26 March 1976, Volume 191, Number 4233 SCIENCE

Energy from Biomass

There has been much talk of solar energy, but most thought has been devoted to physical means of collecting sunlight. An obvious resource has had only nominal attention: energy, materials, and chemicals from plants and trees. For the coming decades in the United States, the major shift from oil and natural gas is likely to be toward coal and oil shale. In many countries, however, where there is little or no coal or oil shale, trees and plants could become important sources of energy and materials. Moreover, burning of fossil fuels yields carbon dioxide—a hazard of unknown magnitude. The use of trees and plants as sources of energy involves a closed cycle with respect to CO_2.

In comparison to the amounts of incident solar energy on earth, human utilization of energy is relatively trivial ($\sim 5 \times 10^{-5}$). The people of the United States consume an amount that is about 10^{-3} that of solar energy falling on it. Under favorable conditions, about 3 percent of solar energy can be fixed in photosynthesis. Thus, in principle, energy needs of the United States could ultimately be met by devoting only a small fraction of the land to this purpose. The same is true of the rest of the world. The present annual production of biomass on the land areas has been estimated at 100 billion tons (dry weight). This has an energy equivalent that is about a factor of 6 greater than current utilization of energy by the world's peoples. Moreover, these figures do not take into account the large additional production of biomass that might be achieved through agronomy and silviculture.

There is, of course, a long distance between potential and practice. Feeding the earth's billions of people has top priority though only a small fraction of the energy is represented by food. Perhaps a more restraining factor is the diffuse character of the biomass. Effective utilization of the potential might require many small conversion plants. This would facilitate return of nutrients to the land while cutting costs of transportation. But at present prices and with current technology, only a tiny portion of energy needs in the United States could be met today from renewable sources.

Ultimately, trees may be the preferred source of energy. However, effective use of them for other than direct burning involves complex technology. Cellulose and lignin must be separated and then processed further or the wood must be converted to carbon monoxide and hydrogen and from thence to methanol or methane. Plant materials lend themselves to anaerobic fermentation resulting in methane and CO_2 with the latter easily removed.

One potentiality that merits further study is the hydrogenation of wood which is known to yield combustible liquids.

The United States has so many possible energy sources and so much wealth that it can perhaps afford long controversies about what to do. Other nations cannot equivocate. They will adopt nuclear energy unless alternatives quickly become available. This will be true ultimately even in the tropical, less developed countries that have abundant renewable resources. Where will those countries find the billion or so dollars to buy a nuclear power plant? Where will they find the skilled technicians to operate the plants safely? Would the world not be better off and safer if such countries were obtaining their energy from biomass?

Thus, although there seems to be no great urgency in the United States to develop renewable energy sources, it would be desirable to give this matter high priority and substantial funding. The effort should include fundamental work in photosynthesis, plant genetics, artificial creation of new species, and related aspects of agronomy and silviculture. Research and development work should include imaginative approaches to better processes for utilizing plants and trees. Some of the efforts should be devoted to creating simple inexpensive devices that would enable rural peoples to obtain various types of energy including even electricity from biomass. With a moderate investment of money and scientific and technical personnel, we could perform work of immense global significance while moving toward long-term solutions to our own energy problems.—PHILIP H. ABELSON