CHANGING POWER BASIS FOR MAN*

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As the expotential expansion of urban man on planet earth becomes the critical issue in man's view of his own future, one of our most general magazines of scientific concern considers again the questions of the present and future energy basis for the biosphere and human affairs within it.

In its focus on critical topics Scientific American has often provided book-size volumes of dual use, first as textbook-like clear presentations for introductory understanding highly useful to students at many levels, and second, as sharp high level statements of the critical scientific issues at the base of public policy considerations. The first aim is accomplished in part by clear, engrossing diagrams and careful use of language, the second aim is accomplished by selection of authors who are in the fore-front of the arguments and interfaces of science and the public.

In this energy volume the effort succeeds in its first educational role by considering energy in various sectors of our world system. The volume begins with an orientation of the reader to the power basis for modern man by C. Starr. Then Freeman Dyson recapitulates the perspectives of earth energies in cosmological and nuclear phenomena. Next, David Gates brings solar energies into the biosphere and W. B. Kemp and Roy Rappaport connect the energy flows of the biosphere with the simpler social systems of man on anthropological scales with the examples of Eskimoes and the Pig Gardeners of New Guinea. For the modern industrial based system King Hubbert updates his accounts of reserves and Earl Cook details its flow in the U.S. System. Details of energy processing mechanisms and transformers are given by Claude M. Summers. Myron Tribus and Edward McIrvine relate energy and macroscopic information concepts. Finally, Milton Katz brings the discussions back to the energy basis for man's future and the meaning of power for public policy planning.

By the time the reader has worked through the volume he will be cognizant of such definitions as power being the rate of energy flow and the various energy, or energy related units, the calorie, the watt, the bit, the BTU, and the electron volt. He will be turning over in his mind the interesting overall measures of system function such as the ratio of entropy and energy, the ratio of power to population, the ratio of power to gross national product, and some concepts of efficiency. Most important of all, from the Dyson and Tribus-McIrvine chapters he will begin to sense that energy as a concept is being broadened and that it is more than some ever declining or ever constant commodity to be thought of as if it were the monthly pay-check. Thus, the reader is left interested, sensitized, and aware that

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Principles are in the offing, but does the volume actually recognize the real issues of energetics and public policy?

Consider next, therefore some of the critical questions about energetics and survival which seem missed or mistreated in the volume. For lack of the following, the volume could well be regarded as an endorsement to present national group policies, whereas the following issues may indicate that our present course of action is incorrect for survival.

1. In several chapters power reserves are measured and discussed equating weight of fuel materials with a set energy value regardless of the dispersal or depth of the fuel in the earth or under the sea. This is incorrect. Power reserves must be calculated as the NET power available to the system after the necessary feedback of power of the power industries to gaining, concentrating, and transporting the fuel to site of use. NET power per unit fuel weight is rapidly declining and with it must go the activity of our system in items that we sometimes call our standard of living.

2. Optimistic predictions for new types of energy resources such as fusion are based on gross power hopes, not including the unknown feedback energy requirement to produce net power.

3. Even with Nuclear Power we don't yet know the net value of power of this new source since the power industry work is 90% paid for by the general economy in which this specialty is imbedded and that is still running 90% on fossil fuels.

4. Several authors still think that net power from solar energy can be increased over that derived from the photosynthetic plant machinery a hope that should have been put to rest long ago. Sunlight is dilute energy and the costs of concentrating it have already been optimized and yield maximized by the millions of years of natural selection for this maximization. The highest gross conversions of solar energy are the natural systems and agricultures uses have been by channeling it or augmenting yield by addition of auxiliary fossil-fuel energies to release self service energies of the plants to yield (Allowing genetic breeding to substitute yield for maintenance).

5. Graphs are shown with increasing efficiencies of conversion devices such as turbines compared to earlier engines implying progress in use when in fact the increase is based on fuel subsidies to the economy to make better machinery for the process. In other words the calculations of efficiency hide the energy subsidies that come through heavy fuel utilizations by the manufacturing and maintenance of the parts. Similar misleading calculations accompany discussions of solar cell potentials and other devices that ignore the structure and maintenance costs that are included in the living converters.

6. Just as nuclear power discussions take for granted the levels of fossil fuel power to which they are coupled and supported, so the discussions of the energy support of modern urban man are made without recognition of the 10/1 ratio of energy support of the natural sector of seas, atmosphere, and vegetation as the life support for man. Thus, extrapolations of expansions of urban man are made

without subtracting the losses from the natural sector's support that the urban expansion is now causing by its preoccupation of area cycles, and pollution stresses. The fallacy that emerges from this separation of energy coupled inputs is the belief that more energy using technology can solve the environmental crisis.

7. Most authors apparently have missed the principle that in the degradation of potential energy use, surviving systems rebuild order and structure that feeds back special energy work services to the upstream that have equal effect to the loss and in effect eliminate the degradation effect of second energy law. The possibility that this may occur in space forall the energy flows is an open issue that should have been mentioned more succinctly.

8. Handling of productivity data makes some attempt to separate gross and net but the data graphs may mislead them. Any definition of net yield must specify the time interval since the net yield in processes of filling and discharge become larger as the time is made shorter. One graph suggesting different levels of productivity for polluted streams, natural streams, estuaries, and ponds are possibly not representative. Stirred estuaries and fertile streams have similar levels.

9. The implication that heat emerging from the earth is all residual may be incorrect since some is from radioactive decay and the magnitudes could be accounted for the geochemical energies of oxidized and reduced substances left in sediments from the net production process.

10. Landscape architects would have appreciated a description of the principles of power density for planning a balance of man and nature. Power transmission is one important aspect of the geography of energy, but synthesis of all energies is the real issue.

11. The dichotomy of regarding energy as fuels, light, and electric power and the flows of information, matter, money, and materials as something separate without energy values in their own reactions is incorrect and this error is implicit in many discussions of resources.

The difficulties aforementioned suggest that our national energy policies are not adequately founded:

A. Expanding energy policy may not lead to expanding welfare or survival.

B. Rumors are that present administrations will de-emphasize such "pure" science aspects of universities or of NASA as studies of energy patterns of the universe, high energy astronomy, etc. Yet it is in the nature of the overall energy laws of the very large and very small that our questions about the optimum energy policy for survival of man may be based.

C. New technology may not increase energy efficiency, if that efficiency is based on hidden subsidy from power expansion.

D. New energy hopes are not yet based on any efforts to calculate net energies and gross energies are not relevant.

E. The assumption that expanding energy will lead to expanding economy may be incorrect if the natural energies displaced are as high in economy stimulating value.

F. Policies based on incorrect calculations of reserve (gross instead of net) are hazardous.

Many of the problems of myopia come from looking at one flow at a time.

Almost all of the authors are guilty of this. Even though we mailed them an improved diagram, the authors insisted on using an 18 year old diagram of mine on energy flow for the biological system of Silver Springs which has only the light energy showing, whereas, later versions have more of the input energies, the chemical potential energies of the nutrient inflow, the current energies from the hydrostatic head, and the feedback multipliers which are present in all surviving systems.

The largest failure is an implication that what is good for man, examined separately is good for survival. This is comparable to the famous statement some years ago that "what is good for General Motors is good for the United States". The criterion of survival and hence of good is the survival of the biosphere's system which will include man as long as his efforts go for this end. It looks like it will take another generation of younger writers to put it all together and really use the energy method which allows synthesis rather than fragmentation that this issue has inadvertently done. Maybe Scientific American needs a synthetic section and editor.