Energy-The Key to an Ecologically Sustainable Development

*by Bruno Fritsch**

We do not consume resources but different states of energy. If a certain resource is "depleted," its material components have not become inexistent (law of conservation). Rather, this resource or its component parts are not available with the proper concentration, in the proper place, and at the proper time. Given the present level of knowledge, these three requirements - availability in terms of proper concentration, place, and time - can be fulfilled for practically all elements of the periodic system. This, however, requires energy. For this reason, the resource or raw material problem is "reduced" to the problem of energy - "the ultimate resource," as Goeller and Weinberg rightly observed 16 years ago in their pioneering paper "The Age of Substitutability."

Energy is the crucial issue of the environmental problem. Under present circumstances, both the supply (generation) and the use (consumption or utilization) of energy is related to material dissipation. Unlike the dissipation of energy which is the inevitable result of energy utilization, i.e., the conversion of high energy levels to lower energy levels (waste heat), dissipation or concentrations of materials can be transformed via terrestrial sinks or dilution to such an extent that their concentration is compatible with man's living conditions and social existence. In ideal circumstances, what remains is the waste heat which is eventually released into the deep of space.

Managing a sustainable cycling of materials - the prerequisite for man's continued existence on earth - is a difficult task. First, what matters is not only the concentration of a particular toxic substance, but also the speed of both its production or composition and its decomposition (residence time). Second, due to the non-linearity of ecological systems, a particular concentration of toxic substances in the different strata of the ecosystem (hydrosphere, atmosphere and lithosphere) might effect sudden and principally unforeseeable phase transitions. Obvious examples are the eutrophication of a lake or changes in the composition of the atmosphere. As a rule, these phase transitions are irreversible, establishing a new quality of the overall system.

Moreover, we do not know the long-term effects of certain environmental influences on man, e.g., the long-term effect of weak radiation; therefore, we are not sure whether - and if so, when - we have to reckon with health damages.

There are still other reasons why an ecologically optimum management of material cycling appears to be rather difficult. But it is not impossible. Today, it is both technically and economically feasible to realize integral product cycles: the whole production process - with its preliminary products, product components, the means of production (e.g., machines) as well as the manufactured product - is structured in such a way that, after the use of the product, its component parts can be reduced to the original materials at minimum costs in terms of energy and dissipation. We are already on our way to realizing such an integrated material conversion cycle. Within this cycle, using a particular material configuration as an investment or consumer good, i.e., providing the required service for investment or consumer purposes, constitutes only one single phase.

The realization of an integrated material conversion cycle with the attendant service phase requires stimulation by economic incentives which, on their part, must comply with certain laws and regularities. For example, these incentives must not possess the character of parametric regulations but should rather be designed as universally applied marginal conditions that, in ideal circumstances, do not effect market distortions. As a rule, measures imposing limits on certain emissions prove to be an adequate tool as long as it is technically possible to conform to these limits and as long as the costs of the technologies involved are financially acceptable. It is in this context that, at plant level, industries and institutions can benefit from the chance of implementing "eco-efficiency" by providing for production processes with maximum efficiencies and small losses of materials, i.e., configurations of materials which, under the prevailing technological and economic marginal conditions, appear to be of waste character, thus requiring deposition in non-dissipating sinks.

A decisive factor in this context is the speed with which both individuals and societies succeed in increasing their knowledge. Basically, this is an open and essentially infinite process. What is new is the interaction between natural processes and anthropogenic processes, with an increasing impact of man's activities on naturally occurring changes. For example, in the case of aerosols, the anthropogenic influence has reached 40 to 50% of the amount of natural aerosols transported into the atmosphere due to desert storms. Moreover, substances are given off to the various strata of the ecosystem which did not naturally occur in the system, e.g., CFCs or plutonium.

Two basically different kinds of knowledge require close interactions: (1) knowledge in terms of achieving scientific progress, and (2) knowledge in terms of its practical and political application. Two well-known examples are the prudent use of nuclear energy and the application of gene technologies. When it comes to making use of knowledge, the interaction between natural and anthropogenic processes is paralleled with the interaction of systems exhibiting different time constants. In other words, the time scale of man-influenced ecological processes differs from the time scale of political decision processes.

Considering this situation, we have to gain time and perspectives:

- by intensifying scientific research work in ecologically relevant areas;
- by making combined efforts to increase our knowledge about environmental resources and energy economics; and
- by carrying out precautionary measures to achieve decelerated rates of energy and material consumption by means of increased efficiencies.

A major political task is the constant search for ecologi-

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