



3.8 Energy efficiency and emissions

	GDP per unit of energy use		Traditional fuel use		Carbon dioxide emissions					
	PPP \$ per kg oil equivalent		% of total energy use		Total million metric tons		Per capita metric tons		kg per PPP \$ of GDP	
	1980	1997	1980	1996	1980	1996	1980	1996	1980	1996
Albania	..	8.5	13.1	9.3	4.8	1.9	1.8	0.6	..	0.2
Algeria	4.7	5.3	1.9	1.5	66.2	94.3	3.5	3.3	1.1	0.7
Angola	..	2.6	64.9	69.3	5.3	5.1	0.8	0.5	..	0.3
Argentina	4.3	6.9	5.9	3.5	107.5	129.9	3.8	3.7	0.6	0.3
Armenia	..	4.3	..	0.0	..	3.7	..	1.0	..	0.5
Australia	2.0	4.0	3.8	3.7	202.8	306.6	13.8	16.7	1.4	0.8
Austria	3.2	6.7	1.2	3.1	52.2	59.3	6.9	7.4	0.7	0.3
Azerbaijan	..	1.3	..	0.0	..	30.0	..	3.9	..	2.0
Bangladesh	2.9	6.8	81.3	43.3	7.6	23.0	0.1	0.2	0.2	0.1
Belarus	..	2.4	..	0.8	..	61.7	..	6.0	..	1.1
Belgium	2.2	4.1	0.2	0.3	127.2	106.0	12.9	10.4	1.3	0.5
Benin	1.2	2.3	85.4	87.5	0.5	0.7	0.1	0.1	0.3	0.1
Bolivia	..	4.1	19.3	13.4	4.5	10.1	0.8	1.3	..	0.6
Bosnia and Herzegovina	..	..	..	12.7	..	3.1	..	0.9	..	..
Botswana	..	..	35.7	..	1.0	2.1	1.1	1.4	0.7	0.2
Brazil	4.4	6.5	35.5	29.2	183.4	273.4	1.5	1.7	0.4	0.3
Bulgaria	0.8	1.9	0.5	1.2	75.3	55.3	8.5	6.6	3.1	1.3
Burkina Faso	..	..	91.3	87.4	0.4	1.0	0.1	0.1	0.1	0.1
Burundi	..	..	97.0	92.4	0.1	0.2	0.0	0.0	0.1	0.1
Cambodia	..	..	100.0	89.3	0.3	0.5	0.0	0.0	..	0.0
Cameroon	2.3	3.6	51.7	68.8	3.9	3.5	0.4	0.3	0.5	0.2
Canada	1.4	3.0	0.4	0.5	420.9	409.4	17.1	13.8	1.5	0.6
Central African Republic	..	..	88.9	91.4	0.1	0.2	0.0	0.1	0.1	0.1
Chad	..	..	95.9	97.6	0.2	0.1	0.0	0.0	0.1	0.0
Chile	3.0	5.7	12.3	12.7	27.9	48.8	2.5	3.4	1.0	0.4
China	0.7	3.3	8.4	5.6	1,476.8	3,363.5	1.5	2.8	3.6	1.0
Hong Kong, China	5.8	10.6	0.9	0.7	16.3	23.1	3.2	3.7	0.5	0.2
Colombia	4.9	8.2	15.9	22.9	39.8	65.3	1.4	1.7	0.4	0.3
Congo, Dem. Rep.	3.7	2.7	73.9	90.8	3.5	2.3	0.1	0.1	0.1	0.1
Congo, Rep.	1.1	2.2	77.8	52.1	0.4	5.0	0.2	1.9	0.4	1.8
Costa Rica	4.7	7.7	26.3	12.6	2.5	4.7	1.1	1.4	0.3	0.2
Côte d'Ivoire	2.7	4.0	52.8	55.3	4.6	13.1	0.6	0.9	0.5	0.6
Croatia	..	4.0	..	3.4	..	17.5	..	3.9	..	0.6
Cuba	..	..	27.9	26.0	31.0	31.2	3.2	2.8	..	..
Czech Republic	..	3.3	0.6	0.4	..	126.7	..	12.3	..	0.9
Denmark	2.5	6.0	0.4	2.3	62.9	56.6	12.3	10.7	1.3	0.5
Dominican Republic	3.3	6.6	27.5	15.1	6.4	12.9	1.1	1.6	0.6	0.4
Ecuador	2.8	4.6	26.7	14.3	13.4	24.5	1.7	2.1	0.9	0.6
Egypt, Arab Rep.	2.8	4.7	4.7	3.5	45.2	97.9	1.1	1.7	1.0	0.6
El Salvador	4.0	5.9	52.9	36.5	2.1	4.0	0.5	0.7	0.2	0.2
Eritrea	..	..	..	..	..	..	..	..	..	..
Estonia	..	2.0	..	2.8	..	16.4	..	11.2	..	1.6
Ethiopia	1.3	2.1	89.6	93.0	1.8	3.4	0.0	0.1	0.1	0.1
Finland	1.6	3.2	4.3	5.1	54.9	59.2	11.5	11.5	1.3	0.6
France	2.7	5.0	1.3	1.0	482.7	361.8	9.0	6.2	0.9	0.3
Gabon	2.0	4.5	30.8	32.6	4.9	3.7	7.1	3.3	1.6	0.5
Gambia, The	..	..	72.7	78.6	0.2	0.2	0.2	0.2	0.3	0.1
Georgia	7.0	7.9	..	1.4	..	3.0	..	0.5	..	0.2
Germany	..	5.2	0.3	0.3	..	861.2	..	10.5	..	0.5
Ghana	2.7	4.5	43.7	78.1	2.4	4.0	0.2	0.2	0.2	0.1
Greece	4.0	5.7	3.0	1.2	51.7	80.6	5.4	7.7	0.8	0.6
Guatemala	3.9	6.5	54.6	58.6	4.5	6.8	0.7	0.7	0.3	0.2
Guinea	..	..	71.4	72.4	0.9	1.1	0.2	0.2	..	0.1
Guinea-Bissau	..	..	80.0	57.1	0.1	0.2	0.2	0.2	0.5	0.2
Haiti	3.4	5.9	80.7	80.5	0.8	1.1	0.1	0.1	0.1	0.1
Honduras	2.7	4.7	55.3	50.0	2.1	4.0	0.6	0.7	0.4	0.3



Energy efficiency and emissions 3.8

	GDP per unit of energy use		Traditional fuel use		Carbon dioxide emissions					
	PPP \$ per kg oil equivalent		% of total energy use		Total million metric tons		Per capita metric tons		kg per PPP \$ of GDP	
	1980	1997	1980	1996	1980	1996	1980	1996	1980	1996
Hungary	1.9	4.0	2.0	1.5	82.5	59.5	7.7	5.8	1.5	0.6
India	1.8	4.2	31.5	21.2	347.3	997.4	0.5	1.1	0.8	0.5
Indonesia	2.0	4.5	51.5	28.7	94.6	245.1	0.6	1.2	0.8	0.4
Iran, Islamic Rep.	2.7	3.0	0.4	0.9	116.1	266.7	3.0	4.4	1.1	0.9
Iraq	..	..	0.3	0.1	44.0	91.4	3.4	4.3	..	..
Ireland	2.2	6.0	0.0	0.2	25.2	34.9	7.4	9.6	1.4	0.5
Israel	3.3	5.8	0.0	0.0	21.1	52.3	5.4	9.2	0.7	0.5
Italy	3.7	7.3	0.8	0.8	371.9	403.2	6.6	7.0	0.7	0.3
Jamaica	1.7	2.2	5.0	6.3	8.4	10.1	4.0	4.0	2.1	1.1
Japan	3.0	6.0	0.1	0.4	920.4	1,167.7	7.9	9.3	0.9	0.4
Jordan	2.3	3.3	0.0	0.0	..	..	..	..	..	..
Kazakhstan	..	1.8	..	0.1	..	173.8	..	10.9	..	2.5
Kenya	1.0	2.0	76.8	78.9	6.2	6.8	0.4	0.2	0.6	0.2
Korea, Dem. Rep.	..	..	3.1	1.5	124.9	254.3	7.1	11.3	..	..
Korea, Rep.	2.5	3.9	4.0	0.7	125.2	408.1	3.3	9.0	1.2	0.6
Kuwait	..	..	0.0	0.0	..	..	..	..	..	..
Kyrgyz Republic	..	3.8	..	0.0	..	6.1	..	1.3	..	0.6
Lao PDR	..	..	72.3	86.5	0.2	0.3	0.1	0.1	..	0.0
Latvia	18.3	3.1	..	24.1	..	9.3	..	3.7	..	0.7
Lebanon	..	3.3	2.4	2.8	6.2	14.2	2.1	3.5	..	0.9
Lesotho	..	..	..	..	..	..	..	..	..	..
Libya	..	..	2.3	0.9	26.9	40.6	8.8	8.0	..	..
Lithuania	..	2.6	..	5.9	..	13.8	..	3.7	..	0.6
Macedonia, FYR	..	..	..	5.2	..	12.7	..	6.4	..	1.5
Madagascar	..	..	78.4	85.6	1.6	1.2	0.2	0.1	0.3	0.1
Malawi	..	..	90.6	89.7	0.7	0.7	0.1	0.1	0.3	0.1
Malaysia	3.2	4.0	15.7	6.0	28.0	119.1	2.0	5.6	0.8	0.6
Mali	..	..	86.7	88.6	0.4	0.5	0.1	0.0	0.1	0.1
Mauritania	..	..	0.0	0.0	0.6	2.9	0.4	1.2	0.4	0.8
Mauritius	..	..	59.1	32.4	0.6	1.7	0.6	1.5	0.3	0.2
Mexico	2.9	5.1	5.0	5.6	251.6	348.1	3.7	3.8	0.9	0.5
Moldova	..	2.1	..	0.5	..	12.1	..	2.8	..	1.3
Mongolia	..	..	14.4	3.8	6.8	8.9	4.1	3.6	3.8	2.4
Morocco	6.4	9.5	5.2	4.8	15.9	27.9	0.8	1.0	0.5	0.3
Mozambique	0.6	1.6	43.7	91.4	3.2	1.0	0.3	0.1	0.6	0.1
Myanmar	..	..	69.3	63.9	4.8	7.3	0.1	0.2	..	..
Namibia	..	..	..	..	..	..	..	..	..	..
Nepal	1.5	3.7	94.2	90.9	0.5	1.6	0.0	0.1	0.1	0.1
Netherlands	2.1	4.6	0.0	0.1	152.6	155.2	10.8	10.0	1.1	0.5
New Zealand	2.9	4.0	0.2	0.0	17.6	29.8	5.6	8.0	0.6	0.4
Nicaragua	3.0	3.9	49.2	43.4	2.0	2.9	0.7	0.6	0.4	0.3
Niger	..	..	79.5	80.0	0.6	1.1	0.1	0.1	0.2	0.2
Nigeria	0.7	1.1	66.8	69.0	68.1	83.3	1.0	0.7	1.9	0.9
Norway	2.2	4.8	0.4	10.1	90.4	67.0	22.1	15.3	2.2	0.6
Oman	..	..	0.0	..	5.9	15.1	5.3	7.0	..	..
Pakistan	2.0	3.9	24.4	17.3	31.6	94.3	0.4	0.8	0.6	0.4
Panama	2.8	6.1	26.6	18.6	3.5	6.7	1.8	2.5	0.7	0.5
Papua New Guinea	..	..	65.4	62.5	1.8	2.4	0.6	0.5	0.5	0.2
Paraguay	4.0	5.5	62.0	47.5	1.5	3.7	0.5	0.7	0.2	0.2
Peru	4.0	7.3	15.2	27.2	23.6	26.2	1.4	1.1	0.5	0.3
Philippines	5.1	7.2	37.0	31.7	36.5	63.2	0.8	0.9	0.3	0.2
Poland	1.0	2.7	0.4	0.4	456.2	356.8	12.8	9.2	3.7	1.3
Portugal	5.1	7.1	1.2	0.9	27.1	47.9	2.8	4.8	0.5	0.3
Puerto Rico	..	..	0.0	..	14.0	15.8	4.4	4.2	..	..
Romania	1.4	3.2	1.3	4.7	191.8	119.3	8.6	5.3	2.1	0.8
Russian Federation	..	1.7	..	1.1	..	1,579.5	..	10.7	..	1.5



3.8 Energy efficiency and emissions

	GDP per unit of energy use		Traditional fuel use		Carbon dioxide emissions					
	PPP \$ per kg oil equivalent		% of total energy use		Total million metric tons		Per capita metric tons		kg per PPP \$ of GDP	
	1980	1997	1980	1996	1980	1996	1980	1996	1980	1996
Rwanda	..	..	89.8	88.3	0.3	0.5	0.1	0.1	..	..
Saudi Arabia	2.8	2.1	0.0	0.0	130.7	267.8	14.0	13.8	1.3	1.3
Senegal	2.1	4.1	50.8	56.3	2.8	3.1	0.5	0.4	0.7	0.3
Sierra Leone	..	..	90.0	84.2	0.6	0.4	0.2	0.1	0.3	0.2
Singapore	2.1	2.9	0.4	0.0	30.1	65.8	13.2	21.6	2.4	0.9
Slovak Republic	..	3.0	..	0.6	..	39.6	..	7.4	..	0.8
Slovenia	..	4.4	..	0.9	..	13.0	..	6.5	..	0.5
South Africa	2.5	3.3	4.9	..	211.3	292.7	7.7	7.3	1.3	0.8
Spain	3.5	5.9	0.4	0.7	200.0	232.5	5.3	5.9	0.8	0.4
Sri Lanka	3.3	7.6	53.5	48.0	3.4	7.1	0.2	0.4	0.2	0.1
Sudan	1.5	3.3	86.9	76.5	3.3	3.5	0.2	0.1	0.3	0.1
Sweden	2.0	3.5	7.7	16.2	71.4	54.1	8.6	6.1	0.9	0.3
Switzerland	4.0	6.9	0.9	1.6	40.9	44.2	6.5	6.3	0.5	0.2
Syrian Arab Republic	2.9	3.0	0.0	0.0	19.3	44.3	2.2	3.1	1.3	1.0
Tajikistan	..	1.6	..	..	..	5.8	..	1.0	..	1.0
Tanzania	..	1.0	92.0	91.4	1.9	2.4	0.1	0.1	..	0.2
Thailand	2.9	4.7	40.3	30.0	40.0	205.4	0.9	3.4	0.6	0.5
Togo	..	..	35.7	71.0	0.6	0.8	0.2	0.2	0.2	0.1
Trinidad and Tobago	1.4	1.2	1.4	0.8	16.7	22.2	15.4	17.5	3.1	2.4
Tunisia	3.7	7.2	16.1	12.7	9.4	16.2	1.5	1.8	0.6	0.3
Turkey	3.3	5.7	20.5	3.4	76.3	178.3	1.7	2.9	0.7	0.5
Turkmenistan	..	1.0	..	..	..	34.2	..	7.4	..	2.4
Uganda	..	..	93.6	90.6	0.6	1.0	0.1	0.1	0.1	0.0
Ukraine	..	1.1	..	0.4	..	397.3	..	7.8	..	2.3
United Arab Emirates	2.9	1.7	0.0	..	36.3	81.8	34.8	33.3	1.5	1.6
United Kingdom	2.4	5.3	0.0	0.9	583.8	557.0	10.4	9.5	1.2	0.5
United States	1.6	3.6	1.3	3.6	4,575.4	5,301.0	20.1	20.0	1.6	0.7
Uruguay	4.9	9.7	11.1	26.0	5.8	5.6	2.0	1.7	0.4	0.2
Uzbekistan	..	1.1	..	0.0	..	95.0	..	4.1	..	2.0
Venezuela, RB	1.7	2.4	0.9	0.8	89.6	144.5	5.9	6.5	1.5	1.1
Vietnam	..	3.2	49.1	40.5	16.8	37.6	0.3	0.5	..	0.3
West Bank and Gaza	..	..	..	..	..	..	..	..	..	..
Yemen, Rep.	..	3.5	0.0	2.0	..	..	..	..	..	..
Yugoslavia, FR (Serb./Mont.)	..	..	1.6	2.0	..	..	..	..	..	..
Zambia	0.8	1.2	37.4	73.1	3.5	2.4	0.6	0.3	1.0	0.3
Zimbabwe	1.6	3.1	27.6	23.4	9.6	18.4	1.4	1.6	1.0	0.6
World	.. w	.. w	7.4 w	7.2 w	13,640.7 t	22,653.9 t	3.4 w	4.0 w	1.2 w	0.6 w
Low income	..	..	26.3	19.5	2,251.0	5,306.2	0.9	1.6	1.6	0.7
Excl. China & India	..	..	59.9	48.1	302.0	690.9	0.4	0.6	0.6	0.4
Middle income	..	..	11.5	6.0	2,679.6	6,617.1	3.2	4.7	1.0	0.7
Lower middle income	..	..	12.3	5.5	1,025.2	3,940.6	2.5	4.6	1.0	0.9
Upper middle income	..	..	9.4	6.7	1,654.4	2,676.6	4.0	4.7	1.0	0.6
Low & middle income	..	..	18.6	12.2	4,930.6	11,923.3	1.5	2.5	1.2	0.7
East Asia & Pacific	..	..	15.0	10.0	1,958.5	4,717.5	1.4	2.7	2.1	0.8
Europe & Central Asia	..	2.2	3.1	1.2	886.9	3,412.7	..	7.4	2.2	1.3
Latin America & Carib.	..	..	18.2	16.3	848.5	1,209.1	2.4	2.5	0.6	0.4
Middle East & N. Africa	..	3.3	1.6	1.2	493.9	987.2	3.0	3.9	1.1	0.8
South Asia	..	..	34.8	23.0	392.4	1,125.1	0.4	0.9	0.7	0.5
Sub-Saharan Africa	..	..	47.3	73.3	350.4	471.7	0.9	0.8	1.0	0.5
High income	..	..	1.0	2.4	8,710.2	10,730.6	12.3	12.3	1.2	0.5
Europe EMU	2.9	5.5	0.7	0.8	1,504.4	2,329.5	7.6	8.0	0.9	0.4



Energy efficiency and emissions 3.8

About the data

The ratio of GDP to energy use provides a measure of energy efficiency. In estimating this ratio, previous editions of the *World Development Indicators* used GDP in 1995 U.S. dollars. This year's edition adopts GDP converted to international dollars using purchasing power parity (PPP) rates to produce comparable and consistent estimates of real GDP across countries relative to physical inputs to GDP—that is, units of energy use. Differences in this ratio over time and across countries reflect in part structural changes in the economy, changes in the energy efficiency of particular sectors of the economy, and differences in fuel mixes.

The data on traditional fuel are from the United Nations Statistics Division's *Energy Statistics Yearbook*. This series differs from those published in previous editions of the *World Development Indicators*, which came from other sources.

Carbon dioxide (CO₂) emissions, largely a by-product of energy production and use (see table 3.7), account for the largest share of greenhouse gases, which are associated with global warming. Anthropogenic CO₂ emissions result primarily from fossil fuel combustion and cement manufacturing. In combustion, different fossil fuels release different amounts of CO₂ for the same level of energy use. Burning oil releases about 50 percent more CO₂ than burning natural gas, and burning coal releases about twice as much. During cement manufacturing about half a metric ton of CO₂ is released for each ton of cement produced.

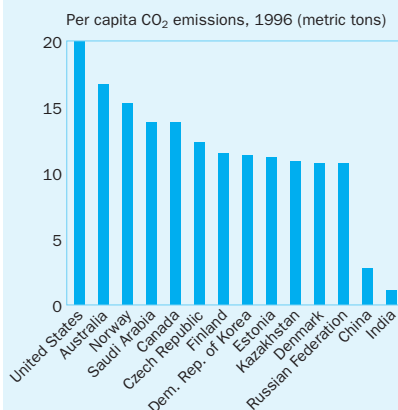
The Carbon Dioxide Information Analysis Center (CDIAC), sponsored by the U.S. Department of Energy, calculates annual anthropogenic emissions of CO₂. These calculations are derived from data on fossil fuel consumption, based on the World Energy Data Set maintained by the United Nations Statistics Division, and from data on world cement manufacturing, based on the Cement Manufacturing Data Set maintained by the U.S. Bureau of Mines. Emissions of CO₂ are often calculated and reported in terms of their content of elemental carbon. For this table these values were converted to the actual mass of CO₂ by multiplying the carbon mass by 3.664 (the ratio of the mass of carbon to that of CO₂).

Although the estimates of global CO₂ emissions are probably within 10 percent of actual emissions (as calculated from global average fuel chemistry and use), country estimates may have larger error bounds. Trends estimated from a consistent time series tend to be more accurate than individual values. Each year the CDIAC recalculates the entire time series from 1950 to the present, incorporating its most recent findings and the latest corrections to its database. Estimates do not include fuels supplied to ships and

aircraft engaged in international transport because of the difficulty of apportioning these fuels among the countries benefiting from that transport.

Figure 3.8a

Carbon dioxide emissions vary widely across countries

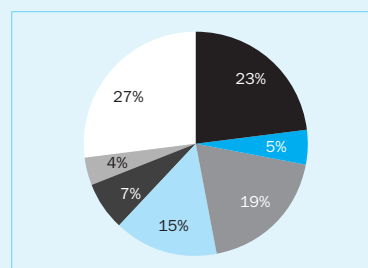


Source: Table 3.8.

Figure 3.8b

High-income countries account for most of the world's carbon dioxide emissions

CO₂ emissions, 1996



- United States
- Japan
- Other high-income countries
- China
- Russian Federation
- India
- Rest of world

Source: Table 3.8.

Definitions

- **GDP per unit of energy use** is the PPP GDP per kilogram of oil equivalent of commercial energy use. PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as a U.S. dollar has in the United States.
- **Traditional fuel use** includes estimates of the consumption of fuelwood, charcoal, bagasse, and animal and vegetable wastes. Total energy use comprises commercial energy use (see table 3.7) and traditional fuel use.
- **Carbon dioxide emissions** are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.

Data sources

The underlying data on commercial energy production and use are from International Energy Agency electronic files. The data on traditional fuel are from the United Nations Statistics Division's *Energy Statistics Yearbook*. The data on CO₂ emissions are from the Carbon Dioxide Information Analysis Center, Environmental Sciences Division, Oak Ridge National Laboratory, in the U.S. state of Tennessee.