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OBSERVATIONS BASED ON DISCUSSION ON GLOBAL PERSPECTIVES AND ENERGY STRATEGIES

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PREFACE

IIASA was created to address important problems confronting mankind through analyses free from the constraints of purely national or unidisciplinary approaches. In doing so, the Institute has tried to create an open environment where differing intellectual views can be listened to and given fair consideration.

One of the most controversial topics of the present time seems to be the world's future energy supply and demand. Ever since its foundation, IIASA has been working on this problem: the Energy Systems Program under the leadership of Wolf Häfele has made considerable progress and is expected to produce some final results by the end of 1978. To establish a balanced view, the IIASA Energy Systems Program has sought periodically to compare its own work with that of other groups researching similar areas. Visitors to the Institute have significantly helped to direct the work in Laxenburg towards the more fundamental problems foreseen by the energy community for the decades ahead.

At the beginning of this year, Dennis Meadows, co-author of the Club-of-Rome study "Limits to Growth", and Amory Lovins of "Friends of the Earth" joined IIASA for a limited time. Both of them favor a "soft technology" path for the world's future energy system. Their stay at IIASA was an opportunity to check whether or not their results provide for a deeper understanding of a complex global future.

This short note summarizes some conclusions that emerged from discussions of D. Meadows, A. Lovins, and members of the Energy Systems Program. Certainly it is just a first step and much more effort seems necessary to really integrate the viewpoints which, as turned out in beginning, largely exclude each other.

SUMMARY

A very lively discussion has developed in recent years as to which way we should go in securing our future energy demands. The debate resorts to technological and economic arguments. Mutually exclusive concepts have been devised, such as "soft" versus "hard" technology, in order to differentiate between opposing views on how to evaluate the benefits and risks associated with technologies. This short paper tries to trace some of the roots of the divergence of views. It concludes with a few research topics which could help to clarify what the implications of alternative paths are and whether they are really open.

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1. REASONS FOR A JOINT EXAMINATION OF THE PHILOSOPHY BEHIND THE ANALYTIC WORK

If one compares publications by Meadows and Lovins with those by members of the IIASA Energy Systems Program [1,2,3], different statements and recommendations are observed regarding desirable future energy technologies. Even more contrasts are seen in the analysis each side uses to support its recommendations for hard and soft energy technology paths. Several seminar discussions at IIASA failed to isolate the essential differences between the two approaches.

Thus several hours of intense, informal discussions were undertaken to identify the source of the disagreement and to define several modest research topics that would help resolve any factual uncertainties responsible for the gap between the two positions.

2. CRITERIA FOR AN ACCEPTABLE APPROACH TO THE ENERGY PROBLEM

In searching for the sources of opposing conclusions with respect to nuclear, large-scale solar, coal, renewable sources in a local or regional context (like wind, wave power, biomass utilization and small-scale solar heat) and energy conservation measures such as better insulation or the cogeneration of electricity and process heat, it turned out to be helpful to address the following questions:

(1) Which long-term fundamental problems other than energy questions have to be faced by mankind within the coming 50 years?
(2) Is the appropriate scale for analyzing these problems global, regional or local?
(3) In which subsectors should the economy be disaggregated in order to tackle the problem of self-reliance and resilience?
(4) How can one define a technological solution for the energy supply with respect to the anticipated state of affairs in terms of do's and not and in terms of don'ts?
(5) How can one specify an energy strategy leading from today's situation into a long-term future when the goals to be achieved vary with time and in principle are subject to revision?

3. PRELIMINARY RESULTS OF THE JOINT DISCUSSIONS

Questions 1 through 3 above were answered in some detail. Questions 4 and 5 remain open for further joint analysis.

Both sides agreed that major global reliance on conventional oil and gas reserves must be phased out over the next fifty years. Both felt that even the provision of plentiful energy supplies would leave many other crucial problems unsolved. Beyond that, two obviously incompatible global perspectives evolved. They are briefly outlined below.

Perspective of Dennis Meadows and Amory Lovins

The carrying capacity of the globe will continue to deteriorate. The global population will not rise above $8 \cdot 10^9$ people, perhaps not above $6 \cdot 10^9$. Population will stabilize in some regions through reduced fertility, in other areas mortality will increase and may even produce declining populations. War, pestilence, and famine will continue in cycles more or less as they have over the millenia. One might term this scenario "Business as Usual" except that it includes for the first time the possibility of massive climate change. The conflicting trends of consolidation of political blocks on one hand and increasing breakup of others will persist. The outcome of this is not clear, but it will almost certainly combine with other trends to decrease the possibilities for free trade world wide.

Under these circumstances it is probably inappropriate to plan on more than 2.5 kW/person, or around a doubling of total global energy production above current levels. The intermediate future could well see a decline in energy availability with concurrent social disruptions. It is unrealistic to expect that any significant political entity will be content to plan deliberately for sole dependence on other national political entities for its energy supplies. However, the difficulties of shifting off oil and gas leave an inescapable period of several decades dependence on the oil and gas exporters.

Under these circumstances one does not count on the adoption of global energy strategies, or even on programs that require massive shipments of energy across national boundaries. One must find sources that use regionally available energy, that are very efficient in satisfying end use demands, and that are highly resilient and easily decoupled.

According to Meadows and Lovins, sociopolitical constraints provide the basic starting point for reanalyzing and further modification of the technological system. For the analysis no concept of a sociopolitical lifestyle can be solely expressed in terms of technology. But general notions of future sociopolitical prospects can lead directly to identification of preferred technologies. Technological fixes are not an end in themselves, however. This view leads to small-scale solar applications, to wind, the use of agricultural wastes and deliberate efforts to attain zero energy growth in the wealthier nations as quickly as possible.

Soft technologies are less vulnerable with respect to social, political or military interference. If the IIASA approach is followed, Lovins and Meadows suggest that the potential damage a nation could sustain from interruption of its energy supplies from centralized facilities will exacerbate international tensions and thus lead to selfdestruction of the technologies and the infrastructure originally designed on the basis of the assumption of internationl order and altruism. Small-scale technologies will in contrast tend to stabilize the political system because small-scale conflicts, which are inevitable in any foreseeable future (this past year was really the first since the beginning of World War II that did not see major armed conflict somewhere on the globe) do not automatically lead to escalation.

It is also felt that the major problems are distributional rather than related to absolute scale. One should concentrate on the minimum or the modal energy availability rather than the average.

Perspectives at IIASA's Energy Systems Program

Starting from the observation that the technological possibility indeed exists to have ample energy for all ages and thereby also a means to practically eliminate all raw material problems and also all environmental problems [4], *it seems to be a prudent and also necessary approach to separate technological and sociopolitical considerations to the extent possible. The rationale is to first identify the features of present and future supply systems capable of providing the required carrying capacity for man in the billions--a systems' capability that is orders of magnitude beyond that which untouched and unmanaged nature can offer. Such an effort shall then serve as a basis for political groups and decision-makers in analyzing and weighing the indeed enormous institutional and social problems against the benefits that accompany the extension and evolution of modern energy systems. Some groups believe that our sociopolitical constraints will be too narrow to permit for a, still further, utilization of our technological possibilities to significantly extend man's material resources. We hold that such a judgement can only be based on an unbiased analysis of the inevitable conditions and implications of such supply systems. The decision to abandon these systems is a highly political one with very far reaching consequences. Therefore, a scientific analysis must not start by implicitly assuming that this decision has already been taken. Instead, it should reveal as clearly as possible what is at stake.*

It is in line with such an approach to reckon with the purely demographic growth path of the presently $4 \cdot 10^9$ people that will level off, according to UN population projections, at 12 to 13 billion people. Consistent with the whole approach, a further growth of the average energy consumption from presently 1.8 kW/cap to 3 to 5 kW/cap is fixed as a figure of orientation. Whereas one considers the accepted fact that

dozens of TW[1] can only be supplied by hard technologies as an attractive or a frightening perspective is not of prime importance here. Such an evaluation asks for an assessment with respect to the general framework chosen. Science can certainly put forward alternative cases. An evaluation and final decision what is to be considered as attractive or frightening is not to be performed, however, by scientists but within the domain of politics.

Some of the present energy systems are already "hard" and global in nature. The Persian Gulf is nearly a point source of energy, yielding 1.7 TW which are supplied across global distances. Discarding hard options and limiting our choices to local, resilient forms of energy, as suggested by Meadows and especially by Lovins, would deprive mankind of many of its cheapest energy sources which are found in only a few areas. This even holds for solar energy. Such a development, though difficult to quantify, will tend to reduce the availability of energy and put the burden of heavy investments on those countries which lack rich natural resources, most of which belong to the family of the Less Developed Countries. Thus, reduction of world tensions will hardly be an immediate and likely consequence of the introduction of soft energy technologies. By contrast IIASA's notion of resilience here applies to large energy systems rather than to single, weakly interacting small entities.

Implying the political preparedness to maintain and further evolve present global structures resilience, as understood within IIASA's Energy Program, points to international cooperation and economic exchange. These rely on efforts that are both a prerequisite and an integral part of hard energy technologies. Such systems do have the ability to compensate for unexpected outages. A case in point was the closure of the Suez Canal followed by the introduction of a new class of large oil tankers, which now take the route around the Cape of Good Hope.

Rather different geographical dimensions of the systems to be organized in a resilient way are chosen both by Meadows and Lovins and IIASA. In the one case, these dimensions result from the implicit goal to adjust technology to an assumed deteriorating sociopolitical environment; in the other case, they are a consequence of the goal to explore the role of energy technology in avoiding a possible degradation of that environment.

This brief and certainly oversimplifying outline of the two approaches, which are characterized by diverging assumptions on development of population, economy and political interdependence, makes it obvious why a purely technical argumentation

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[1] For comparison, the present world energy consumption is at 7.6 TW years/year or simply 7.5 TW. 1 TW year/year is approximately equal to 1 billion (10^9) tons of coal equivalent per year.

will not be able to bridge the gap between the general standpoints of "hard" and "soft" exponents.

Furthermore the need to analyze why such fundamental disagreement exists raises the question of the underlying philosophies of the two standpoints and, more important, as to whether both really cover the extremes.

4. POINTS FOR FURTHER RESEARCH AND ANALYTIC EFFORTS

The participants largely agree that further work should concentrate on the five points listed below. It is likely that even partial answers to these questions could help either to reduce the diverging opinions in interpreting technological advantages or disadvantages or at least more clearly point to the fundamental decision-making processes which will have to be carried out in the near future.

(1) Is energy a critical parameter with respect to solving the anticipated basic problems or to achieving the fixed goals implicit in the perspectives described in Section 3?
Remark: less important for A. Lovins' approach: more important for IIASA's framework; partly followed up by the WELMM effort [5].

(2) Which kind of commercial, legal and political conditions are required to introduce the new energy systems? Both "hard" and "soft" are new.
Remark: it is agreed that the transition period for both is in the order of 50 years.

(3) What is the consistent definition of "regions" for each approach, with respect to the design of strategies and the fixing of a target state of affairs? (How do regions exchange under crisis conditions?)
Remark: more important for A. Lovins; less important for IIASA, because the focus is on global considerations.

(4) Is it possible to design a strategy which at least for some time keeps both paths open?

(5) Which regions of the world will probably experience which consequences of the alternative development paths?

(6) How can one tell which of the two scenarios is more likely? What are the consequences of following the hard or the soft path if the opposite scenario is finally realized?

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