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Energy and Life-Style

Massive energy consumption may not be necessary to maintain current living standards in America.

Allan Mazur and Eugene Rosa

One strategy for countering persistent shortages of energy is to increase the supply. Another strategy—the one that concerns us here—is to reduce the demand. The United States consumes more energy—on both an absolute and a per capita basis—than any other country. There is no doubt that a reduction in our current rate of increase of energy consumption would have short-term negative effects on the society, for example, increased unemployment and decreased pleasure driving. On the other hand, it is equally clear that we waste substantial amounts of energy and that we could use it more efficiently than we do, getting the same output with less consumption (*1*). Perhaps—after a painful short-term adjustment—we would be better off with reduced but more efficient energy consumption. Some obvious advantages would be reduced dependency on foreign oil suppliers, less pollution from power generation, less need to extract fuels from the earth and the oceans, reduction of the massive need for investment capital for the energy industry, and less need to devote large land areas to power generation and transmission facilities. Would these be outweighed by a long-term deterioration in our life-style as an industrialized nation?

We really have very little knowledge of the effect of decreased energy consumption on life-style, but there is sufficient cause for concern. Many observers have pointed to the close relation between per capita energy consumption and per capita gross national product (GNP) (*2*). One can argue that a long-term decrease in energy consumption would lead to a long-term decline in GNP with an associated decrease in the economic (and other) benefits of American life. On the other hand, many aspects of American life seem no better than comparable aspects of life in some countries that consume much less energy than we do.

Here we will report our analysis of energy consumption in a large number of countries. We have used readily available national statistics in order to estimate some of the long-term effects of reduced energy consumption on life-style. There are many shortcomings to this sort of analysis, some obvious and some subtle. We will point to these problems as we proceed, providing a sort of running critique of our own results.

Data and Method

Our sample of 55 countries (Table 1) consists basically of the United Nations member nations with population size of at least 7 million; we have also included three smaller ones—Israel, Denmark, and Switzerland—and we have excluded Communist China, North Korea, and Iran because of lack of data. We have focused on 1971, which is the most

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Table 1. Nations included in the analysis.

Developed market economies (N = 19)		*Developing market economies* (N = 29)	
Australia	Netherlands	Algeria	Morocco
Austria	Portugal	Argentina	Mozambique
Belgium	South Africa	Brazil	Nepal
Canada	Spain	Sri Lanka (Ceylon)	Nigeria
Denmark	Sweden	Chile	Peru
France	Switzerland	Colombia	Philippines
Greece	United Kingdom	Cuba	South Korea
Israel	United States	Egypt	Sudan
Italy	West Germany	Ghana	Tanzania
Japan		India	Thailand
Centrally planned economies (N = 7)		Indonesia	Turkey
Bulgaria	Romania	Iraq	Uganda
Czechoslovakia	Yugoslavia	Kenya	Venezuela
East Germany	U.S.S.R.	Malaysia	Zaire
Poland		Mexico	

recent year for which most desired data are available. Still, we frequently had to estimate 1971 figures from data for the 1960's, and in some instances we could not even make estimates. The quality of cross-national data is notoriously poor, particularly for the developing nations. Since much of our analysis focuses on developed nations this problem is not as serious as it might be, but even for United States data we find different sources giving different figures for what is apparently the same item. Even where figures are reported consistently we have little assurance that they are accurate. Perhaps a worse shortcoming is that the variables available to us are severely limited. Many that we would like to have examined were not in our data sources (mainly U.N. sources), nor probably in any data source. Clearly, our indicators do not touch on many relevant aspects of life-style.

For each country, we have estimated (i) total consumption of all commercially produced energy, (ii) consumption of electric energy, (iii) consumption of electricity specifically for domestic and commercial uses, and (iv) consumption of electricity specifically for industrial use. These variables are expressed in per capita terms in order to remove the effect of population differences between countries (*3*). For each country we have also selected 27 variables that seem indicative of certain aspects of life-style (or "quality of life") and that might be related to energy consumption; these are listed in Table 2 (*4*).

Our analysis is based on correlations between national energy consumption and the various indicators of national life-style. We would like to be able to say whether or not changes in energy

Table 2. Product-moment correlations between energy consumption and life-style indicators. Only correlations significant at the .05 level or better are given.

Life-style indicators	All nations (*N* = 25 to 55, median 47)				Nations with developed market economies (*N* = 15 to 19)			
	Total energy consumption per capita	Electricity consumption per capita			Total energy consumption per capita	Electricity consumption per capita		
		Total	For domestic and commercial use	For industrial use		Total	For domestic and commercial use	For industrial use
Health and health care indicators								
Calories in diet per capita	.76	.69	.49	.58	.53		.40	
Life expectancy	.70	.66	.43	.54				
Hospitals per capita		.27						
Hospital beds per capita	.78	.81	.46	.66	.45*	.75*	.60*	.70*
Doctors per capita	.71	.65	.40	.55				
Pharmacists per capita	.70	.69	.50	.60				
Nurses per capita	.91	.87	.62	.75	.72	.66	.47	.49
Ulcer deaths per capita	.41	.44		.30				
Automobile deaths per capita	.57	.52	.36	.43	.43			
Education and culture indicators								
College students per capita	.77	.76	.79	.82	*	*	*	*
High school students per capita	.68	.73	.59	.63	*	*	*	*
Books published per capita	.56	.58	.37	.38	*	.45*	.66*	*
Newspaper circulation per capita	.78	.79	.50	.64	.75*	.81*	.74*	.72*
Cinemas per capita	.38	.33		.32				
Cinema attendance per capita								
Museum attendance per capita	.77	.73	.79	.79	*	*	.44*	*
General satisfaction indicators								
Divorces per capita	.57	.49	.58	.61	.80	.68	.92	.83
Marriages per capita	.33	.25		.28				
Manufacturing work hours per week	−.54	−.50	−.36	−.39				
Sex discrimination in college	−.41	−.34		−.33				
Sex discrimination in high school	−.54	−.47	−.38	−.50				
Male suicides per capita	.59	.55		.43	.54*	.62*	.58*	.49*
Population density	.24							
Economic indicators								
Telephones per capita	.82	.92	.81	.81	.77	.87	.76	.77
Radios per capita	.78	.71	.88	.86	*	*	*	*
Television sets per capita	.95	.93	.76	.85	.91	.84	.75	.79
Automobiles per capita	.84	.87	.80	.78	.83	.75	.73	.68
Gross national product per capita	.94	.93	.78	.83	.86	.84	.74	.74

* Canada and the United States excluded from the computation.

consumption *cause* changes in life-style. Unfortunately, as is well known, a correlation, however high, between two variables does not imply causation. For example, a correlation of .90 between per capita energy consumption and per capita GNP would be consistent with the hypothesis that rising energy consumption causes rising GNP, but it would also be consistent with several alternative explanations such as that (i) rising GNP causes rising energy consumption; (ii) energy consumption and GNP do not have a major causal effect on each other; instead some third factor—say rising urbanization—causes both to increase; and (iii) energy consumption and GNP are simply two different measures of industrialization and the fact that they correlate is trivial. All of these ideas are consistent with the .90 correlation but none is proved by it. However, we can disprove a causal hypothesis by showing a lack of correlation. For example, if the correlation between energy consumption and GNP had been low, we could throw out all of the foregoing hypotheses. With these considerations in mind, we shall examine the real correlations.

Results and Interpretations

Table 2 contains two correlation arrays, one for all nations in our sample and one for those with developed market economies (*5*). Indicators of life-style are grouped into four somewhat arbitrary categories: health and health-care indicators, education and culture indicators, indicators of general satisfaction, and economic indicators. There is a clear value loading in this labeling, and other interpreters may choose to ignore these categorizations. The most striking feature of the first correlation array (for all nations) is that nearly all the life-style indicators correlate highly with all measures of energy consumption. This probably reflects our own bias in selecting indicators as well as the U.N.'s bias in choosing to collect statistics that differentiate the developed from the developing nations. This pattern of correlations does not prove that energy consumption influences these life-style indicators, but it is consistent with that argument.

Actually, we could hardly doubt that some relatively high level of energy consumption is essential to maintaining the life-style of the industrially developed nations. The relevant question is this: Once a nation has the relatively high energy consumption characteristic of developed economies, does a moderate increment in energy consumption cause a new change in life-style? To put it another way, among the developed market nations do the nations with relatively low energy consumption have "lower" life-styles than those with higher energy consumption? To answer this we must look at the right-hand array in Table 2, which is based on the nations with developed market economies (*6*). Here the majority of correlations drop to insignificance. Perhaps they are reduced because the original correlations were spurious (accidental), or because we have restricted the range of the variables. In any case, variation of energy consumption within the range of the developed nations is not significantly reflected in most of the life-style indicators.

If we examine the categories in detail we see that of nine health and health-care indicators, only hospital beds per capita, nurses per capita, and to a lesser extent calories in diet show consistently significant correlations with the measures of energy consumption. Among seven education and culture indicators, only newspaper circulation and quantity of books published show any consistency of significant correlations. Of seven indicators of general satisfaction, only the divorce and suicide rates are significantly related to energy consumption; both of these *increase* with higher energy use.

Economic indicators provide a different picture: four of the five retain high correlations with the measures of energy consumption. This is consistent with the theory that high energy consumption causes high economic productivity, but also, as noted earlier, with several other interpretations. It is quite plausible that causation is in large part in the reverse direction. That is, high economic productivity and consumption of products may be a major cause of high energy consumption. Certainly the proliferation of cars and televisions in the United States produces a demand for the energy necessary to use them, and to the extent that those and other appliances can be made to operate on less energy than they now use we could reduce energy consumption without deleterious effects.

Perhaps our energy and economic variables are not really distinct variables at all, but simply different measures of one general variable such as level of industrialization. The high correlations may simply be telling us that highly industrialized countries—as measured by energy consumption—are highly industrialized countries—as measured by GNP or by production of automobiles. In this case the correlations have no causal significance at all. Certainly there are reasons to accept this interpretation. The extraction and distribution of fuels, the generation and transmission of electricity, the design and construction of power plants—these are all massive economic activities which are, by definition, part of GNP. Seven of the 20 largest corporations in the United States are oil companies (*7*). The electric power industry is larger than any other industry in the United States in terms of net capital investment (*8*). Our national energy activity is in large part identical with our national economic activity, and to that extent a cutback in energy consumption is synonymous with a cutback in economic indicators; but it is not clear that this would necessarily have a long-term negative effect on the society (*9*).

As we remarked at the beginning of this discussion, there are severe limits to this analysis which keep us far from a complete understanding of the problem. However, within those limits we suggest the following tentative conclusions: Of the life-style indicators examined here, only the economic indicators show a consistently high association with energy consumption. We suggest that so long as America's per capita energy consumption does not go below that of other developed nations, we can sustain a reduction in energy use without long-term deterioration of our indicators of health and health care, of education and culture, and of general satisfaction. The results do suggest a deterioration in economic indicators, although that conclusion remains problematic for us; other interpretations are feasible. Our analysis has been limited to cross-national comparisons at one point in time. Further analysis, of longitudinal data, might clarify the relationship between energy consumption and economic indicators.

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2. S. Schurr, *Sci. Am.* **218**, 111 (Sept. 1963); C. Starr, *ibid.* **224**, 36 (Sept. 1971); E. Cook, *ibid.*, p. 134.
3. Total energy consumption and electricity consumption (which includes production and transmission losses) were taken from *United Nations World Energy Supplies, 1968–71* (United Nations, New York, 1973), series J. No. 6. To estimate electricity consumption in

1971 by domestic and commercial use and industrial use, we obtained a breakdown for the 1960's from *Statistics of Energy, 1965–69* (Organization for Economic Cooperation and Development, Paris, 1971) and N. Guyol [*The World Electric Power Industry* (Univ. of California Press, Berkeley, 1969], and applied this to total electricity consumption for 1971. P. Ehrlich and J. Holdren [*Science* **171**, 1212 (1971)], suggest that per capita energy consumption is a function of population size. However, we obtained insignificant correlations between national population size and each of our four measures of per capita energy consumption.

4. Most of the indicators in Table 2 are straightforward. For most, technical definitions are in the main data source: *United Nations Statistical Yearbook, 1972* (United Nations, New York, 1973). "Calories in diet" refers to average daily supply per capita of foodstuffs at the retail level after deduction for animal feed, seed, industrial purposes, waste, and processing losses. Life expectancies are the average for males and females. We have taken "second level" education to be roughly equivalent to high school, and "third level" to college. Data on male suicides were taken from the *United Nations Demographic Yearbook, 1971* (United Nations, New York, 1972). Museum attendance data were taken from the *Unesco Statistical Yearbook, 1971* (Unesco, Belgium, 1972). "Manufacturing work hours per week" refers to the average number of hours worked per week by a wage earner in manufacturing. Sex discrimination in college (and high school) is represented as the ratio of male students to total students, which is always greater than 0.5.
5. We have used the United Nations designation of nations as developed market economies, developing market economies, or centrally planned (communist) economies, as in *United Nations World Energy Supplies, 1968–71* [see (*3*)].
6. Any summary statistic has the potential to be misleading. In particular, the product-moment correlations used here may be highly affected by a few extreme values of either variable [H. Blalock, *Social Statistics* (McGraw-Hill, New York, ed. 2, 1972), p. 381]. To illustrate, among the 19 developed market nations there is a correlation of .73 between per capita energy consumption and total land area. Among these countries, it is obvious that the United States and Canada are both very high per capita energy consumers, and both have very large land areas. This suggests that the high correlation may be an artifact of these two extreme cases. In fact, when the correlation is recalculated with the two large countries excluded, it becomes insignificant. In order to guard against this sort of artifactual inflation or deflation of a correlation, we have rechecked all correlations with the United States and Canada excluded. Correlations for eight indicators changed substantially (see Table 2); the remaining correlations were stable.
7. *Newsweek*, 11 Feb. 1974, p. 72.
8. Joint Committee on Atomic Energy, U.S. Congress, *Environmental Effects of Providing Electric Power*, part 2, vol. 2 (Government Printing Office, Washington, D.C., 1970), p. 1809.
9. As mentioned earlier, another interpretation is that energy consumption and the economic indicators are correlated because of their association with a third variable such as "level of urbanization." It seems likely that city dwellers use more energy (per capita) than rural dwellers do, and city dwellers also probably consume more manufactured goods. We calculated the partial correlations between energy consumption and the economic indicators while controlling on urbanization. If the original correlations are to be explained as largely an effect of urbanization, then these partials must be substantially lower than the original correlations [H. Blalock, *Social Statistics* (McGraw-Hill, New York, ed. 2, 1972)]. That was not the case.

NEWS AND COMMENT

OCS Oil: Mammoth Lease Plan Encounters Heavy Opposition

The Department of the Interior's plans to embark on a vast new leasing program in the allegedly oil-rich areas of the outer continental shelf (OCS) have generated one of the biggest environment- and resource-related battles now going on within the federal government. Critics of the plan, including environmentalists, congressmen, and government officials, appear to outstrip its adherents in number, if not in influence. Many feel Interior has really taken the bit in its teeth on this one, and has made a unilateral decision that takes little account of recommendations such as those made by the Council on Environmental Quality (CEQ) in its report on the OCS.

They believe the department's intent, which is to lease 10 million acres of OCS lands in the Atlantic, the Pacific off Southern California, the Gulf of Alaska, and the Gulf of Mexico, is hasty and ill conceived. They say that the department is not prepared to handle such an accelerated program, that environmental data are insufficient, that the states are not ready to deal with the onshore impacts of offshore development, and that oil companies themselves do not have the resources to properly exploit the huge menu of riches the government wants to lay before them.

Proponents of the accelerated leasing plan emphasize that the unexplored areas of the OCS contain the most bountiful sources of untapped energy that will be available in the United States within the next 15 years, and that it can be recovered with far less environmental damage than would be caused by, say, a crash program of coal extraction in the West.

Intense new interest in OCS possibilities sprang up in 1973 when President Nixon announced that the Interior Department would step up offshore oil leasing from 1 million to 3 million acres a year. Then in January 1974 Nixon announced a new jump—as part of the kickoff for Project Independence, Interior was aiming to triple the acreage again, this time to 10 million acres, all to be sold in 1975. It is still not clear whether Interior wants to make it a yearly practice to lease 10 million acres, but since the figure is generally acknowledged to have been arbitrarily chosen, it is enough to say that the department wants to get as much acreage as possible into exploration as soon as possible. The rationale for this is simply that it is essential to increasing domestic oil supplies, reversing inflationary trends, and ameliorating the balance of payments crisis, and in sum, to combating the extortive pricing policies of oil-exporting nations.

It should be emphasized that there is no unequivocal evidence that there are large recoverable amounts of oil in any of the frontier areas. The richest deposits are thought to be in the Gulf of Alaska, which is why Interior wants to hold early lease sales there despite the fact that CEQ (*Science*, 17 May) ranked Alaska exploration as high risk environmentally. But even there, estimates of recoverable supplies vary widely.

If the 10-million-acre leasing program is carried through in 1975, however, it means that as much acreage will be leased in 1 year as has been leased by the federal government since it got into that business in 1954. Obviously, the long-term cumulative environmental effects are impossible to calculate.

While expansion of OCS drilling operations is inevitable, the question is whether such a dramatic increase is what America really needs. President Ford, who has adopted the Nixon line on energy policy, evidently thinks so. Interior Secretary and newly appointed energy sheik Rogers C. B. Morton thinks so. And so does Interior Undersecretary John C. Whitaker, the chief mastermind of the program.

Government agencies are presenting a united front in support of Administration policy, but there are signs of breaks in the ranks. One of the most visible was the recent dismissal of John Sawhill, head of the Federal