THE PROBLEM OF ENVIRONMENTAL MANAGEMENT OF WORLD ENERGY (1)

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HUMAN ENVIRONMENT (II)

Working Group III

"Environmental Management"

The following report was prepared by Working Group III, which considered one of the aspects of the main theme, namely, "Environmental Management".

It was prepared by the members of the Group and reflects the discussions and conclusions that were reached. As complete freedom was given to the Group, its views should not be taken as reflecting necessarily those of the United Nations or of the Specialized Agencies.

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WORKING GROUP III

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THE PROBLEM OF ENVIRONMENTAL MANAGEMENT OF WORLD ENERGY

I - INTRODUCTION

1. Proposed limitation of the scope of the subject area of the report

We propose to limit our discussion of environmental management to specific areas within the general field of energy. Thus we shall impose an artificial limit on the discussion of the total "environmental management" problem by omitting consideration of other important areas. This approach was considered necessary because of the following reasons :

(a) Treatment of all aspects of the world environmental problem would be too vast an undertaking in view of the time and resources available.

(b) The environmental management concept is so complex that a brief account would have been superficial and would have minimised the opportunities for constructive suggestions about management practice.

(c) By taking a specific subject area, it is possible to examine a problem in sufficient detail to draw conclusions about possible strategies that may be implemented.

2. Choice of energy as the topic for consideration

The use of energy has led to the development of a technologically-oriented society and has raised the standard of living of many peoples. Thus the "civilisation" or "evolution" of man is essentially dependent upon the consumption of increasing amounts of energy. Furthermore, energy is required for the utilisation of other natural resources. It is therefore essential that man's energy-harnessing activities remain consistent with the continuance of a stable ecosphere and with his own long term survival. It is argued by some that man's use of energy has enabled him to achieve an inherently unstable domination of the planet. It is therefore necessary to focus attention on the means of achieving some sort of stability. Energy consumption is a product of the size of the population and of the national per capita demand which varies among nations according to their state of technological and economic development. We are now experiencing an exponential increase in energy demand due to increases in both of these factors. This has brought with it concern about the availability of supply, the problems of by-products of high consumption such as pollution and disruption of the ecosphere, and the ethics and long-term effects of energy consumption. Several of these aspects will be dealt with in detail in the report. Since some of these problems are concerned with ethics and principles and cannot be solved with linear management decisions, much of the discussion will be limited to consideration of concepts and attitudes concerning man's production and use of energy.

3. Use of energy by man

Listed below are some of the principal uses of energy which illustrate the fundamental nature of the problem :

- Obtaining other natural resources such as water, minerals, fuel, etc.;
- production of food energy, e.g. fertilisers, mechanised agriculture, etc.;
- industrial and commercial enterprises;

- for essential domestic purposes such as cooking, heating, provision of sanitation and for building; less essential purposes such as labour-saving devices, entertainment, etc.;
- transportation and communication.

For example, in the USA in 1970, the total energy consumption of 67.8 x 10^5 BTU (34 % of the total world energy consumption) was used principally in the residential/commercial (18 %), industrial (25 %) and transportation (23 %) categories.

Current public attention on the problems of energy mainly concerns the polluting aspects both of energy production (e.g. SO2 and radioactive emissions from coal-burning and nuclear power stations), and of energy consumption (e.g. air pollution from automobiles and industry, water pollution from industrial-residential activities, noise pollution from aircraft, traffic, etc.). However, less attention has been directed towards problems of energy supply and of the evaluation and benefits of the various alternatives. There has been little consideration of the related energy demand/population exponential and the problem of its ethical and practical management.

4. UN Conference on Human Environment, Stockholm (1972)

Problems of energy were given insufficient attention at Stockholm, partly because energy is a sensitive national issue. Most countries regard it as their prerogative to consume as much energy as they wish regardless of any extra-national effects. The justification for this is that increased energy consumption is required for increases in the standard of living. Significantly, there was no discussion at Stockholm of two important areas : 1) the relationship of energy demand to population growth and 2) the problems of the different possibilities of energy supply in nations possessing different natural energy resources and different technological capacities.

Resolution II 196 was the only one dealing with energy which was adopted and which will significantly clarify any of the issues. This resolution proposes that international studies of the possible sources of energy supply and consumption should be set up to plan and forecast the environmental effects of future energy use. This is to be achieved by instituting suitable monitoring systems for the measurement and analysis of data relating to the effects of energy production and use. It is recommended that special attention be directed towards providing a suitable mechanism for the exchange of information. However, the resolution makes no reference to the possibility that some countries may be unwilling to provide adequate monitoring and technical information for reasons of the "safeguard" of national interests.

II - IMPACT OF ENERGY UTILIZATION ON TERRESTRIAL ECOSYSTEMS

In order to sustain the present range of man's various activities, it has become necessary for him to convert potential energy sources to available energy. Fuel extraction, energy production, and utilization of energy for productive work or for the manufacture of material goods has had many deleterious effects on terrestrial ecosystems. These effects include :

1. Loss of land from natural production for the immediate future;
2. increasing strain placed on natural ecological processes to become more dependent upon man-made energy inputs and to adapt to rapidly changing environmental conditions;

3. introduction into the atmosphere of increasing quantities of energy utilization by-products, such as waste heat and pollutants, so that in some instances accumulation of pollutants in ecological sinks has reached dangerous levels;

4. shifting emphasis from natural communities in equilibrium stages of ecological succession to one's in growth-oriented stages.

Forecasts of increasing energy demands in the future are not encouraging and suggest that these trends will continue. To allow these trends to continue unchecked indefinitely could seriously endanger the ability of the natural life support systems on earth to sustain life.

The situation in highly industrialized nations gives far more reason for concern than in developing nations. Industrialized nations appear to be unavoidably locked in a situation that demands increasing power for greater production of material goods and services. As a result, the side effects of energy utilization are increasing at a rapid and seemingly uncontrolled rate. Currently there is no institutionalized mechanism which takes into account the cumulative effect of negative ecological impacts such as the four outlined above. Such an assessment is clearly needed. What we must do immediately is to ask the following questions :

1. How much land can we remove from primary production at present and future population levels without jeopardising our natural life support systems ?
2. What is the net energy cost of removing terrestrial ecosystems from natural production ?
3. What is the net energy cost of replacing ecosystems supported by natural energy flows with ones dependent on man-made energy processes ?
4. How rapidly can ecosystems adapt and adjust to rapidly changing environmental conditions ?
5. How much artificial instability can we safely introduce into terrestrial ecosystems before we set off harmful trigger effects ?
6. What are the ecological limits to continued energy growth ?
7. What kind of a world do we want to live in? One increasingly dependent on artificial energy processes or one in which there still remain large areas of land devoted to natural energy cycles ?

Answering these questions is only the first step towards proper environmental management. Taking the answers into account when making decisions is the second and more important step.

III - STRATEGY FOR THE PROVISION OF ENERGY - SOURCES AND FUTURE DEMAND

Type of energy supply

Table A-1 gives some details of the principal potentially useful ways of obtaining energy. Columns IV and V (nuclear fusion and magnetohydrodynamics) relate to energy generating techniques which are not yet developed, but it is considered that technological advances will put them within reach by about the year 2,000.

TABLE A-1 : SOURCES OF ENERGY MANUFACTURE*

	I Fossil fuels	II Hydroelectric power	III Nuclear fission	IV Nuclear fusion	V Magnetohydrodynamics
Energy potentially available : estimated resources	Large resources of coal and lignite (= 2.1 x 10^{20} BTU) but oil, natural gas very limited.	Potential energy available 8.6 x 10^{16}, but very little has been exploited (8.5 %). Possibilities limited except in Africa, South America. Resource naturally renewable.	Calculated energy reserves depend on price of uranium and type of plant (viz, fission or breeder). Thus in fission plants, the estimated world uranium supply costing less than $ 15 per lb yields 4.3 x 10^{16} BTU. Used in breeders this amount yields 6.1 x 10^{21} BTU, but the increase in energy yield would make more expensive uranium an economic proposition.	Limitless energy : and low cost. (e.g., one millionth part of the deuterium in sea water yields 1.0 x 10^{22} BTU).	(large)
Factors governing plant siting	Requirement for cooling water.	Limited geographically.	Requirement for cooling water. Public opinion disfavours siting near centres of population (radioactive fallout).	No limitation : little hazard to health.	
Costs	High operating costs, but low capital costs.	Operating cost negligible. Very high capital cost per KW. (Problem in developing countries).	Capital costs intermediate between fossil fuels and hydroelectric plants. Operating costs also intermediate.	Development of new technology. Plants must be very large, but operating costs will be small.	Development of new technology
Environmental effects	Very polluting : 1) SO_2 particulate emissions into air. 2) Thermal pollution (30% thermal efficiency). Ecological effects.	Clean and relatively little pollution. Large losses of land (socio-economic effects). Ecologically hazardous.	High level of thermal pollution (30% thermal efficiency). Radioactive pollution small, providing that solid wastes (stored in steal containers in salt mines) are not released. Average exposure planned for 2000 will only be 1/125 of that due to cosmic irradiation. Breeder reactors giving higher energy outputs per unit uranium are potentially much more dangerous.	Radiation will probably be very small. Thermal pollution very small (since efficiency should be about 95%).	less thermal pollution than most techniques (ca. 70% efficiency predicted
Technology	Available now. Technology for economically reducing SO_2 pollution not developed.	Available now.	Technology available for fission; technology for breeder reactors well developed; available ca. 1980	Technology not available. Predict feasibility ca. 1995 - 2005. Probably few problems of radioactive waste, but high neutron fluxes might be tricky.	new technology - no moving parts or use of steam cycle.
Comments	Perhaps the most polluting form of obtaining energy. Emission from coal power plants accounts for more than 50 % of world SO_2 pollution.	Limit to useful life of plant (e.g., silting of lake and generators, etc.). Lake can be a useful resource.	Public resistance (largely unjustified). Estimated probabilities of minor disasters 1/1000, major disasters 1/100,000 (war, sabotage ?). Revenues for uranium mining insufficient to finance necessary expansion of exploration.	Technique of fusion could be used to deactivate other radioactive isotopes. Fusion will present less problems than fission when developed.	

* Solar energy is discussed in detail later on in the chapter.

TABLE A-2

Estimated world energy resources and other energy data

	BTU
Recoverable fossil fuels	2.1×10^{20}
Coal and lignite (a)	1.9×10^{20}
Oil	1.1×10^{19}
Natural gas (b)	1.0×10^{19}
Shale oil (economically recoverable)	1.1×10^{18}
Potentially useful hydropower	8.6×10^{16}
Useful geothermal heatflow	4.0×10^{15}
Usable tidal energy	1.9×10^{15}
Estimated world supply of uranium costing less than $ 15 per lb. used in fission power plants	4.3×10^{18}
Same amount of uranium used in breeder reactors (c)	6.1×10^{20}
Deuterium fusion of a millionth part of deuterium in sea water	1.0×10^{22}
Complete conversion of 1 million tons of matter	7.8×10^{22}
1970 world power consumption	1.9×10^{17}
Estimated year 2000 world consumption at 3% annual growth	4.6×10^{17}
Estimated year 2000 world consumption assuming per capita at 1970 USA level	2.1×10^{18}
Annual solar input	5.3×10^{21}
Annual input to photosynthesis	1.2×10^{18}
Evaporation of oceans to atmosphere (annual)	9.8×10^{20}
Vaporisation equivalent of atmospheric water	3.0×10^{19}
Heat capacity per °C of atmosphere	5.0×10^{18}
Heat capacity of oceans per °C	5.4×10^{21}

Notes

(a) Coal forms about 89% of the estimated recoverable fossil fuel source.

(b) A more pessimistic forecast suggests 0.13×10^{18} BTU available, but new discoveries might increase this figure.

(c) Since breeder reactors increase the amount of active uranium isotope, the price restriction on uranium is abolished, and the potential world uranium supply is much larger than the figure used here (10 million tons U_3O_8).

Table A-2 gives estimates of the amount of energy available from these sources and also lists data relating to actual and projected energy consumption, and the heat capacities of some natural systems.

Table A-1 shows that large amounts of energy are potentially available from fossil fuels (viz, coal which comprises 89% of the estimated total reserves) and from nuclear fission. Oil, gas and hydroelectric sources are much more limited in their future capacity, although hydroelectric power is renewable.

It is probable that future demands for energy will only be satisfied by nuclear power derived from breeder reactors and fusion plants. The potential energy available is almost limitless.

Limits of reserves

Fossil fuels and uranium supplies are not limitless. Current estimates of hydrocarbon reserves and potential economically recoverable shale-oil deposits suggest that the amounts available would yield about 2.2×10^{19} BTU (Table A-2). This includes reasonable estimates for the reserves which have not yet been discovered. The estimation of fossil reserves is complicated by the variable economic restraints imposed by exploration and extraction costs. It is estimated that about 80 % of the world's oil supplies will be exhausted by the year 2020 - 2030 assuming the present annual rate of increase of production (6.9 %). Current estimates put the oil supply as equivalent to 15 - 40 times the present annual world energy consumption. 69 % of the presently known world oil reserves are in the Arab countries which produce about 37 % of the world supply. Natural gas reserves are also small, but have been mapped less comprehensively than those of oil.

Coal remains the principal source of fossil fuel, but its desirability for electricity generation will decrease due to the high pollution problems. World coal production is expanding at about 3.6 % per annum.

There is little hydroelectric potential in developed countries, but this source of power remains an alternative for less-developed countries, provided that capital costs, environmental impact criteria and positive economic benefits can be assured.

Nuclear power (breeder reactors and fusion) seems to be the most viable source of power for the future in view of the likely energy demand. This power option need not be reserved for the developed nations, as capital and operating costs are intermediate following the cost of the development technology. Pollution and environmental effects are less than might popularly be imagined (Table A-1), and a study of the record of nuclear power generation up to the present suggests very strongly that this is certainly a cleaner method of producing power than burning coal. (These two are the major options available in most densly populated highly developed countries). This conclusion is supported by the six fold expansion of nuclear generating capacity in the period 1963-1969.

Future demand

Demand for power is increasing exponentially, and is a product of the population and the per capita demand. Figures for the period 1966-1969 show that the amount of energy consumed (equivalent metric tons of coal x 10^6) increased from [illegible], 5,[illegible], 6,013, 6,[illegible] for those 4 years. Most of the energy was used in Western Europe and North America (20% and 37% respectively) but the fraction of the total remained more or less constant over this period. We have few worldwide figures available for either the expected demands for energy or for its source, except for the USA and Japan, but these figures point to several important conclusions.

TABLE A-3

Estimated energy supply (USA)

	% of total energy supply		
	1970 (actual)	1975	1985
coal	19	20	19
nuclear	0.3	4	18
hydroelectric	4	3	3
gas	32	26	15
oil	44	47	45
Total (BTU x 10^{15})	67.8	83.8	124.9

Estimated energy consumption by sector (USA)

	% of consumption		
	1970 (actual)	1975	1985
residential/commercial	19	18	15
industrial	26	24	20
transport	24	24	23
electric utilities	25	28	34
others	6	6	6

(In 1970, it was estimated that 25 % of the total US energy consumption was used for generating electricity and that 41 % of the total energy consumption was lost as waste heat).

In the USA, total energy demand is expected to increase by 3 - 4 % per annum. It is proposed that this increased demand will be mainly satisfied by increases in the amount of energy obtained from nuclear, oil and coal sources, although only nuclear power will increase its proportional contribution. The contribution of natural gas will diminish (Table A-3).

Similar estimates have been made for Japan, which expects power demand to increase from 18 x 10^{15} BTU in 1975 to 37 x 10^{15} BTU in 1985. There will be an expansion of the relative contribution of nuclear power from 2.1 to 11.3 % of the total, but Japan will remain heavily dependent upon imported oil (76.7 % in 1975 falling to 71.5 % of the total supply in 1985).

The need for solar energy

There are several advantages of extensive development of solar energy, for industrial and agricultural nations alike. These include cheap power, increased industrial productivity, increased food production and decreased environmental deterioration. The realization of the solar battery as a practical means of local power generation can be of tremendous aid to developing nations. It has been estimated that the cost of farm electrification could be cut in half by using solar batteries on each farm. Each solar battery on the farm would foster a measure of independence and self-reliance that is so necessary for a sustained national development. Furthermore, the reliability of power availability would be greatly increased and the present government subsidy of the cost of electricity would be eliminated and replaced by a secured loan for the capital outlay for the solar system on each farm. Countries with vast presently uncultived regions of semi-desert land stand to gain the most from such a development. Once adopted on a large scale, this programme could bring about a significant advance in farming and could solve, to a large extent, the food problems of many developing nations. Furthermore, relatively small units for lighting houses, refrigeration, cooking, drying, desalination, heat engines and a variety of photo-chemical and photo-synthetic reactions, constitute other potentially fruitful areas of development.

IV - MANAGEMENT AND IMPLEMENTATION

The purpose of this section is to set out a general framework for the management of environment problems concerning energy and to suggest some concrete actions that can be taken. Table B-1 shows a general scheme for handling energy-environment problems. In this figure, a distinction is made between management at the national and the international levels.

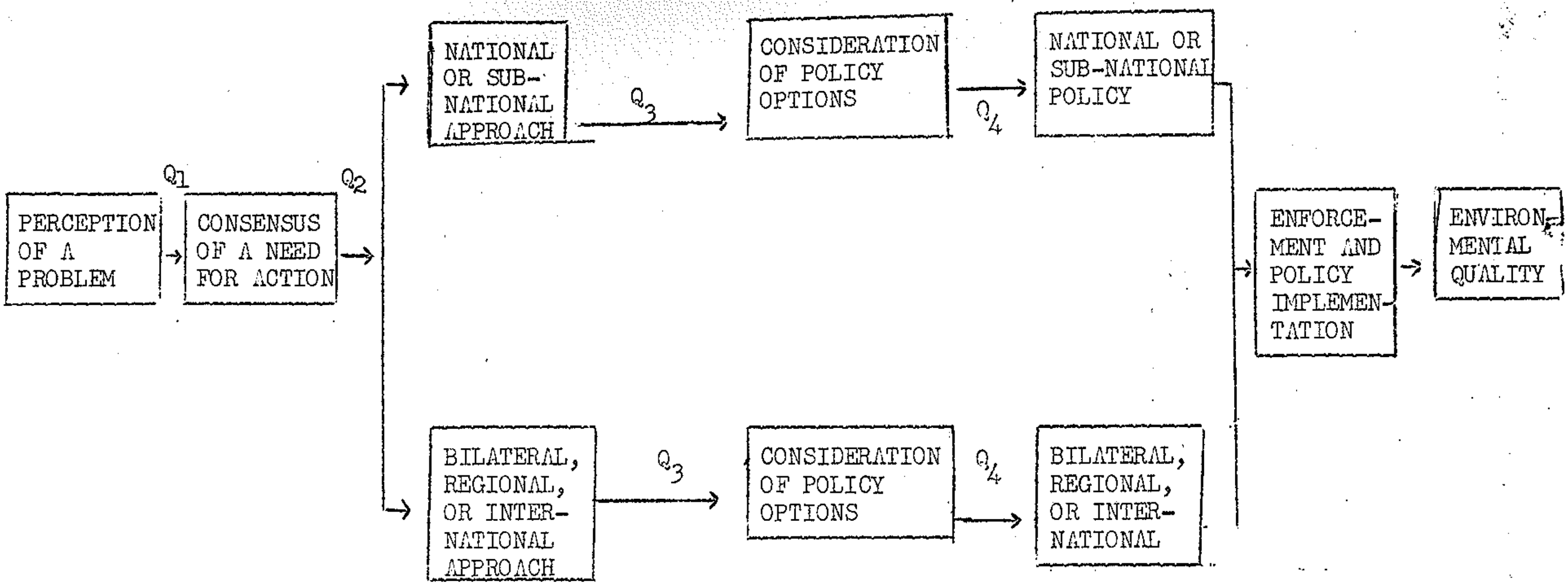
The possible techniques for dealing with a national environmental problem are detailed in Table B-2. Some of these options can be directly applied to energy-environment problems. A detailed listing of specific national level solutions is shown in Table B-4. The aim of many of these actions will be to increase the costs of energy by internalizing the social costs of the extraction, processing, transport, and conversion of fuels into energy.

The possible techniques for dealing with regional environmental problems are shown in Table B-3. The specific suggestions for managing the energy-environment problems include :

- Regional environmental criteria and standards;
- regional economic incentives or disincentives;

TABLE B-1

A GENERAL SCHEME FOR HANDLING ENERGY - ENVIRONMENT PROBLEMS



Q1 : Is the problem significant enough to warrant action ?

Q2 : Which governmental level is best suited to handle this problem ?

Q3 : What policy options are available to handle this problem ?

Q4 : Which is the best policy alternative available ?

TABLE B-2

National and sub-national policy options for management of environmental problems

LEGAL OPTIONS	OTHER OPTIONS	ECONOMIC POLICY OPTIONS
Nuisance or Private law	Governmental assuption of pollution control	Economic Incentives
Environmental standards	Governmental planning (centralized)	Tax aid
Emission controls	Informal options :	Award Payments
Equipment and Fuel controls	Education;	Direct grants
Permits and licences	persuasion;	Indirect subsidies
Regulation of Equipment operators	social pressure	Loans
Prohibition		Technical assistance
		Power of the purse (positive)
		Targeted assistance
		Economic Disincentives
		Effluent Fees
		Denial of tax benefits
		Fines
		Bonds and bond forfitures
		Power of the purse (negative)

- regional controls on fuels, equipment, and equipment operators;
- a multi-national system for permits and licences;
- a multi-national coalition to handle specific environmental problems, such as the creation of a hydro-electric project spanning several countries or the disposal of high level nuclear wastes;
- a multi-national planning commission for energy related problems in shared water or air basins.

The policy options open for the management of international environmental problems are described in Table B-3. The problems can either be delegated to individual countries, referred to the regional commissions or other multi-national groups of nations, dealt with by the Secretary-General of the United Nations and the General Assembly, referred to the specialized United Nations Agencies, or be managed by non-governmental international organizations, such as the International Union for the Conservation of Nature and Natural Resources (IUCN).

Some specific international level recommendations include :

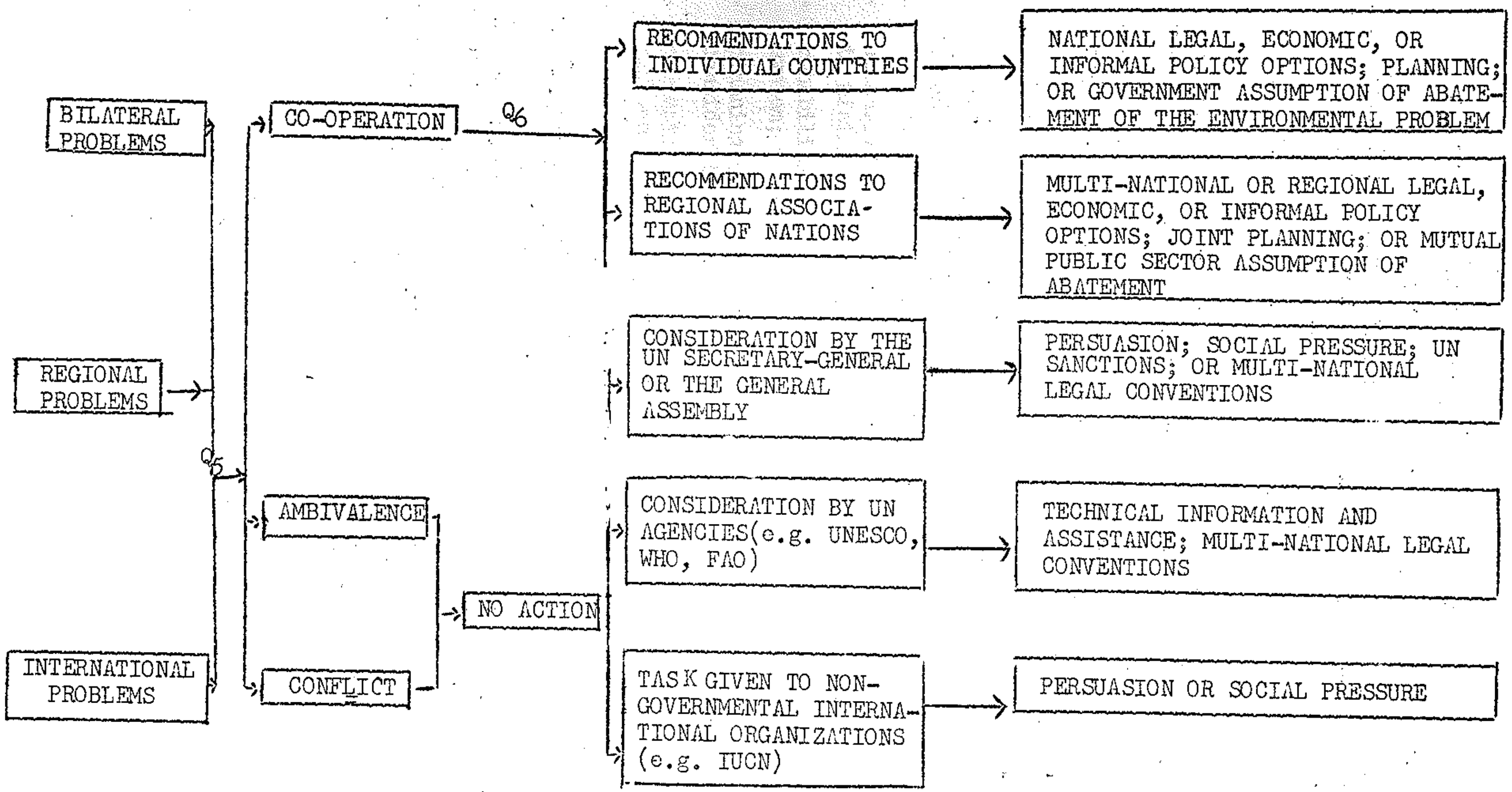
- setting of international energy-environment criteria and standards;
- holding international conventions between governments;
- sharing the results of research and development on energy matters.

Several more detailed considerations that are worthy of consideration include, the need to provide :

- adequate and accurate data on fuel supplies, energy alternatives and their environmental impacts. This should be done on a national level;
- for an extensive education and information system to discuss energy related problems, especially those of limited power supplies, the environmental impacts of energy and fuels, and the unequal distribution of energy. A related problem is the preparation of energy-environment scholars and planners who can study and plan in comprehensive ways the future of energy supply and demand. It is hoped that these scientists will not remain aloof from the decision-making process, but will actively contribute their specialized knowledge to the solution of the social-technological issues of energy and fuel policy. Such an involvement should be contemplated on both the national and international levels;
- some techniques for reducing the costs of power for the poor. One alternative is a system of "energy stamps" which would be analogous to a food stamp system, to provide low cost energy to low income peoples.

TABLE B-3

BI-LATERAL, REGIONAL, AND INTERNATIONAL POLICY OPTIONS FOR MANAGEMENT OF ENVIRONMENTAL PROBLEMS



Q_5 : What general attitude do the respective countries exhibit ?

Q_6 : At what level should the problems best be managed ?

TABLE B-4

POSSIBLE NATIONAL-LEVEL SOLUTIONS TO ENERGY-ENVIRONMENT PROBLEMS

- Establishment of equipment and fuel controls;
- environmental criteria and standards;
- permits and licence requirements for energy related construction;
- regulation of requirements for equipment operators of power-related facilities;
- prohibition of undesirable activities, such as strip mining without reclamation use of various economic incentives and disincentives to achieve environmental objectives;
- government assumption for the control of certain critical environmental problems, such as the disposal of high-level radioactive wastes;
- extensive use of persuasion, education, and social pressure to achieve goals;
- extensive technical specifications for power lines and pipelines to minimize environmental and aesthetic impact;
- rehabilitation of mined areas through the establishment of bonding system;
- planning of power plants siting and power distribution systems to consider the impacts of environmental effluents and aesthetics;
- prevention of accidental discharge of toxic substances and radioactivity as by-products of the energy systems;
- licencing of new energy sources to minimize private exploitation and to insure equal access;
- provision of a research tax on the use of current energy to finance the development of new clean energy sources;
- provisions for sharing of research and development information regarding the control of the environmental impacts of energy.

VI - A PROPOSED MODEL FOR THE COST OF NATURAL RESOURCES AND RECYCLING

Existing System

As a result of the "economic equilibrium"* that has been established, every aspect of human activity may be priced with respect to the other. Since natural resources have in the past been considered to be infinite, the calculated price for these resources only corresponds to the cost of labour that is necessary for their exploitation.

Proposed System

Unfortunately, natural resources can no longer be considered infinite, and man's usage of these resources affects the total amount available. In order to avoid a catastrophe, we must have an economic system which acknowledges this simple fact. The price of a natural resource should include not only the labour charge necessary for obtaining it but also a contribution towards the price of its depletion. Therefore, we must work out the value of all potential natural resources. Price's should be low if the proportion of the amount consumed is small compared to the total amount available, but significantly high when this proportion is large (e.g. industrial use).

Mathematical formulation

Let q be the quantity extracted from a total amount Q of a resource. Let us define an intrisic value of this resource P_1. It will be a function of q and Q : $P_1(q,Q)$.

This function must obey the following conditions :

1) $p_1(q, \infty) = 0$ for any value of q : for example, at present the intrinsic price of a resource is zero because we consider the amount available (Q) to be infinite.

2) $\lim_{q \to 0} p_1(q, Q) = 0$ because the use of small amounts has little effect (e.g. : there will be no charge for breathing !).

Let us take the simplest function which obeys both these relationships, $p_1 = \delta \frac{q}{Q}$ where δ is a constant.

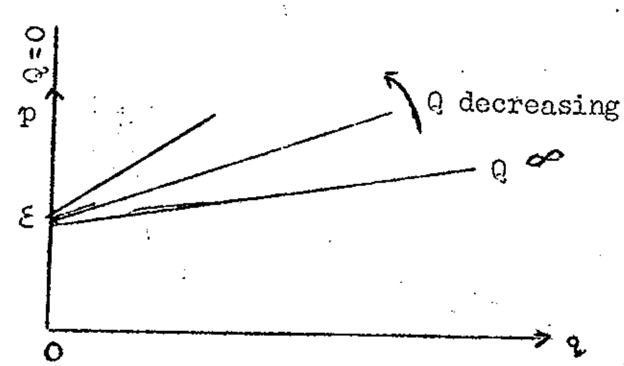
This defines the intrinsic price of a resource. To this must be added the price of its extraction, which may be considered to be proportional to the quantity taken :

$p_2 = \gamma q + \varepsilon$ where γ and ε are constants.

Thus the total price of the resource, p, is given by :

$$p = p_1 + p_2 = q\left(\gamma + \frac{\delta}{Q}\right) + \varepsilon$$

The behaviour of p as a function of q can graphically be represented as follows :



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* viz., balance of economic factors.

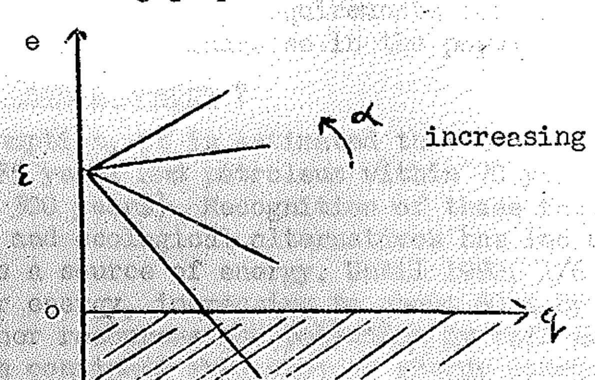
Recycling

If a part, α is recycled, and if the cost of recycling one unit is r, the saving, e will be :

$$e = \alpha q\left(\gamma + \frac{\delta}{Q}\right) + \varepsilon - r\alpha q$$

$$= \alpha q\left(\gamma + \frac{\delta}{Q} - r\right) + \varepsilon$$

as represented on the following graph :



When Q decreases, one must adjust the values of the constants γ , δ and ε such that the line representing e as a function of q does not enter the cross-hatched area. Therefore, when $\alpha q\left(\gamma + \frac{\delta}{Q} - r\right) + \varepsilon > 0$, it is economical to recycle.

Thus, the consumer will be constrained to limit his consumption, and therefore this economic equilibrium implies an ecological equilibrium.

VII - ENERGY AND ECONOMIC GROWTH : FUTURE DIRECTIONS FOR GLOBAL, SOCIAL AND ECONOMIC POLICY, WITH SPECIAL REFERENCE TO ENERGY

Growth and differences in per capita consumption between nations

Energy is an intrinsic factor of economic growth. Technological advancement has greatly increased the rate of economic growth, and over the last 50 years the amount of energy required to produce one unit growth of Gross National Product (GNP) has decreased. The increased efficiency of energy usage has offset the increased energy consumption, but this trend appears to be changing because we seem to have reached a limit of the efficiency of energy conversion.

Differences in energy use relating to GNP and per capita consumption can usefully be considered with respect to "rich" and "poor" countries*. The difference between "rich" and "poor" countries as defined by their GNP correlates well with their per capita energy consumption. We must note that GNP is a rather simplifying economic parameter.

The average per capita energy consumption of the "rich" nations amounts to over 4.5 tons coal equivalent (c.e.) per year, whereas that of the "poor" nations is less than 0.3 tons per annum - giving a ratio between the two of about 14 : 1.

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* "rich" defined as > 1 ton c.e. energy consumption per annum per capita.

Assume that the "rich" populations grow at a rate of 1.25 % per annum and the "poor" at 2.5 % per annum. If we assume further that the policy of "raising consumption standards" continues everywhere, and that the starting "rich" population is 1.0×10^9 and that of the "poor" is 2.3×10^9, then the total world energy consumption would grow from 5.5×10^9 tons c.e. in 1966 to 23.2×10^9 tons c.c. in the year 2000. The "rich" would account for nearly two-thirds and the "poor" for only a little over one-third of the increase in the world energy consumption.

Even if the populations classified as "poor" grew only at the rate assumed for the "rich", the effect on the total world energy requirements would hardly be significant - showing a reduction of just over 10 %. On the other hand, if the "rich" nations were to accept a "zero growth" policy, the energy requirements for the year 2000 would be cut by more than 30 %, despite the projected increase in the population.

<u>What happens if we don't have enough energy</u> ?

At present rates of consumption, it is estimated that known reserves of natural gas will be exhausted within 35 years and petroleum within 70 years. Coal is likely to last much longer (at least 300 years). Recognition of these facts and the lack of other realistic technological and ecological alternatives has led us to place increased emphasis on nuclear fission as a source of energy. Until 1980, 1/6 of the energy demand should be satisfied by nuclear energy, increasing to about 60 % by the year 2000. Nevertheless, shortages of other resources and pollution by radioactive by-products and waste heat may prevent the continued expansion of energy consumption. Up to now, some of these problems have been minimised by experts who tend to believe that better technical solutions can always be found.

<u>Basic questions of social and economic policy</u>

Only a few scientists have tried to criticise one of the most important root causes of energy problems : viz, that of economic growth. Most prognoses about future energy requirements imply that this kind of economic growth is necessary.

We can propose some short-term measurements to minimise external effects of energy by setting standards, restrictions and new directions for production. Within the present energy structure, this would mean that the price of energy would rise. But who is going to pay the bill ? Should the consumer in rich countries pay an increased tariff or should the cost be weighed against the poor countries, or both?

As proposed below (see appendices), a change of structure of world economy and a change in the distribution of energy is necessary. If this does not happen in the near future, we might encounter such risks as :

(i) the necessity for limitation of energy supply for ecological reasons and

(ii) unequal distribution of energy. The consequences could be mass unemployment in countries short of energy, social tensions and even economic "war". A lack of communication of know-how concerning energy technology between developed and developing countries could also cause tensions.

Briefly, we think that the following points are among the most important :

(a) <u>General</u>

- Equality of distribution of materials (including energy) - see also section V;
- reorientation of the economic system away from growth, e.g. steady state economy, (q.v., Appendix 2);
- worldwide budgeting of energy;
- reconstruction of the monetary system (q.v., Appendix 3).

(b) <u>Specific energy related issues</u>

- Who benefits from energy supplies?
- Which power structures and interests are worried by the projected world energy crisis?
- What effects can a given national energy programme have on lower income gro
- Will increases in energy supply be equitably distributed?
- How will the national energy plans of advanced industrial societies influenc Third World prospects for development?
- Should formulation of energy needs be dominated by economic criteria at the expense of social criteria?
- What effects will the present energy utilisation have both in the short-term and the long-term on the social and natural environment?
- How does one create a pattern of energy supply that will enable different communities to create meaningful and productive economies?

VIII - <u>CONCLUSION - THE NEED FOR AN ENERGY ETHIC</u>

Satisfactory resolution of the variety of attitudes and the diversity of concerns which make up the energy crisis cannot solely be achieved through the acquisition of more data nor greater educational efforts. Such measures will help, but they do not go to the root of the problem. They fall short of addressing the question of striking a balance amongst conflicting issues. Such a balance can only be achieved within a broade framework - within what might properly be called an <u>energy ethic</u>.

The fundamental problem is all too easily illustrated. Who amongst us can perceive a rational calculation which will uniquely define the proper balance between such conflicting factors as national security, environmental quality, encouragement of private investment and promotion of international accords ? Yet these seemingly unrelate issues and many more are all closely interrelated when viewed from the perspective of energy policy. To arrive at some solution requires that one makes a set of value judgements within a broader moral framework or ethic. When shared between people, such an ethic can provide a basis for their common decision making.

While the need for such a consensual ethic seems clear, its detailed content cannot of course be determined <u>a priori</u>. One is not seeking <u>the</u> answer but <u>a</u> consensus. The most that can be done is to discern some of the conflicts in the value systems which such an ethic must address. Provided below is a list based on some issues which constantly appear to be of importance and urgency and against which an energy ethic can be tested.

1. Is there some minimal level of energy consumption to which each individual has a right?
2. Should nations possess a total freedom to use their energy as they see fit, or are they bound by some world responsibility to mankind?

3. Does the State have any right to determine how or for what purpose the individual should use the energy available to him ?
4. Should man's tendency to use even more energy be regarded as a civilizing trend or a mere addiction to energy consumption ?
5. What is the proper balance between co-operation and self-sufficiency with respect to energy in the international arena ?

These questions can be epitomized in one simple question : Is energy a right, a privilege, or a commodity ? A comprehensive energy ethic will provide for the resolution of such a question.

Appendix 1

"UNIFICATION OF THE WHOLE OF MANKIND"

This is a key phrase of the ideals of a new era. The following sentences suggest some of these ideals.

World unity is the goal towards which a harassed humanity should be striving. Nationalistic expansion would come to an end. Economic planning would have as its sole aim the general good of man and not merely the interests of certain limited groups of people such as classes or nations. This system would require a world currency (most objections are based on a limited nationalistic outlook). All the barriers to world trade which now exist would vanish as well as war, the greatest of all economic burdens. Along with the war of armaments, the economic war of tariffs and quotas would vanish too. The whole world would become a single State economically as well as politically. Of course, in sum, it is upon the behaviour of individuals that the success of any economic system depends.

Appendix 2

RECONSTRUCTION OF THE MONETARY SYSTEM

We need a new monetary system, which covers the needs of our time and attitudes better than the one of today. The present monetary system is based on medieval trade and conditions operative at a time when everything was valued in money and capital goods.

A new monetary system should be based on values created through wise use of natural resources, such as for instance forests, use of rain for irrigation, dam building plus fish breeding, etc. This proposed new monetary system is based on real utilities and may be called a Green Gold system, and would supplant the yellow metal which is the artificial base for the present system of money.

As a first step towards the use of a universal currency, let us create an International Fund for Environment. We proposed that the International Monetary Fund ought to accept mortgages in, for instance, forests, dams and power stations as a security for real value certificates. These certificates could provide an internationally accepted complement to the existing currencies of the world. They will mean a contribution to those countries who wish to invest in projects that are friendly towards the environment.

The effect of such a new monetary system would be to increase the possibilities of a higher standard of living (and/or quality of life) and increased social security for everyone, particularly the poor and unemployed of the developing countries.

Today we have no room for long-term investments which lead us to plunder natural resources and to destroy the environment. Production must benefit the majority of people living on earth. Money should be used as a receipt for the achievement of work since one must look upon work and natural resources as capital. Money itself is only something printed on a sheet of paper.

Politicians and decision-makers must be more aware of this need for the creation of loans based on new values.

Appendix 3

NOTION OF A STEADY-STATE ECONOMY

This kind of economy may be defined by constant stocks of people and physical wealth, maintained at chosen desirable levels by a "low" rate of throughput. Benefits come from the services provided from stocks of funds of wealth and people. A service is the satisfaction of a certain human need. The immediate benefit of the stock is the service it renders, and its immediate cost is the maintenance throughput it requires. The ultimate benefit yielded by the stock is life itself and its enjoyment. Social limits are less recognisable than physical limits, but are probably more likely to be the effective limits. Indeed, biophysical limits imply that a steady-state economy is necessary. Note that once we obtain a steady-state economy we are not for ever frozen at that particular level of population and wealth. As values and technologies evolve we may decide that a different level is both possible and desirable. But the growth (or decline) necessary to reach the new level is a temporary adjustment process - a transition from one steady-state to another, not a return to growth as the norm.

What kind of institutions are necessary for the attainment of a steady-state economy ? They follow from the definition : an institution for maintaining a constant population; an institution for maintaining a constant stock of physical wealth and, less obviously but most importantly, an institution for limiting the degree of inequality in the distribution of the constant stock among the constant population. The institutions suggested are radical and will never come to be without a moral and political renewal.

The guiding design principle for the three social institutions is to provide the necessary control with the minimum sacrifice of personal freedom, to provide macro-stability while allowing for a micro-variability, to combine the macro-static with the micro-dynamic. To do otherwise, viz. to aim for microstability and control, is likely to be self-defeating and result in macro-instability as the capacity for spontaneous coordination, adjustment, and evolution (which always occur on the micro level) are stifled by centralized planning.

EXAMPLE

Proposed system for constant population through individual licences to have children

Each couple, at marriage, might receive certificates permitting one or two children, or whatever number corresponds to replacement fertility. The licences could be bought and sold on a free market. Thus macro-stability is obtained, micro-variability is permitted. Furthermore, those having more than two children must pay for an extra licence and those who have fewer than two children receive payments for their unused licence certificates. The right to have children is distributed equally. Market supply and demand then redistributes these rights. People who do not or who cannot have children are rewarded financially. People who wish to have more than two children are penalised financially. The effect of the plan on income distribution is equalising because the new marketable asset is distributed equally since as the rich have more children their family per capita incomes are lowered and as the poor have fewer, their family per capita incomes increase. Furthermore, we propose that income and wealth distribution should be controlled by a separate institution.

It has been suggested that the notion of private property is justified as a bastion against exploitation. But this is true only if everyone owns a minimum personal holding. Otherwise private property becomes an instrument of exploitation, rather than a guarantee against it. It is implicit in this view that private property is legitimate only if there is a distributing institution. Such an institution is lacking at present. An institution of maximum and minimum wealth and income limits would remedy this severe defect and once more legitimise private property.

The basic difference between depletion quotas and effluent taxes (the usual "solution to pollution" offered by economists) is that the former places macro-physical constraints (beyond which the market economy may not go) and leaves the price system alone, whereas the latter sets no physical constraints, but seeks by micro-intervention to rig all prices. The effect is that the market economy automatically counts the costs of all ecological effects of growth and automatically stays within properly ecological bounds. The campaign slogan for effluent taxes is "internalisation of externalities" which means calculating the full social cost of production and including it in the money prices of the product for each commodity and community. However, the effluent taxes do not limit growth of the throughput (GNP). They keep the throughput at its least-cost-mix for any given level of total throughput, but the level itself can continue upwards as the population and economic growth continue. Every time we "internalise an externality" we not only increase costs, but also incomes. Aggregate expenditure always equals aggregate income.

Maximum income and wealth would remove many of the incentives to monopoly. Why conspire to corner markets, fixed prices, etc., if you cannot keep the whole lot ?

Do we have the moral resources necessary for such changes as mentioned above ? Can the "realists" be persuaded to face reality, including the reality of the normative dimension of man's existence ? If not, then the institutions advocated in this appendix are mere dreams. But survival under institutions which do not depend upon moral resources is a nightmare.