consumption by area. The residential category is the second largest after the large business category in Bangkok.

Year	kWh
1998	20,129,448,740
1999	19,614,191,609
2000	21,167,216,600
2001	22,174,739,013
2002	23,302,072,529
2003	24,281,953,324
2004	25,203,305,666
2005	25,674,575,714
2006	28,367,076,323
2007	29,180,095,754

Source: Metropolitan Electricity Authority, 2008.

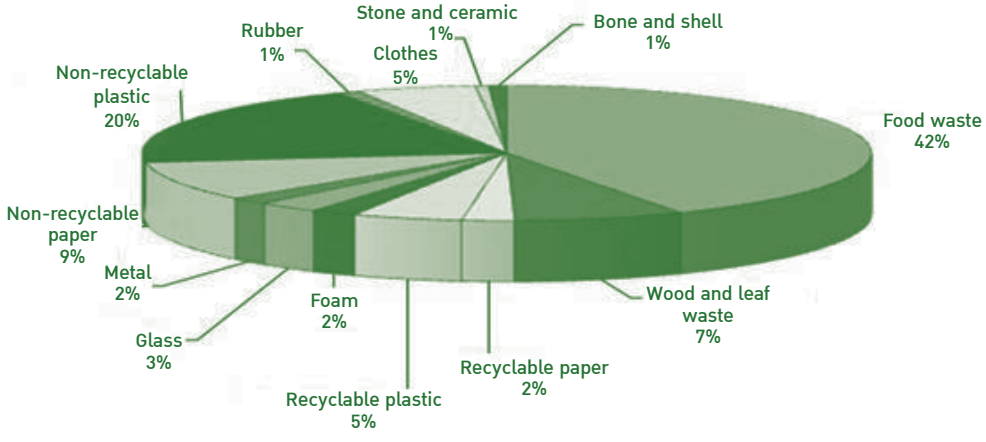
Figure 3.11 Percentage of energy sales within Metropolitan Electricity Authority areas by category in 2007



Source: Metropolitan Electricity Authority, 2007.

Solid waste and waste water are sources of 1.13 million tons of greenhouse gas emissions in Bangkok and account for 3 per cent of the city's total greenhouse gas emissions annually. It has been estimated that solid wastes in the city increased from 6,634 tons per day in 1995 to 8,718 tons per day in 2007, or an average increase of 0.6 tons per annum (see table 3.4). The composition of solid wastes from the Bangkok metropolitan area is shown in figure 3.13; it reveals that food waste accounts for the highest proportion, that is, over 42 per cent of the total (BMA, 2005).

Figure 3.12 Solid waste composition at BMA Transfer Station in 2007



Source: Office Presentation of Department of Environment, BMA 2008

As of 2007, the Bangkok Metropolitan Administration managed approximately 1,900 hectares of park area, including at least 3 million trees. These trees, together with trees on private land, are able to absorb about 100,000 tons of carbon dioxide per year. Thus, the net reduction of greenhouse gases in Bangkok through this means is equivalent to 42.65 million tons of carbon dioxide per year.

Table 3.4 Solid waste generation and collection in Bangkok

Year	Waste collected (tons/day)	Total (tons/year)
1995	6,633.71	2,421,304.15
1996	7,961.12	2,905,808.80
1997	8,694.79	3,173,598.35
1998	8,585.49	3,133,703.85
1999	8,772.49	3,201,958.85
2000	8,988.19	3,280,689.35
2001	9,162.32	3,344,246.80
2002	9,460.40	3,453,046.00
2003	9,349.97	3,412,739.05
2004	9,356.69	3,415,191.85
2005	8,495.97	3,101,029.05
2006	8,376.95	3,057,605.71
2007	8,717.78	3,182,353.68