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Terminating Fallacies in National Policy on Energy Economics, and Environment

Howard T. Odum

Energy is finally being recognized as a principal determinant of economic vitality although its relationship to economics and environment continues to be confused. The thinking of many people in 1974 and the national and international policies of nations continue to advocate policies that may oppose their own goals.

This paper indicates fallacies in public policy of the United States and suggests alternative measures. As in a companion paper (Odum, H. T. 1973. Energy, Ecology, and Economics, AMBIO, Vol. 2, No. 6. pp 220-227.), and an earlier book of principles (Odum, H. T. 1971. *Environment, Power and Society,* John Wiley.), insight into this matter comes from laws of energetics and their portrayal through energy flow diagrams. With the diagrams, the human mind can regain, for the overall system of man and nature, an overview and perspective that the farm-boy once had about his simpler local world under the name 'common sense'. Along with the diagrams several principles are illustrated that suggest fallacies in national policy.

POLICY NO. 1. Pump priming with money fails when energy is limiting. When energy flows into the economy it cannot be accelerated due to inherent limits in the energy flows, the economy cannot be stimulated by increasing money supply (deficit financing, increasing loans, printing more money, mining more gold). Under these conditions growth is not possible. Money merely devaluates in its true work per dollar.

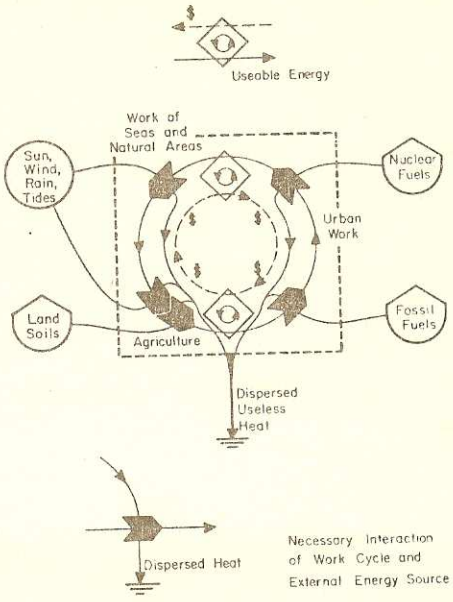

Figure 1

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FIG. 1 is a simplified view of the circle of work of the United States' economy of man and nature. Energy inflows from fossil fuels, nuclear fuels, the sun, rain, soils, etc. interacting with the circulating goods, services, materials of the economy of man and the economy of the natural areas as well. All the energy contributes to is the general turning of the energy wheel, which is performing the total work of man and nature. The energy, after its work is done, is in degraded form and can no longer be used for work so that it disperses as degraded heat into the environment and ultimately into space. Although the energy enters the wheel of recycling materials, services, and information at particular places, it disperses its effect throughout the wheel's effort. Thus, the wheel accumulates the energies distributing their work actions throughout the circulation thereby making it hard to tell which of the driving energy inputs is contributing the most. As the wheel turns it serves to help pump in the energies at each point. The wheel is necessary for energy processing.

Circulating in an opposite direction inside the energy wheel is a flow of money that facilitates and lubricates the circle of energy. If one adds to the circulation of money, it may tend to lubricate and facilitate pumping of new energy by the energy wheels.

Dollars and Calories

The true value of a circulating dollar is equal to the work that the dollar flow causes in the energy wheel. (Here we mean work in regular engineering units, whether it is done by machines or by people. This concept of value as work, towards survival of the overall system, is different from labor theories of value associated with Marx or technocrats.) This value can be determined by adding up the total calories of energy (all units expressed in fossil fuel equivalents) flowing per year and dividing by the dollars flowing per year (the gross national product).

Some of the energy inputs are the sun, winds, tides, rains, geological supply of lands and soils, and many other inputs to the cycles that are not always considered in dollar calculations. Money is exchanged for things that circulate from person to person and not received by the energy sources. Rather, money is passed to the oil industry or to agriculture for their services of getting energy, but not to the energy source itself.

If a source of energy fails, and the circulated money is constant, then the work each dollar represents drops by the same proportion as the decrease in the external energy sources. If some of the energy sources become more dilute or more remote, the result will be the same as having less incoming energy. This is because the fossil fuel equivalents actually contributed to the main circulating work wheel over and beyond that which was necessary.

When the energy sources are available but are not pouring into the work wheel as fast as they could, adding money may speed up the wheel and draw in more energy. Current economic concepts attempt to stimulate the work wheel by creating more money in advance of the pumping in of the energy (demand). Such economy stimulating keeps the number of dollars increasing ahead of the energy so that the work per dollar keeps going down. Recent advisors to government have advocated this sort of inflation in order to keep the work wheel stimulated. Also it was a device for taking money out of peoples' savings without their knowledge and investing it in efforts to get energy. Survival requires the use of energy to produce more energy. Thus, the policy was adaptive.

Growth in energy involvement, and thus increases in assets, goods, services, etc., has been possible in our recent history because new energy sources have been drawn into the support of the work wheel at a faster rate. But growth has subsided as the sources have become the type that are limited.

It was soon recognized that the net yield of world fossil fuel energies over and beyond that necessary to get the energies was becoming limited and in prospect of actually decreasing. Countries began to conserve supplies and it was possible for suppliers to hold back the richer sources and sell them for the same high rates as those who had only dilute and deep energy sources to sell.

POLICY NO. 2. *Inflation can be eliminated by adjusting the total money circulating to the total energy flows of man and hidden contributions of nature expressing all of these in the same energy quality, for example, fossil fuel equivalents.*

The idea of an energy certificate to replace the gold standard or other stabilizer of currency is an old one in economics and in many minds is associated with activities of technocrat organizations, etc. Previous efforts at putting money on an energy standard may have been erroneous because no effort was made to translate all qualities of energy into the same quality with realistic quality factor conversions before making a comparison or summation. Including the energy cost of the power plant, it takes about 4 kilocalories of coal to put out one kilocalorie of electricity. This is a higher quality form of energy since it requires more energy conversion steps to develop.

Comparing electricity with coal, one converts with a factor of 4 to obtain fossil fuel equivalents of coal. For the very dilute energy of sunlight it takes 1000 or more kilocalories of sunlight to develop work of a kilocalorie of coal. The total energy that operates the United States is the sum of all the energy flows: sunlight, coal, oil, natural gas, nuclear power, wind, etc. each converted to fossil fuel equivalents. It is this total that contributes to the total value of the system of man and nature. The winds from the heated lands move air pollution out of cities and thus contribute in enormous ways to the energy basis for man.

The idea of the energy certificate is to keep a dollar worth a set number of kilocalories of fossil fuel energy. When the dollar circulates it represents the work done: (example: 40,000 kilocalories in fossil fuel equivalents). If dollar quantities are adjusted to flows of energy each year, then money will always represent the true ability of energy to generate value towards survival and well-being of the system of man and nature. There will be no more inflation.

POLICY NO. 3. *Efforts to conserve energy are often fallacious if they consider only the direct input of fuels or primary energy sources while forgetting about the indirect energies used to develop goods, services, information, and complex technology. High quality inputs require more energy than is supplied as raw fuels in many processes.*

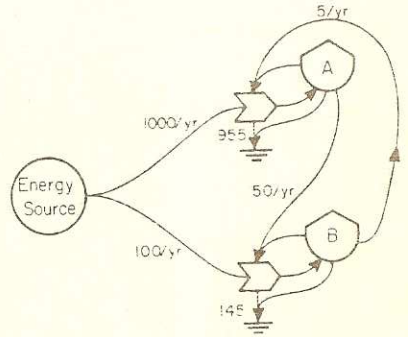

FIG. 2 illustrates two industries in which the high quality products from *A* are used in the processes at *B* and those of *B* in *A*. If only the direct pathway of inflowing energy were considered, *B* would be regarded as con-

suming less energy, but, both require the same. Most of the output from *A* goes to *B* so that the processes at *B* are using more energy when the indirect and direct are considered. Energy contributions can be evaluated by adding the energy flow from externals to the energy equivalents of the money spent for the purchased iteams using the standard overall ratio.

POLICY NO. 4. *Efforts to evaluate the relative desirability of some action involving external energy sources such as the inputs from or impacts on nature cannot be made using prices, since the contributions of the external sources are dispersed throughout the economy, never being represented in any money flow except in the total. The desirability of some action affecting environmental or other external energy sources is, however, measured by the fossil fuel equivalent, which can be used for energy cost-benefit analysis.*

For example, agricultural land yielding $1,000 in sales of food products might be regarded as a poor use compared to a proposed housing development that would yield $2,000 in rent after the housing system was established. However, this may be a fallacy since the $1,000 was only paid for the human exchange effort and not for the inputs of sun, wind, rain, soil etc. Suppose we evaluate these roughly and convert to fossil fuel equivalents, and then to dollars using the overall ratio of work in the total systems work wheel inputs was $2,000, the total agricultural use ($3,000) was actually contribiting more value to the whole economy than use as housing. The work is not recognized locally and does not affect the price, without an energy evaluation.

POLICY NO. 5. *Political, military, and economic power among nations is dependent on their flows of real energy. Comparative abilities among nations can be calculated from the fossil fuel equivalents of total energy flowing including the marine, the natural land areas, the agricultural, and the urban sectors.*

Energy flows may indicate military potentials, economic potentials for export and obtaining a favorable balance of payments, and images for attracting individuals. However, there are opportunities for great miscalculations by earlier trained leaders since the relative amounts of these flows have changed substantially in recent years. Wars may develop from attempts to maintain areas of influence and boundaries which are not in proportion to the energy flows of competing nations. For example, the relative drop in the percent of the world's high grade energy being used in the United States reduced its potentials for world influence markedly between 1940's and the time of the Viet Nam war. Attempts to operate such far-flung influences as NATO and SEATO are less feasible than earlier. The relative effect of oil embargo was greater on the competitors of the United States economy that on the U.S. Balance of payments of the U.S. improved but this will reverse if the U.S. uses its last good energies or if competing nations become closer to better energies.

POLICY NO. 6. *Since purchasing power cannot be added to an economy without adding new energy flows, capital becomes short in energy restricted times. Capital is available in proportion to net additions of energy storage.*

When there was growth there were new energies and new assets and thus there were profits, loans, and other uses that added money, representing the new assets developed with expanded energies. Without growth there can be no general increase in capital. Loans can be made but they will have the effect of taking energy from one part of the system and giving it to another. Deficit financing also has this role. Incorrect assumptions are being made in national energy policies that state that capital will be available to make giant new energy systems for new processes. Energies can be shifted from consumers to energy input industries only so long as there is some extra energy storage in the consumer sector. Stocks are an investment that pay off when there is energy expansion and do not yield much and are not rated high during a steady state.

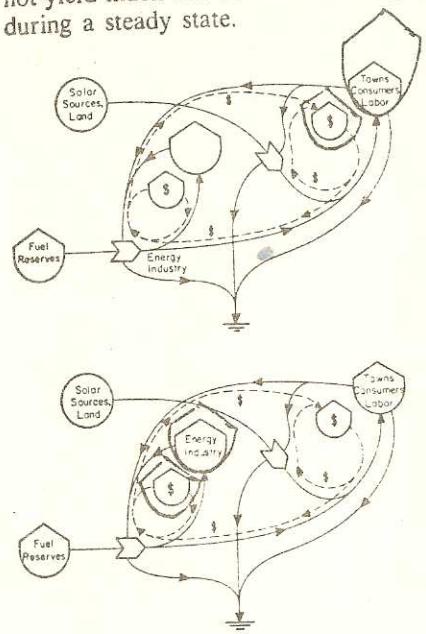

FIG. 3 shows power industries as a subsystem with a small money loop pumping energy to the rest of the economy. At first **(Fig. 3a)** the energy is rich and easily processed so that most of the energy does its work in the consumer-labor sector. Little work is needed in getting energy so it is available for other uses. Later **(Fig. 3b)** as energy gets deeper and more difficult to process, due to the ultimate consumption of richer sources, more of the energy obtained has to go to the power industry while the consumer sector receives less. Although both situations may have the same total money and total energy processed, people are misled because the economy of circulating money is booming as their standard of living continuously drops. As energies get even less in fuel reserves, the relative role of traditional energy from the sun, through agriculture and forestry, begins to yield as much for the effort as the effort on fuel. As this develops we move into more of a steady state.

It can be concluded that leveling is in process and that those systems will fail that make futile efforts to use stored assets to attempt growth when there are not unused flows to support new activity.

The development of a plan for economic prosperity, in the stead state, in which busy activities of good maintenance and improved ways of doing similar things are made the priority, should be the most urgent priority for our nation and all the people of the world.

Fig. 3 was incorrectly drawn in that both upper and lower diagrams were made the same. The upper diagram was supposed to have small tanks for energy industry and money.

The lower diagram was supposed to have large tanks for energy industry and money.