

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Science serves its readers as a forum for the presentation and discussion of important issues related to the advancement of science, including the presentation of minority or conflicting points of view, rather than by publishing only material on which a consensus has been reached. Accordingly, all articles published in *Science*—including editorials, news and comment, and book reviews—are signed and reflect the individual views of the authors and not official points of view adopted by the AAAS or the institutions with which the authors are affiliated.

Editorial Board

1983: FREDERICK R. BLATTNER, BERNARD F. BURKE, CHARLES L. DRAKE, ARTHUR F. FINDEIS, E. PETER GEIDUSCHEK, GLYNN ISAAC, MILTON RUSSELL, WILLIAM P. SLICHTER, JOHN WOOD

1984: ARNOLD DEMAIN, NEAL E. MILLER, FREDERICK MOSTELLER, ALLEN NEWELL, RUTH PATRICK, BRYANT W. ROSSITER, VERA C. RUBIN, SOLOMON H. SNYDER, PAUL E. WAGGONER

Publisher: WILLIAM D. CAREY
Associate Publisher: ROBERT V. ORMES

Editor: PHILIP H. ABELSON

Editorial Staff

Assistant Managing Editor: JOHN E. RINGLE
Production Editor: ELLEN E. MURPHY
Business Manager: HANS NUSSBAUM
News Editor: BARBARA J. CULLITON
News and Comment: COLIN NORMAN (deputy editor), JEFFREY L. FOX, CONSTANCE HOLDEN, ELIOT MARSHALL, R. JEFFREY SMITH, MARJORIE SUN, JOHN WALSH

European Correspondent: DAVID DICKSON
Contributing Writer: LUTHER J. CARTER
Research News: ROGER LEWIN (deputy editor), RICHARD A. KERR, GINA KOLATA, JEAN L. MARX, THOMAS H. MAUGH II, ARTHUR L. ROBINSON, M. MITCHELL WALDROP

Administrative Assistant, News: SCHERRAINE MACK;
Editorial Assistant, News: FANNIE GROOM
Senior Editors: ELEANORE BUTZ, MARY DORFMAN, RUTH KULSTAD

Associate Editors: SYLVIA EBERHART, CAITILIN GORDON, LOIS SCHMITT

Assistant Editors: MARTHA COLLINS, STEPHEN KEPPLE, EDITH MEYERS

Book Reviews: KATHERINE LIVINGSTON, *Editor*; LINDA HEISERMAN, JANET KEGG

Letters: CHRISTINE GILBERT
Copy Editor: ISABELLA BOULDIN

Production: JOHN BAKER; HOLLY BISHOP, ELEANOR WARNER; JEAN ROCKWOOD, SHARON RYAN, BEVERLY SHIELDS

Covers, Reprints, and Permissions: GRAYCE FINGER, *Editor*; GERALDINE CRUMP, CORRINE HARRIS

Guide to Scientific Instruments: RICHARD G. SOMMER

Assistant to the Editor: SUSAN ELLIOTT

Assistant to the Associate Publisher: ROSE LOWERY

Assistant to the Managing Editor: NANCY HARTNAGEL

Membership Recruitment: GWENDOLYN HUDDLE

Member and Subscription Records: ANN RAGLAND

EDITORIAL CORRESPONDENCE: 1515 Massachusetts Ave., NW, Washington, D.C. 20005. Area code 202. General Editorial Office, 467-4350; Book Reviews, 467-4367; Guide to Scientific Instruments, 467-4480; News and Comment, 467-4430; Reprints and Permissions, 467-4483; Research News, 467-4321. Cable: Advancesci, Washington. For "Information for Contributors," write to the editorial office or see page xi, *Science*, 30 September 1983.

BUSINESS CORRESPONDENCE: Area Code 202. Membership and Subscriptions: 467-4417.

Advertising Representatives

Director: EARL J. SCHERAGO
Production Manager: GINA REILLY
Advertising Sales Manager: RICHARD L. CHARLES
Marketing Manager: HERBERT L. BURKLUND
Sales: NEW YORK, N.Y. 10036: Steve Hamburger, 1515 Broadway (212-730-1050); SCOTCH PLAINS, N.J. 07076: C. Richard Callis, 12 Unami Lane (201-889-4873); CHICAGO, ILL. 60611: Jack Ryan, Room 2107, 919 N. Michigan Ave. (312-337-4973); BEVERLY HILLS, CALIF. 90211: Winn Nance, 111 N. La Cienega Blvd. (213-657-2772); DORSET, VT. 05251: Fred W. Dieffenbach, Kent Hill Rd. (802-867-5581).

ADVERTISING CORRESPONDENCE: Tenth floor, 1515 Broadway, New York, N.Y. 10036. Phone: 212-730-1050.

Carbon Dioxide Emissions

Two recent reports have dealt with the climatic effects of increasing amounts of atmospheric CO₂. The tone of the reports is less panicky than that of earlier statements. This is particularly true of the study conducted under the auspices of the National Research Council (NRC).^{*} Earlier predictions were based on the then current rate of increase in combustion of fossil fuels. This amounted to 4.3 percent per year and would have led to a doubling of the concentration of atmospheric CO₂ in about 57 years, with an estimated rise in global temperature of 3.0°C. Estimates of average annual rates of increase in CO₂ emissions to 2030 range from 1 to 3.5 percent. Using a rate of 2.0 percent gives an estimated doubling time of 88 years. Perhaps more important are some considerations about possible societal impacts. The NRC report pointed out that human societies are flexible in dealing with new situations provided sufficient time is available. As an example, the great changes that have occurred in this century were cited.

The NRC report was careful to outline uncertainties in the predictions. The possible temperature rise is based on model studies which may or may not be valid. The projected rise is necessarily to be superimposed on unpredictable natural climatic trends. More controllable, but still unpredictable, is the rate of burning of fossil fuels. For nearly two decades ending in 1973, consumption expanded at a compound rate of 4.3 percent per year. During the past decade the rate of burning has been static. If present trends continue, the doubling time for CO₂ will be 220 years.

Whatever the rate of increase of CO₂ content and corresponding change in temperature, ultimate melting of a large Antarctic ice mass seems highly probable. This would lead to an estimated rise in sea level of 5 to 6 meters and to flooding of highly populated areas. Can such an event be delayed or even forestalled? The answer is that it probably can. Continued effort to increase the efficiency of energy use could lessen demand. A number of measures could be employed to slow the rate of increase of CO₂. One method for decreasing net emission of CO₂ is close to commercial feasibility. It has the potential advantage of curtailing the emission both of CO₂ and of gases responsible for acid rain. In an electric power plant now being built at Cool Water, California, coal is gasified and impurities such as sulfur are captured. Following the combustion of fuel gases, the CO₂, being present in high concentration, could be easily removed. Later it would have a market value for injection underground to promote tertiary recovery of oil.

A transition to greater dependence on renewable energy would also be helpful. It is useful to be reminded that energy consumption by humans amounts to only 0.1 percent of the solar energy falling on the earth. Recent progress in tapping some of this energy by improving the increased production of biomass is large. With good management and superior choice of vegetation, CO₂ fixation might be increased fivefold or more. The product would be sufficient to sustain a prosperous civilization. Any surplus fixed carbon could be stored. Correspondingly, the amount of CO₂ in the atmosphere would be reduced.

The advent of fusion energy would change energy usage drastically. It would reduce demand for fossil fuels to produce electricity. It would make possible a hydrogen economy that would require no net use of carbon. Some of the fusion energy could be used to capture CO₂ from the atmosphere for injection into geological formations. Alternatively, the energy could be used to convert CO₂ into solid carbon.

When the environment is altered on a global scale, major problems can arise. Careful monitoring and study of the trends in CO₂ is desirable, together with efforts to develop contingency alternatives. The process of providing adequate energy need not lead to catastrophic consequences.

—PHILIP H. ABELSON

^{*}*Changing Climate*, Report of the Carbon Dioxide Assessment Committee, National Research Council Board on Atmospheric Sciences and Climate (National Academy Press, Washington, D.C., 1983).