

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

1981: PETER BELL, BRYCE CRAWFORD, JR., E. PETER GEIDUSCHEK, EMIL W. HAURY, SALLY GREGORY KOHLSTEDT, MANCUR OLSON, PETER H. RAVEN, WILLIAM P. SLICHTER, FREDERIC G. WORDEN

1982: WILLIAM ESTES, CLEMENT L. MARKERT, JOHN R. PIERCE, BRYANT W. ROSSITER, VERA C. RUBIN, MAXINE F. SINGER, PAUL E. WAGGONER, ALEXANDER ZUCKER

Publisher

WILLIAM D. CAREY

Editor

PHILIP H. ABELSON

Editorial Staff

Managing Editor
ROBERT V. ORMES
Assistant Managing Editor
JOHN E. RINGLE

Business Manager
HANS NUSSBAUM
Production Editor
ELLEN E. MURPHY

News Editor: BARBARA J. CULLITON
News and Comment: WILLIAM J. BROAD, LUTHER J. CARTER, CONSTANCE HOLDEN, ELIOT MARSHALL, COLIN NORMAN, R. JEFFREY SMITH, MARJORIE SUN, NICHOLAS WADE, JOHN WALSH

Research News: RICHARD A. KERR, GINA BARI KOLATA, ROGER LEWIN, JEAN L. MARX, THOMAS H. MAUGH II, ARTHUR L. ROBINSON, M. MITCHELL WALDROP

Administrative Assistant, News: SCHERRAINE MACK;
Editorial Assistants, News: FANNIE GROOM, CASSANDRA WATTS

Senior Editors: ELEANORE BUTZ, MARY DORFMAN, RUTH KULSTAD

Associate Editors: SYLVIA EBERHART, CAITILIN GORDON, LOIS SCHMITT

Assistant Editors: MARTHA COLLINS, STEPHEN KEPFLE, EDITH MEYERS

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

Letters: CHRISTINE GILBERT

Copy Editor: ISABELLA BOULDIN

Production: NANCY HARTNAGEL, JOHN BAKER; ROSE LOWERY; HOLLY BISHOP, ELEANOR WARNER; JEAN ROCKWOOD, LEAH RYAN, SHARON RYAN, ROBIN WHYTE

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

Guide to Scientific Instruments: RICHARD G. SOMMER
Assistants to the Editors: SUSAN ELLIOTT, DIANE HOLLAND

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*, 27 March 1981.

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.

Energy and Chemicals from Biomass

Economic forces and prospective future shortages of oil are inducing widespread interest in biomass as a source of energy and chemicals. A new *International Bio-Energy Directory** lists activities in 60 countries, including 1850 different projects. The majority of the less-developed countries obtain most of their energy from biomass. About 15 percent of the world's total energy is derived directly or indirectly from photosynthesis.

At the moment, there is a so-called oil glut, but this could be short-lived. If environmental problems, such as CO₂ or acid rain, connected with other energy sources become unbearable, biomass could quickly rise to importance. Exploitation of biomass is not without controversy, however. In the United States the increasing conversion of grain to ethyl alcohol creates an issue of food versus fuel. In many developing countries excessive use of wood is leading to deforestation and soil erosion.

For decades biomass and its products were relatively neglected, except for research to increase yields of food crops. But lately there have been expanded efforts to improve yields of nonfood plants and trees and to find better ways of obtaining fuels and chemicals from them.

Good forest management is already improving the yields of trees. This includes selection of superior stock in reforestation, thinning, and use of fertilizers. Considerable attention is being devoted to the coppicing of fast-growing trees. In the *Bio-Energy Directory* it is stated that hybrid poplar trees in Pennsylvania produce 20 metric tons per hectare per year (dry basis) when harvested on a 4-year coppicing cycle. Other claims include annual tropical growth rates per hectare of 88 dry metric tons of Napier grass, 85 tons of water hyacinths, and 300 tons of algae (grown under 100 percent CO₂). These numbers are probably atypical but in the future they may well be exceeded as a result of selection and genetic research.

Work on the utilization of biomass is also active. Of special importance is research aimed at unlocking the values inherent in cellulose, which is a polymer of glucose. Glucose is a feedstock for many fermentation processes besides that yielding ethyl alcohol. Were glucose sufficiently inexpensive in comparison to petroleum, most of today's tonnage of petrochemicals would be derived from it.

Until recently, there were two principal approaches to breaking the lignocellulose complex and making glucose available. They involved microbial enzymes or treatment with aqueous mineral acids. Yields were not good or the digestion was slow. A technique that employs anhydrous hydrogen fluoride is now drawing attention. The chemical splits cellulose rapidly at 0°C with high yields. Other approaches to the use of wood include subjecting it to gasification or rapid pyrolysis. Wood is much more easily gasified than coal, being converted to gases at 700°C. Fast pyrolysis yields substantial quantities of ethylene.

Use of energy and chemicals from biomass in the United States is likely to increase slowly at first. But substantial research activity here guarantees more efficient production of biomass, and better, innovative processes for using it. One can visualize a possible gradual transition in which biomass replaces an increasing fraction of petroleum as an energy source and feedstock. The process is likely to begin with increased use of ethyl alcohol and with production of some chemicals that can be readily derived by fermentation of glucose. In addition, functions now being served by products derived from petrochemicals may be served in new ways by items made from processed biomass.

In looking toward the future and planning our research activities, we should also consider possible international applications of our work; and should be alert to new results elsewhere. As the developed countries join the less-developed countries in a greater dependence on biomass we shall have much to learn from each other.—PHILIP H. ABELSON

**International Bio-Energy Directory*, Paul F. Bente, Ed. (Bio-Energy Council, Washington, D.C., 1981). \$90.