Notebook

1993 Carbon Dioxide Fact Sheet

JOHN H. WALSH

This issue of the *Carbon Dioxide Fact Sheet* provides new data for 1993 presented in the same manner as earlier *Fact Sheets* and also provides a time series retrospective of regional and world emissions back to 1983. As in previous reports in this series, the calculations rely on the *BP Statistical Review of World Energy* for energy consumption data for the world and its principal regions and nations. This well-accepted source of energy data appears in June of the year following the year under review and thus provides a means of estimating emissions of carbon dioxide throughout the world on a consistent basis as early as six months after the conclusion of the subject year.

The conversion of one million tonnes of oil equivalent (MTOE), the basic energy unit adopted in the *Review*, was taken as 42 petajoules, the value also adopted by the World Energy Council. The specific factors applied to the three fossil fuels were those employed by the International Energy Agency: for oil — 19.9 million tonnes of carbon (not the dioxide) per exajoule (MTC/EJ); for natural gas — 13.8 MTC/EJ; and for coal — 24.1 MTC/EJ, calculated on the basis of the higher heating value (HHV).

The greatest uncertainty in the selection of appropriate factors centers on coal, which may

John Walsh is an independent energy advisor in Ottawa.

vary from one production region to another. Should it be desired to express emissions in terms of carbon dioxide rather than the carbon convention used in this note, the factor is 3.67. The limitations of the use of energy consumption data for the estimation of carbon dioxide emissions have been noted in previous reports (Walsh, 1993).

CO_2 Emissions in 1993

In 1993, world emissions of carbon dioxide decreased slightly, by 0.3%, although world energy consumption grew by 0.2%, raising total demand almost back to the record level of 1990. This was due to the record level of consumption of natural gas: emissions from oil and coal declined, while those from natural gas increased 1.6%. A pronounced decline in emissions continued in non-OECD Europe, reflecting the severe economic dislocation in that region, but there was also a decline in the European Union due to the recession. Emissions continue to grow rapidly in the developing nations, especially China and the countries of south-east Asia. The United States is the largest single source, accounting for 25.2% of the world's total with per capita emissions at 5.7 tonnes C per person.

Canadian emissions of carbon dioxide grew 1.9% in 1993 accounting for 2.2% of the world's total. Per capita emissions in Canada were 4.4 tonnes C/person.

Emissions Estimates Over Time

Though the aggregative calculations reported here cannot be a substitute for detailed sector-by-sector calculations, they are sufficiently accurate to present a timely indication of world trends on a coherent basis. The remainder of this note consists of a summary of estimates made in this way for the period 1983-1993.

The many political changes during the period under review posed some problems in the selection of the regions to the studied. To maintain consistency throughout the period, an estimate was made of emissions from the former German Democratic Republic and these were added to OECD Europe and subtracted from Non-OECD

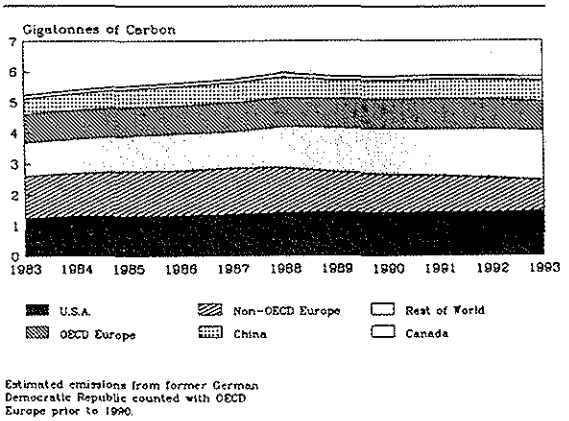

Figure 1: Total world emissions from fossil fuels

Table 1: Carbon Emissions (MT) from Fossil Fuels — World

	1992	%	1993	%
Oil	2629.1	45.1	2608.9	44.9
Natural Gas	1019.7	17.5	1035.8	17.8
Coal	2179.6	37.4	2167.2	37.3
Total	5828.4	100.0	5811.9	100.0

Decrease – 1993 over 1992: - 0.3%.
World per capita emissions from the three fossil fuels: 1.0 tonnes C/person/year (1993).
The world's emissions of carbon from oil are somewhat greater than those from coal: carbon derived from natural gas is much less but the relative proportion is increasing.

Europe prior to 1990. With the category definitions used, no other such correction was necessary to the data provided in the *BP Review*, but it should be noted that Turkey was included in OECD Europe.

World emissions of carbon dioxide from the six countries and regions defined appear in Figure 1. Total world emissions increased from 1983 to 1988 and then were essentially stable. There were four major events during this time that influenced the consumption of energy. The international price of oil began to fall (especially in 1986) and only rebounded slowly in later years: it never recovered its previous levels, except briefly during the Gulf War. Later in the 80's there was the major economic dislocation arising from political changes in Eastern Europe. A recession was then experienced in Canada

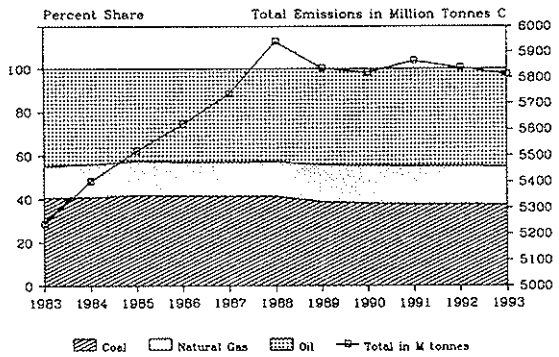

Figure 2: World total and share in fossil fuel CO_2 emissions

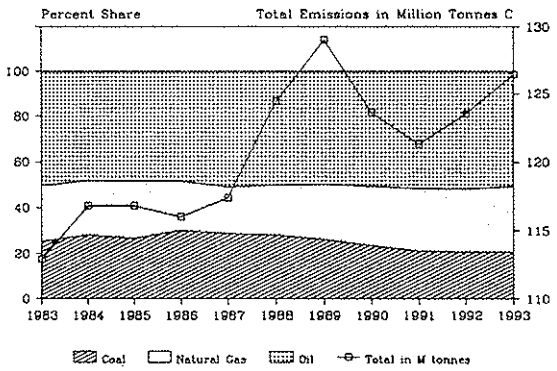

Figure 3: Canada total and share of fossil fuel CO_2 emissions

in the early 90's, which struck somewhat later in Western Europe. This same recession also affected the US, but less severely. Economic growth accelerated in the countries of south-east Asia and to a lesser extent in the nations of Latin America later on in the period. Natural gas increased its share in the fossil fuel mix, especially after 1988.

This same data set is re-plotted in Figure 2 to illustrate the total emissions of carbon dioxide (as the line) in relation to the shares among the three fossil fuels. After 1988, the large fall in emissions in the Non-OECD nations has been balanced mostly by the rapid increase occurring in the nations of the Rest-of-World category. The continuance of the present nearly-stable period is unlikely. It is easy to imagine circumstances whereby the steady increase experienced in the middle 1980's might resume in the next decade.

The Canadian situation is illustrated in Figure 3. Emissions rose rapidly prior to the recession until 1989 and then fell two years in a row before increasing again. The share of emissions due to natural gas increased mainly at the expense of coal in the later years. This country is unusual in that emissions from gas exceed those from coal, though oil remains by far the largest source. Canada accounted for 2.2% of world emissions in 1993 — a proportion which remained quite steady throughout the period.

In the case of the US, illustrated in Figure 4, emissions increased rapidly in the economic expansion of the late 1980's, but stabilized during

Table 2: Carbon Emissions (MT) from Fossil Fuels — Canada

	1992	%	1993	%
Oil	62.6	50.5	64.0	50.6
Natural Gas	34.9	28.1	36.3	28.7
Coal	26.5	21.4	26.1	20.6
Total	124.0	100.0	126.4	100.0

Increase – 1993 over 1992: +1.9%.
Canada as a percentage of the world's total: 2.2% (1993).
Canadian per capita release of carbon: 4.4 tonnes C/person/year (1993).
Oil is by far the largest contributor to carbon emissions in Canada followed by natural gas.

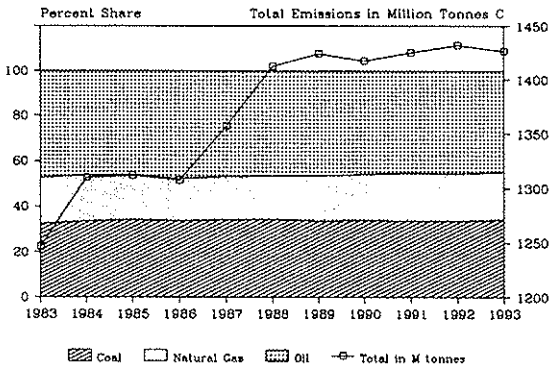

Figure 4: US total and share of fossil fuel CO_2 emissions

the recessionary period. The shares from the fossil fuels remained about the same. The US accounted for 25.2% of the world's emissions

Table 3: Carbon Emissions (MT) from Fossil Fuels — United States

	1992	%	1993	%
Oil	653.8	45.7	658.2	45.0
Natural Gas	294.0	20.6	303.6	20.8
Coal	481.3	33.7	500.7	34.2
Total	1429.1	100.0	1462.5	100.0

Increase – 1993 over 1992: +2.3%.
US as a percentage of the world's total: 25.2% (1993).
US per capita release of carbon: 5.7 tonnes C/person/year (1993).
Oil is the largest contributor in the US case followed by coal.

in 1993.

In Non-OECD Europe (with the contribution from the former German Democratic Republic deducted before 1990 as noted), emissions increased regularly until 1987 and then fell precipitously after that date with no sign of stabilization by 1993, as illustrated in Figure 5. There was a tendency for the share from natural gas to increase during the period of decline, but the shares from the three fuels remained very close to one another. Non-OECD Europe accounted for 17.2% of the world's emissions in 1993.

In OECD Europe, as illustrated in Figure 6, emissions rose during the economic expansion to 1991 and then declined two years in succession due to the recession now ending. OECD Europe accounted for 16.5% of the world's emissions in 1993.

China depends heavily upon coal for its energy supply as illustrated in Figure 7. Emissions are rising, but declines are shown in the graph for 1989 and 1992. This irregularity is believed due to an artifact of the statistical source: the Chinese economy has expanded continuously at a rapid rate throughout the period. More reliable data will no doubt became available as the Chinese economy becomes better integrated into the world trading system. In 1993, China accounted for 11.6% of the world's emissions.

The emissions for the case of the Rest-of-World in Figure 8 were calculated by difference. In this rather heterogeneous group of countries, emissions have risen rapidly in the last six years.

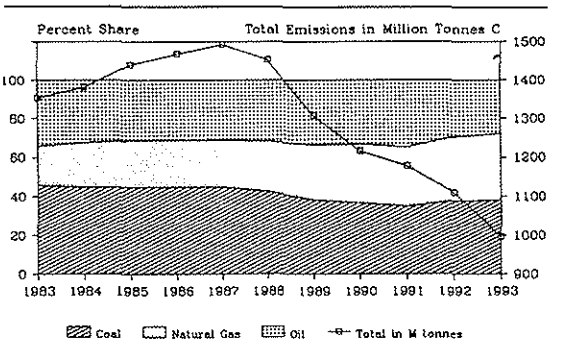

Figure 5: Non-OECD Europe total and share of fossil fuel CO_2 emissions

Table 4: Carbon Emissions (MT) from Fossil Fuels — Non-OECD Europe

	1992	%	1993	%
Oil	332.5	30.2	277.5	27.8
Natural Gas	354.8	32.2	340.3	34.1
Coal	413.8	37.6	379.0	38.0
Total	1101.1	100.0	996.8	100.0

Decrease – 1993 over 1992: -9.5%.
Non-OECD Europe as a percentage of the world's total: 17.2% (1993).
Non-OECD Europe per capita release of carbon: 2.4 tonnes C/person/year (1993).
Emissions are fairly evenly divided among the three fossil fuels with coal the largest source.

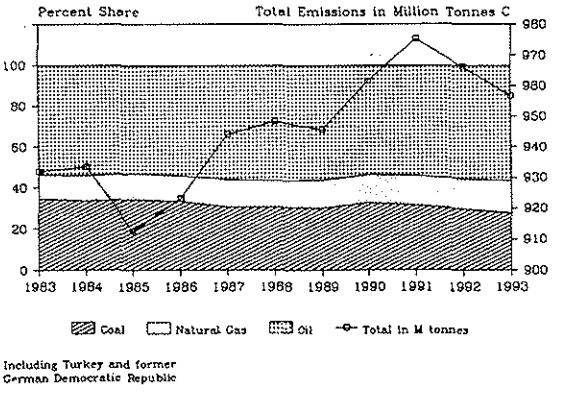

Figure 6: OECD Europe total and share of fossil fuel CO_2 emissions

Oil is the dominant energy source with some tendency for the greater use of natural gas. The

Table 5: Carbon Emissions (MT) from Fossil Fuels — European Union

	1992	%	1993	%
Oil	472.1	54.8	469.1	55.7
Natural Gas	133.5	15.5	141.9	16.8
Coal	255.9	29.7	231.4	27.5
Total	861.5	100.0	842.4	100.0

Decrease – 1993 over 1992: -2.2%.
European Union as a percentage of the world's total: 14.5% (1993).
European Union per capita release of carbon: 2.4 tonnes C/person/year (1993).
Oil is the largest contributor to carbon emissions in the European Union and the proportion from natural gas remains small compared to the US and Non-OECD Europe.

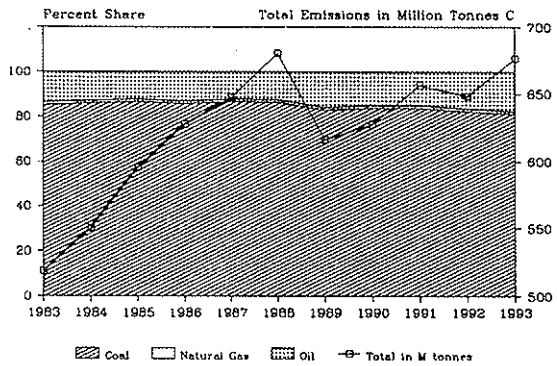

Figure 7: China total and share of fossil fuel CO_2 emissions

Table 6: Carbon Emissions (MT) from Fossil Fuels — China

	1992	%	1993	%
Oil	107.8	16.6	119.8	17.7
Natural Gas	7.9	1.2	8.2	1.2
Coal	533.5	82.2	548.1	81.1
Total	649.2	100.0	676.1	100.0

Increase – 1993 over 1992: +4.1%.
China as a percentage of the world's total: 11.6% (1993).
Chinese per capita release of carbon: 0.6 tonnes C/-person/year (1993).
Coal is by far the largest source of emissions in China.

Rest-of-World countries accounted for only 20.5% of the world's emissions in 1983, but their share

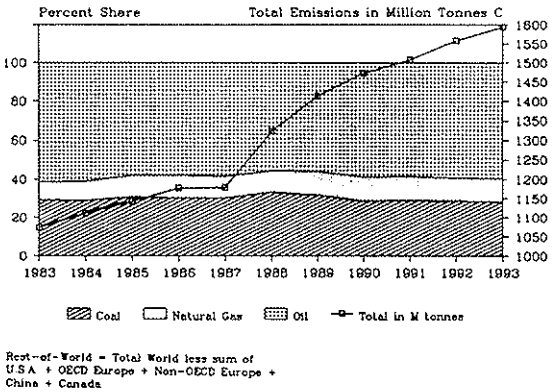

Figure 8: Rest-of-world total and share of fossil fuel CO_2 emissions

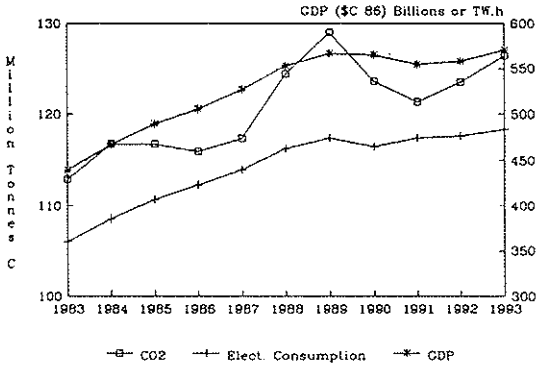

Figure 9: Canadian CO_2 emissions, GDP and electrical consumption 1983-93

had risen sharply to 27.4% by 1993.

The emissions for Canada have been plotted together with GDP ($86 billions (Cdn$)) and for electrical consumption (TWh) over this period in Figure 9. The association of electrical consumption with GDP was high, with the correlation coefficient r = 0.99. The association of carbon dioxide emissions with GDP was less at r = 0.90, but the inflections on the emissions curve appear to give a stronger indication of recession than those on the corresponding electrical curve.

Summary

World emissions of carbon dioxide from the fossil fuels were quite stable from 1987 to 1993. The reason for this stability was a balance struck

among opposing factors: a decline in emissions, resulting from political dislocation in Eastern Europe and recessions of varying severity in the developed countries, was offset by the rapid economic growth occurring in the Rest-of-World countries. There is no reason to believe this period of stability will necessarily last: resumption (or at least stabilization) of economic growth in Eastern Europe, together with recovery from recession in developed countries, combined with continued rapid growth in East Asian and Latin American countries could easily result in a resumption of growth in emissions.

There is a tendency for natural gas to improve its share among the fossil fuels, which may ameliorate the growth in emissions somewhat. It is not surprising that economic conditions and population growth appear to be the major determinants of carbon dioxide emissions. Natural gas consumption appears a little less sensitive to economic fluctuations than that of the other two fossil fuels. It is possible that a sensitive recession indicator could be devised by monitoring carbon dioxide emissions from the fossil fuels.

References

Walsh, J.H. (1993) '1992 Carbon Dioxide Fact Sheet,' *Energy Studies Review*, 5:2:131-35.