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Helmut J. Frank

HOW INDUSTRIAL SOCIETIES USE ENERGY: A COMPARATIVE ANALYSIS

By J. DARMSTADTER, J. DUNKERLEY, and J. ALTERMAN
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According to conventional wisdom, the average American is a terrible wastrel of the world's precious and diminishing energy resources. Is it not a fact that some six percent of the globe's population consumes one-third of the total volume of energy? It follows that a broad range of measures should be taken to eliminate this "waste." Electricity and fuel usage for climatizing buildings and operating appliances, for example, should be sharply reduced, as should gasoline consumption by passenger cars.

Such prescriptions unfortunately rest more often on superficial impressions or arbitrary judgments than on a thorough examination of the facts. Admittedly, the typical American keeps home temperatures too high in winter and too low in summer—paradoxically, often colder in summer than in winter. But would the transactions achievable from adjusting thermostats bring residential fuel consumption down to that of the average European home which is much smaller and exposed to less extreme temperature swings? Similarly, the efficiency of American automobiles certainly can be increased greatly and is, in fact, being raised. But should U.S. policy aim at reducing gasoline usage per vehicle to that of the average English, German or Japanese driver when population densities in the United States are much lower, distances far greater, public transportation less developed and gasoline prices far lower?

A group of three energy specialists at Resources for the Future (RFF) has attempted to strip issues such as these from their usual emotion-charged context and to focus the light of objective research on the intricate patterns of energy consumption in a variety of industrialized countries. Data for 1972, the most recent available when the study was begun, were examined for seven countries in addition to the United States: Canada, five Western European nations, and Japan. In addition to making comparisons of total energy usage, per capita and per unit of output, the authors analyzed sectoral consumption by households and commercial establishments, industry groups and subgroups and transportation of persons and goods. The work was supported by a grant from the Electric Power Research Institute (EPRI). EPRI and RFF also sponsored a subsequent work-

shop in which a number of other investigators of energy consumption participated.[1]

The basic approach taken by the RFF team was straightforward. While there is a rough correlation between energy consumption and economic activity, both historically and cross-sectionally across countries and regions, wide differences in energy use per unit of output exist. To answer the question of why residents of European countries having per capita incomes similar to those of North American nations consume so much less energy, it is necessary to distinguish between differences arising from energy *intensity* (usage for producing similar goods or supporting similar activities), and those related to economic structure (the relative importance of energy intensive industries, product mix, vintage of capital stock, etc.) The latter, in turn, may rest on more basic differences in resource endowment, geography, population density, and relative costs of complementary and substitute inputs as well as on lifestyle preferences.

Not unexpectedly, numerous problems of data availability and comparability were encountered. Their resolution was greatly aided by availability of purchasing power parity measures,[2] which provide a much better basis for international consumption comparisons than does the traditional method based on relative currency values.

The results are interesting. Four major sectors—passenger transport, industry, residential space conditioning, and freight transport, in descending order of importance—account for 60 percent of the variability in energy/gross domestic product ratios. The proportion of inter-country differences accounted for by intensity factors, necessarily subject to a range of error because of incomplete data, also is estimated at 60 percent. The remainder stems from structural differences. There appears to be wide, though not unlimited, scope for studying the foreign experience in greater depth to determine areas where energy usage could be reduced without impinging seriously on living standards.

The question of which changes in lifestyles are acceptable and which unacceptable is necessarily controversial, since it is tied closely to individual values and preference patterns. A reasonable classification is that of Lincoln Gordon, outlined in his contribution to the RFF-EPRI Workshop,[3] that industrial and commercial conservation

1. The workshop proceedings were published in RFF Research Paper R-10, *International Comparisons of Energy Consumption*, edited by Joy Dunkerley, April 1978.

2. Irving G. Kravis, et al., *A System of International Comparisons of Gross Product and Gross Purchasing Power.* The Johns Hopkins Press for Resources for the Future, 1975.

3. *Supra* note 1, at 201-204.

and better insulated housing have no effect on lifestyles (though, manifestly, they are not without costs); that altered thermostat settings, smaller and lighter automobiles and returnable containers have only minor effects, but that shifts to mass transit and apartment living and giving up central heating imply significant changes which would encounter strong public resistance. Gordon admits that others might disagree with these judgments.

The authors are fully aware that their study does not represent the last word on the question it poses. Limiting the analysis to a single year, which preceded the radical changes in world energy, is a severe limitation. One would like to see time series analyses of individual countries, preferably comparing a pre-1974 period with the most recent years, in addition to more detailed cross sectional studies. Analysis of the major effect of differences in energy prices, not covered here, would require use of econometric techniques and a much larger data base. Industrial analysis might be better handled by direct comparisons of industrial processes than with the indirect approach used here. Much additional work is in progress, at RFF and elsewhere, along these and other lines. The present study, however valuable, thus represents only a first step toward development of a firm basis for development of rational and viable energy policies.

HELMUT J. FRANK*

*Director, Division of Economic and Business Research, University of Arizona.