Atmosphere and Climate

Sources: International Energy Agency, Carbon Dioxide Information Analysis Center (CDIAC), National Institute for Public Health (RIVM) and Netherlands Organization for Applied Scientific Research (TNO).

	Carbon Dioxide (CO2) Emissions					Emissions of		CO2 Emisions by Economic Sector				Carbon Intensity Indicators: CO2 Emissions per GDP (PPP)			
	Total		Per Capita		Cum-ulative	Methane	Nitrous Oxide			Road Trans	Public Electricity	(tons CO2 per million $ intl)			
	(million metric tons)	(percent change since	(metric tons per person)	(percent change since	since 1900 (billion	(000 metric tons CO2 equivalent)		Industry	Resid-ential	portation	and Heat	All Economic Sectors		Industry Sector	
						(million metric tons)									
	1999	1990)	1999	1990)	metric tons)	1999	1999	1999	1999	1999	1999	1999	1990	1999	1990
Iran, Islamic Rep	263.2	45.6	3.8	23.0	6,267	67	53	58.4	45.5	66.4	62.1	780	760	317	243
Iraq	81.1	47.7	3.6	14.5	1,863	9	6	17.2	6.4	25.9	16.2	2,820	1,180	X	X
Israel	55.9	58.2	9.5	20.8	1,105	1	2	6.0	1.9	9.5	30.9	520	510	X	X
Jordan	13.4	43.1	2.8	(2.8)	249	1	1	2.0	1.7	3.3	4.9	740	820	167	155
Kuwait	46.5	122.0	25.2	157.4	1,112	7	0	15.1	3.0	6.0	21.2	1,960	1,180	X	X
Lebanon	15.6	143.6	4.5	92.8	288	1	1	2.9	1.9	4.2	6.7	870	720	243	X
Oman	21.1	104.3	8.6	48.3	277	2	1	5.7	0.2	2.5	6.3	520	380	X	56
Saudi Arabia	216.6	35.1	11.0	5.9	5,430	51	9	41.6	3.3	29.7	57.1	1,030	920	X	92
Syrian Arab Rep	48.1	49.8	3.0	17.4	810	6	8	9.7	2.3	3.7	11.2	940	1,050	255	134
Turkey	182.8	32.2	2.8	13.0	3,668	25	41	43.3	22.1	29.9	56.8	470	470	161	127
United Arab Emirates	67.1	59.8	26.2	25.8	1,896	26	1	30.0	0.3	5.4	28.3	1,350	1,010	X	334
Yemen	8.6	17.9	0.5	(22.6)	278 a	6	5	0.5	1.6	3.9	1.3	660	730	X	X

An "X" indicates that data are not available. a. Emissions prior to 1980 are estimates

Sources and Technical Notes

VARIABLE DEFINITIONS:
Total Carbon Dioxide ($C0_2$) Emissions and **Per Capita CO_2 Emissions** include the total and the average emissions of carbon dioxide per person, respectively, from combustion of all fossil fuels used by a country.
Cumulative CO_2 contribution since 1900 consists of the sum of CO_2 produced during the consumption of solid, liquid, and gaseous fuels, gas flaring, and the manufacture of cement from 1900 to year 2000. The variable does not include emissions from land use change or bunker fuels used in international transportation.
Methane and Nitrous Oxide emissions include emissions, in thousand metric tons of CO_2 equivalent, from energy, agriculture, waste and other sources. Emissions from energy comprise the production, handling, transmission, and combustion of fossil and biofuels (IPCC categories 1A and 1B). Agriculture comprises animals, animal wastes, rice production, agricultureal waste burning not intended for energy production, and savanna burning (IPCC category 4). Waste includes emissions from landfills, wastewater treatment, human wastewater disposal, and waste incineration not intended for energy production (IPCC category 6). Other sources include industrial process emissions and tropical and temperate forest fires (IPCC categories 2 and 5).
CO_2 emissions by economic sector represents total emissions from fossil fuel burning by individual economic sectors. It is important to note that emissions from electricity generation are not distributed to end users, but is treated as an independent sector. **Industry** represents CO_2 emissions from manufacturing industries and construction. Carbon dioxide emissions from **residential** sources include emissions from combustion of all fossil fuel types in households. **Road transportation** refers to emission from all road vehicles and and agricultural vehicles while they are on highways. Emissions from **public electricity and heat** production include the sum of emissions from combustion of all fossil fuel types used for public electricity generation, public combined heat and power generation, and public heat plants. Public utilities are defined as those undertakings whose primary activity is to supply the public. Emissions from electricity and heat production for use by the producer (autoproduction) are not included in this variable.
Carbon intensity indicators: All economic sectors is the amount of CO_2 emitted per amount of GDP in PPP terms generated by the country's economy. This measure provides an indicator of how efficiently, in greenhouse gas emission terms, a country's overall economy is able to generate wealth.
Industrial sector is the amount of CO_2 emitted by the industry sector per amount of income generated by the industrial sector. The industry sector is defined as including International Standard Industrial Classification (ISIC) divisions 15-37. This measure provides an indicator of how efficiently, in greenhouse gas emission terms, a country's industrial sector is able to generate wealth.

FREQUENCY OF UPDATE BY DATA PROVIDERS:
The IEA, World Bank, CDIAC, and IEA update their data annually. RIVM calculates emissions of methane and nitrous oxide periodically. The UN Population Division updates population data every other year. Most data providers revise past data; data may therefore differ from those reported in past editions of *World Resources*.

METHODOLOGY:
IEA CO_2 Emissions Data:
The CO_2 emissions presented here are based on the International Energy Agency's (IEA) energy data gathered and rectified for their *Energy Balances of OECD Countries* and *Energy Balances of non-OECD Countries* databases (please see the notes for the Energy and Resource Use table in this book for more information on how these data are gathered and adjusted). Methods and emissions factors are spelled out in the Revised 1996 International Panel on Climate Change (IPCC)Guidelines for National Greenhouse Gas Inventories Guidelines available at http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm. The IPCC allows countries to use either the reference or the sectoral approach when reporting their emissions. The figures provided here are based on the reference approach, which calculates emissions using data on a country's energy supply, and captures emissions from refining, flaring, and other "fugitive emissions" that do not result directly from end-use fossil fuel combustion. The sectoral approach estimates emissions based on the combustion rather than supply of fossil fuels.

The Reference Approach is calculated by accounting for the carbon in fuels supplied to the economy. Primary fuels (fuels which are found in nature such as oil, coal, and natural gas) and secondary fuels (fuels or fuel products that are derived from primary fuels such as gasoline, gasified coal, and lubricants) are distinguished. Apparent consumption of fuels is calculated using production minus exports plus imports. Net stock changes are either added or subtracted. International marine and aviation bunkers (fuels used for international transport) are subtracted from the national total as well, as these figures are accounted for separately. The production of secondary fuels is not accounted for, as the carbon contained in those fuels is already included in the primary fuel. Imports and exports of secondary fuels, however, are included in the calculations.

Some additional issues in the accounting methodology include stored carbon resulting from the use of a fuel as a feedstock for a non-energy use such as plastics manufacture or bitumen for road construction. Stored carbon is subtracted from the total carbon emissions. Emissions from biomass fuels are not included in these estimates because the IPCC assumes emission from these fuels to equal sequestration during regrowth.

Cumulative CO_2 contribution since 1900:

WRI calculates cumulative CO_2 emissions levels based on CDIAC's CO_2 emissions data from 1900 to 1980 and on the Energy Information Administration data from 1980 to 2000. CDIAC and EIA both report CO_2 emissions as the weight of the elemental carbon portion of CO_2; WRI converted the values to the actual mass of CO_2 by multiplying the carbon mass by 3.664 (the ratio of the mass of CO_2 to that of carbon).

CDIAC bases CO_2 emissions from before 1950 on several compilations of fossil fuel production and trade: "World Energy Production 1800-1985" by Etemad et al. and four regional volumes of "International Historical Statistics" authored by B.R. Mitchell. Emissions from 1950 to the present estimates are derived primarily from energy statistics published by the United Nations in their "Energy Statistics Yearbook". The statistics are compiled from annual questionnaires. UN gas flaring estimates are supplemented with data from the U.S. Energy Information Administration, G. Marland at CDIAC, and a 1974 paper authored by R.M. Rotty entitled "First estimates of global flaring of natural gas".

Emissions are calculated from data on fuel production, trade, and net apparent consumption by CDIAC. For further information on the data, methodology, and sources used, please consult following the web page: http://cdiac.esd.ornl.gov/trends/emis/meth_reg.htm. A complete record of the formulas and assumptions used to calculate CO_2 emissions is available on-line at http://cdiac.esd.ornl.gov/trends/emis/factors.htm.

Methane and Nitrous Oxide Emissions
EDGAR uses activity data taken from international statistical data to estimate emissions of the individual gasses reported by the database. This helps to ensure that the data will be internationally comparable. For the sources, used for each element of the analysis, please refer to the documentation provided with the data downloads at the EDGAR site: http://www.rivm.nl/env/int/coredata/edgar/index.html.

All activity data were multiplied by emissions factors specific to that activity. Emissions factors were primarily taken from Olivier et al. (1999). Various factors were taken from other sources, including international and national-level ones. For more information, see Olivier, J.G.J., Bouwman, A.F., Berdowski, J.J.M., Veldt, C., Bloos, J.P.J., Visschedijk, A.J.H., Van der Maas, C.W.M. and P.Y.J. Zandveld (1999) Sectoral emission inventories of greenhouse gases for 1990 on a per country basis as well as on 1o x 1o. Environmental Science & Policy, 2, 241-264.

Carbon Intensity Indicators: All Sectors
WRI calculated CO2 emissions per GDP PPP using IEA data to divide total CO_2 emissions by total GDP in PPP terms. IEA's GDP PPP data were used as they had already been converted into constant dollar terms.

Gross Domestic Product (GDP), PPP in constant 1995 international dollars is gross domestic product converted to international dollars using Purchasing Power Parity (PPP) rates, and rescaled to 1995 to give a common reference year. An international dollar has the same purchasing power in a given country as a United States dollar in the United States. In other words, an international dollar buys an equivalent amount of goods or services in all countries. Please see the technical notes for the Economics Indicator table for more information on how data for GDP PPP is gathered and how the figures are calculated.

Carbon Intensity Indicators: Industrial Sector
Industry GDP in PPP terms was calculated by multiplying GDP PPP (see above) and the percent of GDP generated by industry provided by *World Development Indicators*. Industry CO_2 emissions are based on IEA data adjusted for the fact that the definition of industry and manufacturing used by the IEA is broader than that used by the World Bank. The World Bank defines the sector as including International Standard Industrial Classification (ISIC) divisions 15-37 please see http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=17 for more information on ISIC classifications). WRI subtracted emissions from mining and quarrying (ISIC Divisions 13-14) and construction (ISIC division 45) from IEA's total industrial CO_2 emissions in order to closely align the definitions. The only differences remaining are that the World Bank definition includes the manufacture of coke, petroleum products, and other derived fossil fuels (ISIC division 23), manufacture of coke oven products (ISIC group 231), manufacture of refined petroleum products (ISIC group 232), and processing of nuclear fuels. According to the IEA, however, the emissions from these activities are captured by the allocation of the energy contained in the original fuels to the industry that uses them. The differences remaining between the World Bank and IEA definitions of the industry and manufacturing sector should therefore be small. After the definitions of Industry GDP in PPP terms and CO_2 emissions from industry were aligned, CO_2 was divided by GDP PPP.

DATA RELIABILITY AND CAUTIONARY NOTES:
CO_2 Emissions Data:
The IEA CO_2 emissions data are based on well-established and institutionalized accounting methodologies and undergo thorough review and adjustments. The reference and sectoral approaches will, in most cases, give very similar results. However, because the reference approach is calculated using energy supply, it can lead to slight overestimates. For some countries, especially developing countries, statistical differences in basic data or

unexplained differences in the two approaches can lead to significant discrepancies. This can cause the data reported in this volume to differ from the data reported by a country to the IPCC. Individual country and the IEA estimates of national fossil fuel emissions may also differ due to other reasons including different energy figures and differences methods of calculation such as the treatment of bunker fuels. Potential differences in energy statistics result from extensive IEA efforts to create an energy database representing as true an estimate of energy statistics for each country as possible. These statistics, which are then used to calculate GHG emissions, can differ from the national statistics held by individual countries and lead to discrepancies. In addition to unexplained differences between IEA and country estimates, there are numerous potential reasons for differences that can be explained. These reasons include IEA's use of average net calorific values instead of more specific ones that a country can sometimes apply, different treatments of military emissions, and the inability to allocate emissions from autoproducers into end-use sectors. The latter should not affect the total emissions for a country, however.

Cumulative CO_2 contribution since 1900:
The share of carbon emissions for recently formed countries such as the independent republics of the former Soviet Union is estimated based on each country's CO_2 emissions in the years immediately following its formation. For example, Kazakhstan was formed in 1992. Total 1992-1996 emissions for the former Soviet Union were 3,802,544 tons; Kazakhstan's emissions from 1992-1996 were 6.3% of this total. It is then assumed that Kazakhstan produced roughly 6.3% of the carbon emitted in the former Soviet Union each year before 1992. As a result, total contributions from the former Soviet republics, the former Yugoslav republics, and other newly-formed countries should be taken only as rough approximations.

Methane and Nitrous Oxide Emissions
The methane and nitrous oxide emissions data are calculated using a standardized methodology and reviewed for accuracy by the UNFCCC. The data can therefore be use with considerable confidence in their accuracy.

Carbon Intensity Indicators
While CO_2 emissions per GDP PPP is a useful indicator of greenhouse gas efficiency at the scale of the entire economy, it does not necessarily indicate how efficient the individual elements that make up the economy are. For example, it does not differentiate between economies that are more focused on industry as opposed to services, which are generally require less energy and generate comparatively more income than industry. Interpretation of between-country comparisons should therefore be made with care. In addition, a number of countries, particularly rapidly-developing countries, over-report GDP and the rate of GDP growth in their countries. This tendency will serve to make those countries appear more efficient than they actually are. Given the close match achieved between the World Bank and IEA's definitions when calculating the **industrial sector** indicator, the results of WRI's calculation can serve as an acceptable indicator of energy efficiency in the industry sector. However, the match achieved is not perfect and could lead to slight distortions in some countries. In addition, while focusing in on the industry sector reduces the potential for mismatched comparisons as discussed above, industries in different countries can have different foci. Between-country comparisons should again be made with care.

SOURCES:
Carbon Dioxide (CO_2) Emissions variables: International Energy Agency (IEA), 2001. *CO_2 Emissions from Fossil Fuel Combustion (2001 Edition).* Paris: Organization for Economic Cooperation and Development (OECD). Electronic database available online at: http://data.iea.org/ieastore/default.asp. **Cumulative CO_2 Emissions since 1900**: Carbon Dioxide Information Analysis Center (CDIAC), Environmental Sciences Division, Oak Ridge National Laboratory: 2001. *Global, Regional, and National CO_2 Emission Estimates from Fossil Fuel Burning, Cement Production, and Gas Flaring: 1751-1998*, NDP-030. Oak Ridge, Tennessee: CDIAC. Available online at http://cdiac.esd.ornl.gov/ftp/ndp030/. and Energy Information Administration of the U.S. Department of Energy: 2001. Carbon Dioxide Emissions from Use of Fossil Fuels, International Energy Annual,2000. Washington, DC: EIA. Available on-line at http://www.eia.doe.gov/iea/carbon.html. **Methane and Nitrous Oxide Emissions:** National Institute for Public Health (RIVM) and Netherlands Organization for Applied Scientific Research (TNO). 2001. *The Emission Database for Global Atmosphereic Research (EDGAR) 3.2: Emissions Database for Global Atmoshpheric Research*. The Netherlands**:** RIVM. Database available online at http://www.rivm.nl/env/int/coredata/edgar/index.html.
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