Table 1. Inputs to the environment before and after installation of desert solar energy farm with 30 percent conversion efficiency [see (1)].

Solar energy flux	Before installation (%)	After installation (%)
Reflected to space	35	5
Desert heating	65	65
Utilized in metropolitan industrial centers	0	30
Additional global heat burden		~ 30
Total	100	100

This assertion would not be correct for an economically competitive solar power system.

According to Aden Meinel and Marjorie Meinel (*1*), the only likely candidate for an economically competitive solar power system is high-temperature thermal conversion interfaced with state-of-the-art, high-pressure steam turbine systems. The goal of such a system would be to operate at 30 percent efficiency rather than at the 2 to 4 percent attainable at the present time. To attain this efficiency, 85 percent of the solar farm energy now reflected back to space would be utilized (see Table 1). If care were exercised in the manner of discharge, there would be no net thermal problem in desert regions. However, the industrial-metropolitan and global heat burden would be increased by the extent to which the ordinarily reflected light is captured and converted to solar power.

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1. A. A. Meinel and M. P. Meinel, *Univ. Ariz. Opt. Sci. Cent. Newsl.* **6**, 68 (1972).

Solar Heating and Cooling

Allen Hammond (19 Apr., p. 278) omits any reference to the work of Harold Hay of California in his discussion of solar-heated houses. Hammond gives good coverage to Harry Thomason's commendable work in Washington, D.C., but the only residence which has been constructed and operated up to this time that derives all its heat from the sun and gets all its cooling from night sky radiation and evaporation is the Hay "Skytherm" system, tested for 18 months in Phoenix, Arizona, in 1967–1968. The "Skytherm" system is now in operation as a full-scale house at Atascadero, California.

Many other companies are now becoming active in the solar heating and cooling field, primarily as a result of the three contracts given by the National Science Foundation to General Electric with the University of Pennsylvania; Westinghouse with Carnegie-Mellon University and Colorado State University; and TRW Systems with Arizona State University. The reports on these three projects are available from the National Science Foundation (*1*).

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Notes

1. A limited number of copies is available from the RANN Documents Center, Room 601, National Science Foundation, 1800 G Street, NW, Washington, D.C. 20550.

Wind Power

Martin Wolf (19 Apr., p. 382) comments on wind power and states that "A conceptual design with aeroturbines stationed off the Atlantic coast to produce 160 billion kilowatt-hours of electricity a year has been completed for the New England region." It is possible to estimate the cost and magnitude of such a wind-power project.

A megawatt of power can be extracted from the air with a very efficient wind turbine if the wind is blowing at 20 knots and the diameter of the turbine is about 60 meters. The Putnam wind generator installed at Granpa's Knob, Vermont, in the 1940's was about that size. The cost of building similar generators today is estimated to be at least $1 million if they are mass produced (*1*). To produce 160 billion kilowatt-hours a year (assuming an average wind of 20 knots) would require more than 15,000 wind generating units. The cost of installation of the units alone, not counting the cost of the offshore platforms, would thus be in excess of $15 billion. If these wind generators were placed in a line on platforms 100 meters apart, the line would stretch for 1500 kilometers, which is about the length of the entire New England coast.

Only 15 modern coal- or nuclear-fueled power plants will supply the same amount of electricity as 15,000 wind turbines, and their cost of installation is at least five times less. Also, electricity can be produced at will at conventional power plants, whereas the wind is undependable.

There is no doubt that there is plenty of power in the wind. The real problem is in economically extracting this power, and since the fundamental technology for building wind machines has already been developed, reasonable estimates of the cost of extracting wind power can be made. My analysis indicates that large-scale generation of electricity by harnessing the wind, even as a supplemental source of power, is not feasible economically.

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1. E. W. Hewson, "Wind power potential in selected areas of Oregon" (Technical Report, Department of Atmospheric Sciences, Oregon State University, Corvallis, 1973).

Industrial Energy Conservation: Dual Incentives

Charles A. Berg, in his article on industrial energy conservation (19 Apr., p. 264), mentions that industry has not felt obliged to conserve energy in the past. There are two major reasons for industry to save energy: economic (it pays) and patriotism (joining in a common effort to meet a common objective). However, without the first incentive, the second will not be able to go very far or be maintained for very long.

Industries measure their efficiency in the rate of return on capital investment (*1*) and use this same gauge to determine the advisability of current investments. Suppose a company has a current rate of return on capital of $r = P/K$, where P is the profit at the current level of sales and K is the capital invested. If an additional investment in energy-conserving alterations and equipment ΔK produces reduction of operating expenses, which in turn produces an increased profit ΔP, the company will be inclined to make the investment if $r \leq \Delta P/\Delta K$ (for simplicity, the cost of capital is included in ΔK). Typically r is in the range of 15 to 20 percent per year (*2*).

There are a number of reasons why companies hesitate to make energy-saving investments, even those which will return r on the investment.

1) There is always some amount of

uncertainty in the estimates of ΔP, while the increased cost of production can usually be passed on to the consumer.

2) An investment which is justified at current sales levels would not be justified if sales fall, since it would increase the fixed cost of the industry.

3) The high cost of capital discourages energy-saving investment, since it raises both ΔK and the minimum acceptable value of r.

Initial investments are often more effective than alternatives in conserving energy, yet, initially the uncertainties are greatest and hence additional investments less likely.

As Berg points out, small companies are least able to make energy-saving investments. Not only is capital harder and more expensive for them to obtain, but they run a higher risk than the larger corporations which have an established market. The paradox is that those companies for whom price competition makes investments which save energy advisable (and hence price cuts possible) are the least likely to be able to make the investments. Large corporations, such as automobile, steel, and so forth, are much more able to set prices where they receive the highest return and hence have the least incentive to make energy-saving investments.

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References

1. See, for example, R. G. D. Allen, *Macro-Economic Theory* (Macmillan, London, 1968).
2. *New York Times*, 24 January 1974, p. 1.

Energy and Food

I would like to correct two errors in the article by John S. Steinhart and Carol E. Steinhart (19 Apr., p. 307) on energy and food. They write, "A dramatic suggestion, to abandon chemical farming altogether, has been made by Chapman. His analysis shows. . . ."

First, in the article they cite (*1*), I discussed the economic consequences of regulating or prohibiting various agriculture chemicals. I did not suggest abandoning "chemical farming altogether." Their error, however, is understandable, since my original title was replaced by the inaccurate title "An end to chemical farming?" without my knowledge. Second, I discussed empirical results of other investigators; I undertook no new analysis. The points summarized by Steinhart and Steinhart are, however, worth considering. The consequences of high export demand and high energy prices will be in many respects similar to the effects of chemical regulation, namely, higher net income in farming, more acreage, less chemicals, and a retardation or reversal of emigration from agricultural areas. And, the competitive position of the family farm is improving vis-à-vis the corporate farm (*2*).

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1. D. Chapman, *Environment (St. Louis)* **15** (No. 2), 12 (1973).
2. B. F. Stanton, *Cornell Agricultural Economics Staff Paper No. 74-8* (Dept. of Agricultural Economics, Cornell Univ., Ithaca, N.Y., 1974).

The distinction between "coastal" and "distant" fishing in Steinhart and Steinhart's article should be clarified, as the reader may be left with the impression that coastal fisheries are more susceptible to overfishing than distant fisheries.

The overwhelming preponderance of catches in the world's fisheries is made in coastal waters. For example, the National Marine Fisheries Service estimates that some 77 percent of the 1973 U.S. catch was taken within 12 miles of U.S. shores. Distant fishing is rarely conducted in mid-ocean, as the term might imply. It is most often distant in the sense that it is conducted off someone else's shores. For example, the more than 300 Soviet vessels fishing off the United States in February were, from their point of view, engaged in distant fishing; from our point of view, a good percentage of them were engaged in coastal fishing.

Distant fishing frequently exploits stocks which have been underexploited by the contiguous country. It is energy-intensive for the obvious reason that it takes a lot of fuel to move the fleet a long distance to the fishing grounds and to move the catch back home. But distant fisheries are more prone to overfishing than traditional coastal fisheries.

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