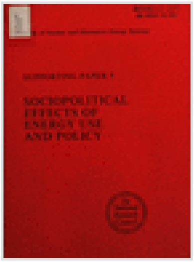

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Study of Nuclear and Alternative Energy Systems

SUPPORTING PAPER 5

SOCIOPOLITICAL EFFECTS OF ENERGY USE AND POLICY

Edited by
Charles T. Unseld, Denton E. Morrison, David L. Sills, and C. P. Wolf

Reports to the
Sociopolitical Effects Resource Group
Risk and Impact Panel
of the
Committee on Nuclear and Alternative Energy Systems
National Research Council

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PREFACE

In June 1975, the National Research Council (NRC) undertook a comprehensive study of the nation's prospective energy economy during the period 1985-2010, with special attention to the role of nuclear power among the alternative energy systems. The goal of the study is to assist the American people and government in formulating energy policy.

The Governing Board of the National Research Council appointed an NRC-wide Committee on Nuclear and Alternative Energy Systems (CONAES) to conduct the study. CONAES consists of 15 members drawn from diverse disciplines and backgrounds. The committee developed a three-tiered functional structure for the study. The first tier is CONAES itself. The ultimate findings, judgments, and conclusions of the study will be embodied in its final report.

To provide scientific and engineering data and analyses, a second tier of four panels was formed to examine (1) energy demand and conservation, (2) energy supply and delivery systems, (3) risks and impacts of energy supply and use, and (4) syntheses of diverse models of future energy economies, respectively. Each panel, in turn, established a number of resource groups--22 in all--as the third tier, to address in detail an array of more particular matters, such as buildings and transportation systems, solar energy, breeder reactors, coal technologies, health and environmental implications, and alternative consumption patterns and economic models. In all, more than 200 informed individuals served on or contributed to the work of the panels and resource groups.

The National Research Council customarily publishes only the final reports of its committees--and then only after the report has been reviewed by a group other than its authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. However, because such a large volume of information and analyses was assembled for consideration by the committee, and because of the diversity and scope of that information and the accompanying judgments, the panel reports and approximately 10 reports by the resource groups are being published as supporting papers. Each of these has been considered and used by CONAES but has not undergone the critical review procedure normal to the NRC.

The primary product of the Sociopolitical Effects Resource Group is a summary report, "Sociopolitical Impacts of Nuclear and Alternative

Energy Systems," which is chapter 8 of the forthcoming Risk and Impact Panel report of CONAES. The present volume consists of the papers, both contributed and commissioned, that served as background in the preparation of the summary report. Some of the papers describe original research, some report or summarize the state of the art of empirical research, and others are of a speculative nature. In addition, this volume contains a research agenda that identifies the gaps in research that the resource group found in its effort to apply social science knowledge to the national debate concerning energy policy. The views expressed in the papers collected here are those of the authors and not necessarily those of all the members of the resource group. What is more, some conclusions in these papers may differ from the conclusions of the CONAES report. Publication of these papers does not necessarily constitute endorsement by CONAES or the National Research Council.

The annotated bibliography, which is a comprehensive review of the literature on energy/society interactions, should serve as a valuable reference aid for bringing the tools and knowledge of the social sciences to bear on energy decisions--a task just now beginning and one that must be intensively developed in the future.

ACKNOWLEDGMENTS

The Sociopolitical Effects Resource Group has benefited greatly from the advice and assistance of a large number of people. We are particularly grateful to John P. Holdren, of the steering committee; to Otis Dudley Duncan; to Chairman James F. Crow and other members of the Risk and Impact Panel; to Richard Silberglitt and Lee Colquitt, Jr., formerly of the CONAES staff; and to a number of colleagues whose advice and written material were extremely helpful: Desmond Connor, Connor Development Services; Dawn Day, Brooklyn College; Mary Hamilton, BDM Corporation; Thomas A. Heberlein, University of Wisconsin; Allan Mazur, Syracuse University; and Judson Parker, Jr., U.S. Department of Energy. Leona Cohen typed much of the original manuscript and all of the correspondence.

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INTRODUCTION

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In recent years, understanding of the nature and dimensions of the "energy problem" has changed drastically--for scientists, policy makers, and the public. What were once considered exclusively technical problems amenable to technical solutions are now correctly viewed as facets of larger concerns that pervade all of society. To state that questions of energy policy are social and political as much as they are technical is now to state the obvious. The direct implication of this realization, however, is only beginning to be fully recognized: that in making decisions about our energy systems we are engaged in no less a task than that of determining what we wish to become as a society and of choosing a path to that future society.

Because energy systems--supply, delivery, end use--play so central a role in determining the nature of a society, all realistic scenarios for the future imply important social changes. This would be as true if cheap, clean, and inexhaustible sources of energy were discovered as it would be if no new major sources were developed. The structure and function of institutions, the face of the land, and the manner in which individuals lead their daily lives all promise to change in the future as we grapple with solutions to the energy problem. The reverse is also true--changing social trends promise to exert important influences on energy choices. This recognition--that a society and its energy systems are interactive and mutually determinative--makes the task much more complex and less amenable to simplistic solutions, but it also creates the opportunity for innovative solutions.

A significant result of the efforts of CONAES has been the central role these social and political themes have assumed in its endeavors. Far from merely expanding the scope of the study, the explicit focus on questions of a social and political nature has changed the manner in which we deal with questions of energy. Questions that once appeared to require only an objective assessment of the economics and operating characteristics of energy technologies are now recognized as heavily value-laden issues that require complex methods of analysis. The knowledge yielded by the social sciences is clearly central to informed policy making.

The task of this resource group was to offer the best available knowledge about the risks and impacts on society of various energy scenarios, characterized by their mix of energy technologies and total energy levels. We were faced, as we are with all futures research, with the problem of attempting to understand systems that can only be imagined, not studied empirically. Empirical research on impacts and risks of existing technologies represent an important component of such an effort, however.

Equally important are the effects of changes in social systems on choices of energy systems. Social variables are not always dependent variables, yet the bulk of research has focused on energy system impacts on society.

This collection of papers was employed as background material by the resource group in preparing its main report, "Sociopolitical Impacts of

Nuclear and Alternative Energy Systems," which is chapter 8 of the forthcoming Risk and Impact Panel report. The organization of this volume and of the main report reflects our attempt at an explicit focus on social variables in their relationship to technological variables; we feel it represents a significant effort to bring issues of social policy directly into the energy arena. In this, we depart from the usual tendency to organize research primarily around technological categories, such as energy source and fuel cycle stage.

The major categories of effects employed here--equity and other differential impacts, as well as institutional, political, and international impacts--are obviously interrelated. At the moment, there are some research areas beginning to yield systematic knowledge, some in which there are more questions than answers, and some in which we have yet to formulate the proper questions.

Clearly, the broad range of issues raised in this collection cannot be adequately resolved in the absence of a concerted research effort directed at exploring these questions in much greater detail. Accordingly, another important task of the resource group, addressed in the final section of this volume, was that of indicating the areas of our present ignorance, and of suggesting directions for future research by which to dispel them. Our hope is that this volume and the main report will inform and inspire continued research into these important areas of energy/society interactions.

I.

LOCAL AND REGIONAL IMPACTS

IMPACTS ON HOUSEHOLD ENERGY CONSUMPTION:
AN EMPIRICAL STUDY OF MICHIGAN FAMILIES

by

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Joanne Goodman Keith

James J. Zuiches

Michigan State University

PREFACE

This research was supported in part by the Michigan Agricultural Experiment Station, Project 3152, "Functioning of the Family Ecosystem in a World of Changing Energy Availability."

This is a revised version of a paper read at the Annual Meeting of the Society for the Study of Social Problems, September 4, 1977, and at the International Workshop, "Responses and Adaptations to Global Energy Constraints," sponsored by the International Federation of Institutes for Advanced Study, Vienna, Austria, September 15, 1977.

All three authors are members of an interdisciplinary family energy research team, whose work has been facilitated through the Institute for Family and Child Study, College of Human Ecology, Michigan State University.

The authors thank Dr. Peter M. Gladhart, Michael Lawrence, Mark W. Roosa, Jeanne Alessi Ortiz, Linda Buttel, and Jacqueline Grossman for computational assistance. They also thank Dr. Denton E. Morrison, Michigan State University, Dr. Jack M. Weller, University of Kansas, and Charles T. Unseld, Solar Energy Research Institute, for their editorial comments on the earlier drafts of this work.

INTRODUCTION

Households consume about two-thirds of all energy used in the United States. About half of household consumption is direct, through the purchase of fuels and electricity, and the other half is indirect, through the energy embodied in the goods and services bought for personal use. The remaining one-third of total U.S. energy consumption is attributable to capital formation, exports, and the goods and services bought by all levels of government (National Research Council, 1977).

Most societal energy decisions today are related directly or indirectly to the nation's households. People as individuals within households constitute a decision making unit in society and, therefore, their beliefs, attitudes, expectations, and values create the collective life-style which produces the total demand for energy.

Since the Arab oil embargo (winter 1973-74), households have experienced increases in energy costs for all forms of energy used in the dwelling unit. Michigan households have experienced a 126 percent increase in fuel oil cost, an 81 percent increase in natural gas prices, and a 50 percent increase in electricity rates between 1974 and 1976 (Gladhart, Zuiches, and Morrison, 1977). How family households have responded to increased energy costs and their concomitant effects in the 1974-76 period is the subject of this analysis.[1] The following questions are addressed:

1. Do Michigan families perceive energy shortages or only the increases in the cost of energy?
2. Do Michigan families believe the energy problem is real?
3. What conservation practices have they employed?
4. Have any changes in energy consumption been made between 1974 and 1976 by Michigan families (if so, what is the percentage of change and in what direction)?
5. What is the relationship between percentage changes in energy consumption and selected household characteristics?
6. Is there potential for energy conservation?

The answers to these questions will be provided in three sections:

I. Impact of the Energy Problem on Families
II. Impact of the Family on the Energy Problem
III. Prospects for Energy Conservation

---

[1] Family households are defined as any household with two or more related persons, one of whom is 18 years of age or older. Therefore, husband-wife; husband-wife-child(ren); single parent-child(ren) and bi-sex committed groupings were included. Single person households were excluded from the survey.

Previous Research

Numerous studies indicate how the public has responded to the scarcity of energy supplies and the more apparent increased cost of energy.[2] Many of these studies are surveys of beliefs, attitudes, and perceptions about the energy problem, while other research examines reported behaviors in relation to conserving energy, for example, reports of turning town the thermostat, using less hot water, insulating, changing driving habits, etc.[3]

Of the studies that contain *actual* fuel consumption measurements, some measure short-term energy consumption,[4] while others concentrate on one energy source rather than the complete set of energy sources unique to each dwelling unit.[5]

Several studies have been completed, or are under way, that monitor or audit actual residential energy consumption precisely over time.[6] Some of these studies assess physical-structural characteristics while others assess socioeconomic characteristics related to energy consumption. Both Grier (1976) and Williams, Kruvant, and Newman (1977) compared consumption of electricity and natural gas for 1972-73 and 1974-75. The figures yield some insight about the percentage of energy consumption changes for selected socioeconomic subgroups.

Studies have not been found that examine belief, attitudes, reported energy conservation behaviors, as well as physical-structural and demographic characteristics related to actual energy consumption. The following analysis is, therefore, an attempt to overcome these apparent omissions.

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[2] Barth, Mills, and Seagrave (1974); Berman and Hammer (1973); Berman, Hammer, and Tihansky (1972); Bloom (1975); Grier (1976); King (1975); Newman and Day (1975a,b,c).

[3] Barnaby and Reizenstein (1975); Bartell (1974); Bee Angell (1975); Bultena (1976); Burdge, Warner, and Hoffman (1976); Curtin (1975); Doering *et al.* (1974); Gottlieb (1974); Gottlieb and Matre (1975, 1976); Hannon (1975); Hogan (1976); Hummel, Levitt, and Loomis (1975); Hyland *et al.* (1975); Kilkeary (1975); Murray *et al.* (1974); Perlman and Warren (1975a); Rappeport and Labaw (1974-75); Schwartz and Schwartz-Barcott (1974); Talarzyk and Omura (1975); Thompson and MacTavish (1976); Warkov (1976); Warren (1974); W. B. Doner and Market Opinion Research (1975).

[4] Cohen (1976); Heberlein (1975); Morrison (1975); Seligman and Darley (1976); Winett and Nietzel (1975).

[5] Gladhart, Zuiches, and Morrison (1977); Gross (ongoing); Levy (1973); Seaver and Patterson (1976); Walker and Draper (1975).

[6] Carter (ongoing); Cunningham and Lopreato (ongoing); Gladhart, Zuiches, and Morrison (1977); Keith (1977); Lockeretz (1975); Socolow and Lopreato (1975).

Sample and Methods

An area probability sampling technique of family households in the Lansing, Mich., Standard Metropolitan Statistical Area was used in both the 1974 and 1976 studies. The probabilities of selection were proportional to population size, using tracts, blocks, and township sections as the sampling frame in each cross-section of the longitudinal study. The 1976 sample, rather than being completely new, was designed to resurvey as many of the 1974 respondents as could be found, and to use all remaining households and addresses (including those not contacted, not at home, or listed as vacant addresses in 1974) as replacements for the attrition brought about by the use of a modified panel design. A total of 216 family households were interviewed in 1974 and 264 in 1976. Fifty-nine percent of those interviewed in 1974 were interviewed in 1976. The 1976 study included 129 reinterviewed households and 135 new households. See the Appendix for a description of the sample distribution.

Responses were elicited from both husband and wife for 235 families; couples were assumed to reflect independent reactions and were, therefore, analyzed as male and female responses (sections I and III). However, for the energy consumption analysis the unit of concern was the family household including their dwelling unit or residence. Of the 264 dwelling units in the study, 130 had complete direct energy data for both 1974 and 1976. These were all single-family dwellings. Thus, the analysis is focused on the individuals in the family in sections I and III (N=499 persons), and on a subsample in section II (n=130 households).

Self-administered questionnaires were used for the energy questions; on the follow-up contact the interviewer asked the background socioeconomic questions and requested permission to contact fuel companies for energy data. Information on the amount of energy consumed by each residence was collected from utility and fuel oil companies (see Lewis, [1977]).[7] The units of measure unique to each energy source (cubic feet of gas, gallons of oil, and kilowatts of electricity) were converted to millions of British thermal units (Btu).[8] The various energy sources were summed for each dwelling unit as the measure of total fuel energy consumption for both 1974 and 1976.

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[7] Consumers Power Company, Jackson, Mich., and the Lansing Board of Water and Light, as well as numerous oil companies, cooperated to make the analysis possible.

[8] Energy conversions to Btu (Ford Foundation, 1974):

Natural Gas	1 cubic foot = 1,031 Btu
Electricity	1 kilowatt hour = 3,412.8 Btu
Heating Oil	1 gallon = 138,800 Btu
Butane	1 cubic foot = 3,225 Btu
Propane/LP	1 cubic foot = 2,572 Btu

IMPACT OF THE ENERGY PROBLEM ON FAMILIES

Perceived Economic Impacts

Increased prices of energy supplies was the most apparent energy impact discerned by the study respondents. In an open-ended question asking "How has the energy problem affected your family?", over half of the respondents mentioned economic concerns. This finding was further supported by 60 percent of the respondents who reported that increased prices of gasoline, heating fuel, and electricity were a "great problem" (see Table 1). Those especially sensitive to increased energy prices had a high school education or less, were rural residents, or had lower incomes. When asked if "the price of energy is too low when considering that most energy resources cannot be replaced," only 29 percent agreed (see Table 8).

Overall, the data suggest that the increased costs, but not necessarily the finiteness, of energy supplies was perceived by our sample.

Belief in the Energy Problem

Although overall belief in the reality of the energy problem declined slightly from 1974 to 1976, approximately 50 percent of the sample for both years reported a belief in the energy problem (see Table 2).[9] When considering differentials by income, sex, age, education, and residential location, the greatest differences in belief at both points in time were reflected by level of education. That is, 60 percent of those in the more educated group reported belief in the energy problem, in contrast to 46 percent for 1974 and 34 percent for 1976 for the less educated group. In both years, rural respondents tended to express less belief than urban respondents. No major differences were apparent in belief by income types.

The 1976 study also measured speculative belief in the energy problem when considering the near future (to 1981) and the distant future (1985-2000). Belief in the energy problem increased with time when defined from the present to the future; however, Table 2 shows the greatest overall increases were between responses for 1976 and 1981 for all subgroups, which suggested that the energy problem was perceived as a growing problem: that is, a problem to be contended with in the near future.

---

[9] Note question wording in 1974 and 1976 at bottom of Table 2.

TABLE 1 Perceived Energy Price Increases: Percentage of Household Respondents Perceiving Energy Price Increases as a Great Problem, by Selected Characteristics, May 1976

		Income		Education		Age		Sex		Residence	
	Total	High	Low	High	Low	≥40	<40	Male	Female	Rural	Urban
Items[a]	(N=499)	(N=250)	(N=223)	(N=217)	(N=282)	(N=243)	(N=248)	(N=237)	(N=262)	(N=180)	(N=319)
Increased price of gasoline	58	50	66	49	66	55	62	61	55	67	54
Increased price of fuel used for heating	63	60	63	56	68	63	63	58	67	63	62
Increased price of electricity	59	59	58	53	65	61	59	55	64	68	55

[a] Average missing data on row variables 2 percent; maximum 3 percent.

TABLE 2 Belief in Reality of Energy Problem: Percentage of Household Respondents Reporting Belief in the Energy Problem at Different Points in Time, by Selected Characteristics, May 1974 and May 1976

	1974 Sample	1974[a] Survey	1976 Sample	1976 Survey[b] 1976	1981	1985+
Total	(N=411)	51	(N=499)	46	62	69
INCOME: High						
Total	(N=164)	56	(N=250)	49	65	77
INCOME: Low						
Total	(N=239)	49	(N=223)	43	60	61
EDUCATION: High						
Total	(N=145)	60	(N=217)	60	75	81
EDUCATION: Low						
Total	(N=261)	46	(N=282)	34	51	60
AGE >40						
Total	(N=169)	50	(N=243)	39	58	70
AGE <40						
Total	(N=236)	51	(N=248)	50	64	69
RESIDENCE: Rural						
Total	(N=111)	47	(N=180)	38	53	65
RESIDENCE: Urban						
Total	(N=297)	52	(N=319)	50	66	71

[a] Question 1974: Do you believe the energy problem is real?

[b] Summary of question 1976: Do you think there was (is, will be in the near future 1981, will be in the distant future 1985+) an energy problem in this country? Average missing data on belief variables 1.3 percent; maximum 2.3 percent.

IMPACT OF THE FAMILY ON THE ENERGY PROBLEM

Reported Energy-Conservation Measures

Reported technical and behavioral energy-conservation measures were assessed.[10] Technical conservation measures including the installation of ceiling and wall insulation were reported in use by 76 percent of the sample family households. Less than 10 percent had added technical energy-conserving features since the Arab oil embargo.

Questions were also asked concerning behavioral conservation measures requiring daily or seasonal application (see Table 3). Each of four conservation behaviors were reported as being applied by about two-thirds or more of the sample: turning off lights not in use (96 percent), sealing windows and doors with storm windows or plastic (85 percent), cleaning and servicing heating equipment (68 percent), and maintaining daytime temperature at 68°F or less in winter (65 percent).

A related question was used to assess which households reported *increasing* the application of these conservation behaviors in the 1974-76 period. The distribution of the reported increases in application reveal which practices received the most emphasis: turning out lights (71 percent of households) and reducing daytime temperatures (64 percent). All other behaviors found increased application in less than 50 percent of the sampled households.

When considering the reported level of application and increased application of energy-conserving behaviors, several areas are suggested by the analysis. Behaviors that represented the greatest potential energy reductions were related to space heating--lowering daytime and nighttime temperatures and not heating some rooms in winter--and limiting the use of hot water. It is likely that the use of storm windows and the servicing of heating equipment were done consistently in Michigan prior to the energy crisis of 1973-74 due to the generally cold winters and thus have limited potential for further application.

Direct Residential Energy Consumption[11]

The perceived and reported impacts of the increased cost of household energy on families and their reported belief and conserving behavior--although extremely interesting and useful--do not give the complete picture. Only when actual energy consumption is compared between one year and another can a valid assessment of the changes due to impact be made. That is, did the family's reported perceptions and behaviors make a difference in the amount of energy consumed? And further, was

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[10] Pilati (1976) developed the notion of technical and behavioral conservation discussed here.

[11] Direct residential energy is defined as the energy used directly within the dwelling unit (metered or gauged), *not* including the measure of transmission of conversion energy necessary to get it to the dwelling unit.

TABLE 3 Household Conservation Behaviors: Percentage of Household Respondents Reporting[a] Application and Increased Application of Household-Related Energy-Conservation Behaviors, in Rank Order, May 1976

Conservation Behaviors[b]	Application	Increased Application
	(N=499)	(N=499)
Turn off lights not in use	96	71
Cover or seal windows and doors with storm windows or plastic	85	43
Have heating equipment cleaned and serviced	68	39
Maintain daytime temperature at 68 degrees or less in the winter	65	64
Limit amount of hot water for bathing, dishwashing, and washing clothes	51	48
Do not heat some rooms in winter	48	40
Turn down thermostat while sleeping to 60 degrees or less in the winter	47	48
Dry clothes on clothesline rather than in dryer	32	34
Share equipment such as lawnmowers or power tools with friends or relatives	27	26

[a] Includes response categories "all the time" and "most of the time."

[b] Average missing data on row variables 1.5 percent; maximum 3.4 percent.

energy consumption or conservation differentiated by household characteristics? Some insights are provided in the following analysis.

Of the 264 families in the 1976 study, total direct household energy data (including the correct energy source mix for each residence)[12] for both 1974 and 1976 were confirmed for 130 families, 80 of which were surveyed in both studies. The first year of the study and the base for the first energy consumption data was 1974, the year of the Arab oil embargo. The second year of the study was 1976, or two years after the onset of the energy crisis. Therefore, the energy consumption data base provided a natural comparison between crisis (or stimulus) and post-crisis reaction (or response).

Using the mean direct total energy consumption for both 1974 and 1976,[13] a difference was calculated and a percentage aggregate change (1974 minus 1976) was generated.[14]

An aggregate reduction of 6.3 percent in energy consumption between 1974 and 1976 ($p = 0.000$) was found (see Table 4). This is a conservative figure because it is not adjusted for weather differences encountered during the heating seasons (1974 and 1976). If the degree day differences (1974-76) are included an approximate 1.2 percentage point reduction must be added, giving a 7.5 percent decrease in overall direct energy used in the sampled residences. The reduction found is larger in magnitude but in the same direction as found in both Grier (1976) and in Williams, Kruvant, and Newman (1976), where an overall reduction of 1.8 percent between 1972-73 and 1974-75 was indicated.[15]

The distribution of percentage changes in energy consumption ranged from a 43 percent decrease to a 45 percent increase, with three-fourths of the sample having reduced energy consumption 1 percent or more, one-half having reduced it 5 percent or more and one-third having reduced it 10 percent or more. About one-fourth of the sample had increased its energy consumption.

The reduction came primarily in those fuels used for space heating (natural gas and fuel oil). Electricity, which accounted for approximately 20 percent of the direct energy used in the sampled households increased on the aggregate level by 2 percent. These findings were consistent with the Grier (1976) and the Williams, Kruvant, and Newman (1976) studies, where a 3.9 percent reduction in natural gas and a 1.2 percent increase in electricity was found for the years 1972-73 and 1974-75. A study by Consumers Power Company[16] found a similar pattern

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[12] "Correct energy source mix" is defined as all the appropriate energy sources depending on what each of the households used (electricity only, electricity and natural gas, or electricity and fuel oil).

[13] Total direct energy consumption was calculated from June 1973 to May 1974 for 1974 and from June 1975 to May 1976 for 1976.

[14] Formula: $\bar{X}'74 - \bar{X}'76 = \Delta$
Example: $(207.83 \text{ Btu} \times 10^6) - (194.8 \text{ Btu} \times 10^6) = (-13.03 \text{ Btu} \times 10^6)$ which represents a 6.3 percent reduction.

[15] Their data were from Washington Center for Metropolitan Studies, Washington, D.C.

[16] Consumers Power Company provided both natural gas and some electrical data for the analysis in this chapter.

TABLE 4 T-Test of Difference Between Annual Means of Millions of Btu for Total Direct Household Energy Consumption, 1973-74, 1975-76 (N = 130)

	Btu × 10^6						
Category	1973-74	1975-76	Difference (1976-74)	Difference 1976-74 (percentage)	t-Value	df	p
Household Total, All Sources							
Mean[a]	207.83	194.82	-13.01	-6.3[b]	-5.62	129	.000
Standard deviation	68.55	65.55	26.42				
Standard error	6.01	5.75	2.32				

[a] Electrical conversion factor 3,412 Btu.
[b] 7.5 percent overall reduction is the actual reduction given the 1.2 percent degree day difference (1976 greater than 1974).

SOURCE: Keith (1977), modified.

for a random sample of its residential consumers for the period between 1974 and 1977.

What contributed to this overall reduction in energy consumption between 1974 and 1976 for the Michigan sample? Several demographic and structural housing variables were used to disaggregate the energy consumption changes into descriptive categories. These will be discussed along with the effects of energy cost, belief, and conservation practices on the reduction of energy consumption.

Cost of Energy

As we will see later, energy costs were perceived by 60 percent of this sample as a "great problem" (Table 8). Does this mean that the cost of energy influenced the reduction in energy consumption? An indirect measure of that question can be obtained by comparing aggregate changes in consumption of fuel oil, natural gas, and electricity with changes of prices (see Table 5).

It would appear that the greater the cost increase, the greater the reduction in energy use--except for electricity, which has increased in price and in use.

One explanation for the increase in electricity consumption might be that for most households (except those that heat electrically) it is a small proportion of the total energy budget (20 percent for this sample). Thus, in spite of increased cost it had a smaller proportional impact.

TABLE 5 Percentage Increase in Energy Cost by Fuel Type and the Percentage Difference in Energy Consumption (1973-74 to 1975-76)

Fuel Type	Percentage Price Increase (1974 to 1976)[a]	Percentage Difference in Energy Use (1974 to 1976)
Fuel Oil[d]	+126	-11.1[b]
Natural Gas[d]	+ 81	- 6.6[b]
Electricity[c]	+ 50	+ 2.2[b]

[a] Gladhart, Zuiches, and Morrison (1977).

[b] Keith (1977), for a test of differences between means.

[c] Includes only two all-electric residences.

[d] Fuel oil was used for space heating exclusively, whereas natural gas was used for hot water heaters, stoves, and dryers as well as space heating, making exact comparisons difficult.

But then why was there a 2.2 percent increase in electrical use overall? Grier offered a couple of reasons worth repeating. First, electricity has been advertised as the more flexible energy source (produced by several means: coal, hydro, and nuclear), whereas petroleum and natural gas have been underscored as finite resources, in danger of being exhausted. So perhaps people employ electric space heaters and electric blankets when dialing down to save fossil fuels. Second, Grier (1976) noted an increase in the purchase and use of air conditioners, which negate some conservation measures accomplished elsewhere in the household.

Belief in the Energy Problem

Belief in the energy problem did not have the expected impact on actual reduction of energy consumption. It was hypothesized that in households where both male and female household heads believed, there would be reduced energy consumption. In fact, those households where male and female heads *did not* believe, energy consumption was reduced more than in households where both believed, however, the differences were not statistically significant.

This finding almost defies explanation except to say that regardless of what the householder believes about the energy crisis, price has forced some reduction in energy consumption. In other words, energy conservation was not based on a moral perception but rather on an economic one.

Impact of Household Conservation Measures

Many surveys, as suggested earlier, have assessed the extent of reported conservation measures but have not evaluated their impact upon changes in actual household energy consumption. The reported behavioral and technical conservation changes that occurred within the sample family households between 1974 and 1976 were analyzed for their impact on the level of consumption in 1976. Specific structural conservation measures included installation of new furnaces, insulation of walls or ceilings, and lowering of the thermostat on the hot water heater. A collective measure of daily or seasonal conservation behaviors is also reported in Table 3. The three most significant variables in rank order were installation of a new furnace (p = 0.002), the collective measure of conservation behaviors (p = 0.003), and installation of insulation in ceilings (p = 0.235) (Keith, 1977). This analysis demonstrates not only the importance of energy-efficient technology but also the role of the behavior of household members.

Selected Characteristics of Energy Consumption and Conservation

When direct consumption across years was analyzed, there were no statistically significant differences between levels of the household characteristics listed in Table 6. However, when looking at differences

TABLE 6 Selected Characteristics of Households: A Comparison in Millions of Btu of Total Direct Annual Energy Consumption (1973-74 and 1975-76) Indicating Differences and Probabilities of Sampling Error

Characteristics		1973-74 (Btu × 10^6)	1975-76 (Btu × 10^6)	Difference 1976-74 (Btu × 10^6)	Difference 1976-74 (percentage)
Total		mean 207.83	mean 194.82	-13.01	- 6.3
Income					
<$ 5,000	(n=8)	146.51	145.54	- .97	- .7
$ 5,000- 9,999	(n=19)	187.31	176.56	-10.75	- 5.7
$10,000-14,999	(n=22)	190.68	177.73	-12.95	- 6.8
$15,000-24,999	(n=52)	207.30	194.26	-13.04	- 6.3
>$25,000	(n=23)	263.56	250.07	-13.49	- 5.1
		p=0.000	p=0.000	p=0.80	
Educational Level					
Male Head of Household					
<High School	(n=27)	193.78	179.38	-14.40	- 7.4
High School	(n=31)	198.28	184.44	-13.84	- 7.0
Some College	(n=26)	233.32	213.38	-19.94	- 8.5
College Graduate	(n=34)	220.11	207.68	-12.43	- 5.6
		p=0.09	p=0.11	p=0.71	
Female Head of Household					
<High School	(n=20)	198.02	176.99	-21.03	-10.6
High School	(n=52)	190.67	178.41	-12.26	- 6.4
Some College	(n=34)	211.57	198.46	-13.11	- 6.2
College Graduate	(n=22)	250.15	241.38	- 8.77	- 3.5
		p=0.006	p=0.001	p=0.49	
Age					
Head of Household					
<30 yrs.	(n=8)	150.83	147.87	- 2.96	- 1.9
30-45 yrs.	(n=53)	228.82	214.63	-14.19	- 4.9
>45 yrs.	(n=69)	198.32	185.04	-13.28	- 6.35
		p=0.002	p=0.005	p=0.53	
Occupational Status					
White Collar	(n=68)	213.16	198.53	-14.63	- 6.8
Blue Collar	(n=61)	201.32	189.98	-11.34	- 5.6
		p=0.33	p=0.46	p=0.48	
Belief in the Energy Problem (male and/or female heads)					
Neither believe	(n=65)	204.59	190.92	-13.67	- 6.17
Either or believe	(n=23)	223.68	210.09	-13.59	- 3.61
Both believe	(n=42)	204.16	192.47	-11.60	- 5.44
		p=0.48	p=0.47	p=0.93	
Old/New Samples					
'74 Sample	(n=80)	211.12	195.31	-15.80	- 6.3
'76 Sample	(n=49)	202.77	193.80	- 8.97	- 4.3
		p=0.50	p=0.90	p=0.15	
Residential Location					
Urban	(n=96)	205.91	192.20	-13.71	- 6.6
Rural	(n=34)	213.25	202.19	-11.06	- 5.1
		p=0.59	p=0.45	p=0.62	
Number in House					
1-2 persons	(n=47)	181.41	168.73	-12.68	- 7.0
3-4 persons	(n=49)	218.35	208.39	- 9.96	- 4.6
≥ 5 persons	(n=34)	229.20	211.32	-17.88	- 7.8
		p=0.003	p=0.002	p=0.41	
Number Rooms in House					
≤ 5 rooms	(n=33)	156.50	145.76	-10.74	- 6.8
6-7 rooms	(n=57)	202.51	191.11	-11.40	- 5.6
≥ 8 rooms	(n=40)	257.76	240.57	-17.19	- 6.7
		p=0.000	p=0.000	p=0.49	

internal to each year of the study, several of the categories of variables were significantly different. The discussion of this outcome follows.

Income. For both years of the study, the greater the income the greater the energy use (not surprising, as energy use is often positively correlated with income) but the reduction varies from 6.8 to 7.0 percent (not significantly) with the greatest reduction occurring in the middle-income groups.

Education. There were statistically significant differences between energy consumption and levels of education for both males and females for both years. However, the pattern of energy use was not monotonic. However, the largest overall percent of energy reduction occurred by educational levels. A 10.6 percent reduction was achieved when the female head had less than a high school education (1974), and an 8.5 percent reduction when the male head had some college (1976). It would appear that in the first case the energy reduction may have occurred out of necessity (low education and income), whereas in the second case, the energy reduction may have occurred out of choice.

Family life cycle. Households in the middle stages of the life cycle (30-45 years) used significantly more energy than younger or older families for both years of the study. The most substantial reduction in energy consumption, interestingly, came from within the over-45 age group; however, the reductions were not significantly different from the other age groups.

Persons per dwelling unit. The more persons per dwelling unit, the more energy consumed for both years of the study, and these differences were significant. However, small families (one and two persons) and large families (five or more persons) reduced consumption near the average 7.5 percent reduction. Three- to four-person households reduced energy consumption by 4.6 percent. Reductions again, however, were not statistically significant across years.

Rooms per dwelling unit. The more rooms in the dwelling unit, the more energy consumed, and the difference was significant for both years; however, those households with the least rooms (less than five) and the most rooms (more than eight) have reduced consumption more than those living in six- or seven-room houses. Once again the reductions were not statistically significant between 1974 and 1976.

All Other Variables

Occupational status, residential location, belief in the energy problem, and old/new sample as categories for comparisons showed no statistically significant differences in levels of energy consumption within each of the study years, and the percentage of energy reduction varied only slightly from the average 7.5 percent.

The findings indicated that the sampled households made about the same percentage of energy reduction across years in spite of significant variation in energy-use patterns within categories for each year. What seems to be an emerging profile is that higher income, well-educated, mid-life cycle large families living in large houses use the most energy compared to others, while reducing their energy consumption at a *rate* comparable to the poor, the elderly, and small families in small homes. The question becomes, is reduction in energy consumption equitable when everyone is doing it with about the same percentage reduction?

Energy Reduction and Equity

Several studies have documented energy use by socioeconomic groupings.[17] The unqualified generalization drawn from these works is: "Lower income households use substantially less energy than higher income households, but compared to higher income households, those with lower incomes spend a much larger proportion of it for basic essentials," including energy (Morrison, 1978).

Thus, it seems necessary to understand that a consistent and diffuse energy reduction as found within this study, although an indication of a mild response to increased energy costs, is neither proportional nor equitable. The high energy user could afford to reduce energy consumption by a larger percentage than the 7.5 percent overall reduction found, without greatly affecting necessities of living, whereas the low energy user does not have the same discretion. Even a reduction of 7.5 percent overall as found in this study tends to cut into energy essentials to the low energy user. As suggested by both Grier and D. Morrison, there is a need to substantially increase the amount of energy reductions for the high energy user, while mitigating the regressive impact of energy price increases on those whose energy consumption is already near the subsistence level (Grier, 1976; Morrison, 1978).

PROSPECTS FOR ENERGY CONSERVATION

With the 7.5 percent overall reduction in direct total residential energy consumption found between 1974 and 1976, is it possible to expect

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[17] Barth, Mills, and Seagrave (1974); Berman, Hammer, and Tihansky (1972); Bloom (1975); King (1975); Morrison (1978); Newman and Day (1975c); Perlman and Warren (1975a,b); Schwartz and Schwartz-Barcott (1974); Walker and Draper (1975)--to name a few.

family households to conserve more in the future? That is, how prepared or willing are they to further reduce their energy consumption? In response to the statement, "The only way to get families to conserve energy is by imposing government controls," 23 percent of the household respondents agreed. Such a policy was less acceptable to lower income, less educated, and rural residents. However, those who believed in the energy problem were more supportive of such controls. Would it follow from these findings that the willingness to conserve more, perhaps on a voluntary basis, becomes a possibility? The following measure of perceived difficulty to undertake further energy conservation was included as an assessment of this question.

Perceived Difficulty to Conserve More Energy

The five activities listed in Table 7 were included to measure the potential difficulty of undertaking further energy conservation measures. An average across all five activities indicated that 19 percent of the respondents would have "great difficulty" in implementing the further reductions that these activities implied.

Consistently greater difficulty in undertaking conservation from within the five activities was reported, particularly by nonbelievers compared to the believers in the energy problem. Rural respondents expressed greater difficulty than urban residents in reducing miles driven, consumption of electricity, and buying of material goods. A larger percentage of low-income household respondents compared to high-income respondents reported all activities would involve "great difficulty." It should, however, be pointed out that 31 percent of the respondents (average over the five activities) perceived no difficulty in implementing these conservation behaviors. This was in spite of the fact that 60 percent of the respondents felt that "government officials are not providing any clear direction to . . . families . . . about energy use," and "the 'energy crisis' was a 'put on' in order to raise the prices of fuels" and, even further, that "the amount of energy all American families could save is unimportant" (see Table 8).[18]

Perceived Optimism for Further Energy Conservation

The analysis provides an even stronger basis for optimism about the ability of family households to perform more energy-conserving practices than the *reported* potentials to conserve given thus far. The first and most concrete evidence for optimism is the actual 7.5 percent overall residential energy reduction measured. This is particularly interesting, given the short period measured and compared, the relatively small real price increase experienced per unit of energy, and the relative overall increase in family incomes from 1974 to 1976 which indicated that

[18] For a discussion of these findings, see Morrison, Keith, and Zuiches (1977).

TABLE 7 Perceived Difficulty in Future Energy Conservation: Percentage of Household Respondents Reporting *Great Difficulty* in Changing Energy-Related Behaviors, by Selected Characteristics

		Income		Education		Age		Sex		Residence		Belief	
	Total	High	Low	High	Low	≥40	<40	Male	Female	Rural	Urban	Yes	No
Items[a]	(N=499)	(N=250)	(N=223)	(N=217)	(N=282)	(N=243)	(N=248)	(N=237)	(N=262)	(N=180)	(N=319)	(N=224)	(N=268)
Reduce the number of miles you now drive	29	26	30	26	31	33	24	25	32	34	26	25	31
Reduce the amount of electricity you now use	18	15	22	12	23	26	11	17	19	28	13	13	22
Reduce the temperature in your home in the winter during the hours you are asleep	17	12	22	16	17	17	16	14	19	17	17	13	20
Reduce the wintertime temperature in your home during the hours people are awake and at home	21	19	23	20	22	22	20	18	24	22	20	18	24
Buy fewer material goods	9	8	11	9	10	6	12	10	9	14	7	6	12

[a] Average missing data on row variables 1.2 percent; maximum 1.9 percent.

TABLE 8 Social, Economic and Energy Issues: Percentage of Household Respondents Agreeing[a] with Selected Statements Related to Selected Characteristics, May 1976

		Income		Education		Age		Sex		Residence		Belief	
	Total	High	Low	High	Low	≥40	<40	Male	Female	Rural	Urban	Yes	No
Items[b]	(N=499)	(N=250)	(N=223)	(N=217)	(N=282)	(N=243)	(N=248)	(N=237)	(N=262)	(N=180)	(N=319)	(N=224)	(N=268)
The price of energy is too low when considering that most energy recources cannot be replaced	29	28	29	32	26	29	27	30	27	22	32	39	19
The "energy crisis" was a "put on" in order to raise prices of fuels	61	57	64	50	70	65	59	66	57	72	55	32	86
The amount of energy all American families could save is unimportant compared to the amount of energy that government and industry could save	46	40	51	32	57	55	37	45	46	54	41	32	56
Government officials are not providing any clear directions to help families make decisions about energy use	59	59	59	62	56	64	54	59	59	61	58	55	62
The only way to get families to conserve energy is by imposing government controls	23	27	18	26	21	27	19	25	22	13	29	28	19
I would accept "possible risks" to health and safety from nuclear power plants, rather than severely restrict my energy use	29	30	26	26	31	31	26	36	22	30	28	23	24

[a] Includes response categories "strongly agree" and "agree."
[b] Average missing data on attitudinal variables 2.5 percent; maximum 10.2 percent.

TABLE 9 Potential Household Changes: Percentage of Household Respondents Agreeing[a] with Selected Statements Reflecting Areas of Potential Household Energy Consumption Change, by Selected Characteristics, May 1976

Items[b]	Total	Income		Education		Age		Sex		Residence		Belief	
		High	Low	High	Low	≥40	<40	Male	Female	Rural	Urban	Yes	No
	(N=499)	(N=250)	(N=223)	(N=217)	(N=282)	(N=243)	(N=248)	(N=237)	(N=262)	(N=180)	(N=319)	(N=224)	(N=268)
Our family is entitled to as many material goods as we can afford regardless of the energy required to produce them	24	22	24	17	29	20	28	25	23	30	20	17	30
The citizens of the United States are entitled to use as much energy as they can afford	19	19	18	11	25	20	19	20	18	23	17	11	25
My family can maintain a satisfying way of living even though we buy fewer material goods	94	96	92	93	95	95	92	94	94	93	94	95	93
The natural environment should be preserved even if I must change my way of living	90	91	88	93	87	91	88	88	91	88	90	93	86
The only way to get families to conserve energy is by imposing government controls	23	27	18	26	21	27	19	25	22	13	29	28	19
If most Americans continue their present high levels of living, they will deprive people in poorer parts of the world of basic necessities	45	40	50	46	45	43	46	41	49	40	48	58	34
If we continue our high levels of energy use, future generations will not be able to have a level of living like ours	68	68	67	71	66	66	69	61	74	60	73	81	57

[a] Includes response categories "strongly agree" and "agree."

[b] Average missing data on attitudinal variables 2.5 percent; maximum 10.2 percent.

approximately 5 percent of the net income was used for energy sources for both years of the study. In other words, the reaction was greater than the stimulus might seem to have demanded.

The second piece of evidence indicates a moral or ethical position which appears to be developing and was evidenced in the response found in Table 9. High levels of respondent concern for the natural environment, for future generations, for the poor in other parts of the world, and for the consequences of present levels of material and energy consumption imply that the attitudinal groundwork has been laid for implementing further energy conservation. When 94 percent of the respondents believe their family can maintain a satisfying life with fewer material goods, certainly further adjustment in living patterns toward becoming an energy-conserving society is more than a remote possibility.

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APPENDIX

DEFINITIONS OF VARIABLES AND SAMPLE DISTRIBUTION

Frequency and percentage results for questions were compiled for the male respondents, female respondents, total sample and the following subgroups:

	Male Respondents	Female Respondents	Total Sample
<u>Income</u>			
High--above $15,000 per year	123	127	250
Low--below $15,000 per year	102	121	223
<u>Education</u>			
High--more than high school	113	104	217
Low--high school education or less	124	158	282
<u>Age</u>			
40 years or older	123	120	243
Less than 40 years	111	137	248
<u>Residence</u>			
Rural	87	93	180
Urban	150	169	319
<u>Believe energy problem is real?</u>			
Yes	100	124	224
No	136	132	268

METROPOLITAN IMPACTS
OF
ALTERNATIVE ENERGY FUTURES

by

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SUMMARY OF CONCLUSIONS

This paper addresses the interrelated changes that may occur over time with energy supply, metropolitan structures, and the energy use patterns of different socioeconomic groups. Present patterns of consumption are determined, in part, by the physical inventory of buildings, roadways, facilities, and by existing land use patterns. Given these structures, changing energy prices and availability have short-term effects on the consumption patterns of social groupings and long-term effects on the structures themselves.

Four energy futures are examined:

- Business as Usual: moderate growth of energy supply, accompanied by 3 percent per year rise in real energy prices (discounted for inflation)
- Conservation Incentives and Mandates: little or no growth of energy supply, accompanied by a sharp rise in energy prices
- Acute Shortage: short-term, acute shortage of energy, accompanied by a sharp rise in energy prices
- High Electricity: rapid growth of electrical energy supply, accompanied by low, stable prices.

The four energy futures are examined in the context of a basic set of assumptions consisting of a moderate rate of economic growth, a 1-2 percent increase in personal disposable income, unemployment exceeding 5 percent, and a continuation of present low levels of fertility.

Recent Energy Consumption Changes

Data on energy consumption were analyzed for the period preceding and following the oil embargo of 1973 (1972 and 1974). These data provide concrete figures that describe short-run responses to changes in energy cost and availability. The increases in energy costs led to only limited attempts to conserve energy in most households. However, two points emerge: The poorer the household, the less energy used and the quicker the cutback in consumption (Grier, 1976). The higher-income households, while implementing some energy conservation measures, actually increased overall consumption. Further reductions in energy consumption by low-income households may lead to severe discomfort, health hazards, or increased crowding. Conservation among middle- and upper-income households has had little impact on life-styles. Of all age groups, the elderly consume the least energy and have the least ability to reduce their consumption. Following are the four energy futures and a summary of their impacts on four types of metropolitan structures--housing, land use, employment, and transportation--to the year 2010.

Business as Usual Assessment

Housing

If Business as Usual (BAU) energy conditions persist over the time span under study, housing availability will remain about the same for affluent, suburban, and white households of all sizes. It will decline moderately among middle-income and most city households and be reduced sharply and critically among groups whose needs are the greatest and whose means are the least, including many blacks, elderly, and youth.

The housing mix will not change significantly for most residents. A moderate trend toward more energy-conserving apartment-type constructions will be noticeable in development of structures close to transportation and commercial/industrial nodes. These will house an increasing proportion of the elderly population. The trend toward multifamily housing or small townhouses is a function primarily of land development costs and not a consequence of energy costs.

Land Use

A moderate trend toward greater population density and intensity of land use will occur both in the city and suburbs among some groups. The rich will continue to occupy as much space as before, and the poorest households are likely to remain in densely settled places. Moderate income households will enjoy better housing in as densely or more densely settled areas, in response to conditions external to energy influences.

The rising trend in property values will continue, not because of a BAU situation, but in response to significant external influences including rising numbers of households in prime working years, land scarcity, and improved levels of living. There may be some relative gain in city property values as the advantages of central locations become more important.

Employment

The suburbanization of jobs will continue to overshadow energy considerations under BAU conditions. The only exception may be a weak but noticeable trend of jobs returning to some major cities to take advantage of central locations and particular consumer and labor pools.

Transportation

To save on transport costs as well as time, many households will try to locate closer to where their members are employed. Those tending to be successful will exclude workers who earn least, and, of course, the elderly, most of whom are not in the labor force. The well-off will not respond to high transport energy costs similarly. The moves they make will be influenced more by economic and social considerations--increasing land cost, housing availability, accessibility of schools, and environmental quality.

Under BAU conditions little shift to public transit will occur among those not using it today. Most Americans either have or want an automobile and prefer to drive or ride in a car to get to work.

Conservation Incentives and Mandates Assessment

Housing

The already high and rising cost of housing will accelerate under the sharply increasing energy costs embodied in the Conservation Incentives and Mandates (CIM) scenario. This will lead to an exceptionally tight housing market. The well-off, however, will feel the pinch least and will still be able to buy or build at a moderate rate. The poor, the elderly, the young, and other groups already in centrally located units will be the hardest hit by the displacement resulting from escalating housing prices and renovation of inner city housing.

A strong trend toward energy-conserving new units and energy conservation in existing units will occur. Poor households will be less affected. Almost everyone else will benefit from incentives or requirements for renovation or retrofitting.

Land Use

A strong tendency to renovate and to conserve space because of high land prices and high materials costs will lead to greater density and intensity of land use. The effects will not be so great on those who already live in densely populated areas--the poor, many black households, and central city dwellers in the largest metropolitan areas. The well-off will also move only moderately toward greater intensity of land use.

Property values will rise, especially in cities and at suburban employment-transportation nodes. Low-income groups (the poor, minorities, and the young) will continue to own little property.

Employment

Present locations in and out of the central city will be much more intensely used, leading to diminished movement to the far suburban areas and, on the average, more jobs at suburban shopping and industrial centers and in cities.

Transportation

Distances to employment places will not change greatly, since job location will tend to stabilize around already established areas. There has been a substantial movement of jobs to the outer suburbs. Moderation of this trend could be helpful to poor households by keeping travel distances about the same or reducing them.

A shift to public transit will take place among all groups in all areas because of sharp energy price increases and restrictions on commuter auto use. The rich, who can afford high gasoline prices, and groups that have less access to public transit, will be affected least. Public transit incentive programs will produce innovative services to encourage people to overcome attachments to private automobiles.

Acute Shortage Assessment

Housing

An Acute Shortage (AS) scenario for energy supply will result in particularly restricted availability for the most vulnerable groups.

Governmental regulation and incentives will increase or improve energy conservation features in the existing housing supply. Those households which already have energy-conserving features will benefit the most, but public policy could improve the equity picture by supporting rehabilitation and retrofitting.

Land Use

Because of the short duration of this critical condition, little change will occur in land use. However, uncertainties of future energy supplies will limit new construction.

Property values in suburban areas may stabilize, while inner city housing will increase in value. Steps taken for energy conservation will become recognized in the marketplace. Properties convenient to public transportation will become relatively more valuable.

Employment

Business and industry will either stay put or, if incentives are given, move into suburban nodes or previously abandoned city locations. A slackening of available jobs in suburban areas could benefit metropolitan workers, but little change will take place in the short run.

Transportation

Jobs will be at the same or shorter distance from home, but the shift will not affect any group substantially in the acute period.

Because of energy rationing during the acute shortage period, households across the board will resort to public transit much more than before, but the short time span will not permit greatly expanded mass transit services and capacity will, therefore, likely be strained.

High Electricity Assessment

Housing

The provision of ample and cheap energy under the High Electricity (HE) scenario could lead to a sharp upswing in housing construction and rehabilitation. Energy shortages and costs will not restrict expansion of the existing housing supply. There will be greater opportunities to provide housing to those groups needing it most, as well as to those groups wanting to move into larger and more expensive units.

New home building will concentrate once more on single-family, freestanding units, insofar as land costs make it feasible. Many single people may settle for apartments, but they and younger households will be able to spread out in a looser housing market.

Land Use

Whether the high energy supply source is centralized or decentralized, many new homes will be built in the far suburbs for the intermediate-cost market. Rehabilitation in the central city and in deteriorating close-in suburbs will become possible for moderate-income groups, thus upgrading the supply without adding to density. Low-income tenants and owners will have larger supplies of vacant and larger units from which to choose.

Property values will stabilize as market demand becomes more fully satisfied.

Employment

A housing boom will again lead to new commercial and industrial centers, and to regional complexes. This could shift the job market dramatically for all kinds of workers. Whole industries might settle in previously rural areas, making workers more dependent on their cars than ever before.

Transportation

For some, the distance to work will decline and for others it will increase, depending on whether new housing is built close to new plants or commercial development. On the average, the distance for most workers will increase when HE arrives, then tend to stabilize and later decline.

If public transit has not made progress when HE conditions appear, it could be held back indefinitely in the largest areas. On the other hand, HE conditions might give public transit a boost in growing, smaller metropolitan areas with workplaces on their peripheries. By avoiding the constraints of older cities, these new areas will be able to plan rational transit systems to be used by workers in getting to their jobs in the peripheral areas.

INTRODUCTION

The Nature of Metropolitan Development

An expanding energy supply at low cost was a fundamental factor in metropolitan development between 1945 and 1970. Energy availability and technological applications made possible the rapid suburbanization of residences, retailing, and industry. Expanding production of automobiles and the proliferation of energy-consuming products have served to make older properties and businesses obsolete. Retail facilities without parking capacity are no longer economic. Whole neighborhoods have become outmoded due to narrow streets and limited parking. Obsolescence, aging, physical deterioration of environment, and absence of repair in inner-city buildings have led to problems of blight. These neighborhoods provide shelter for people earning the lowest income; those with the means have moved to revitalized city neighborhhods and to the suburbs.

The private automobile made suburbia possible. The single-family house with its own back yard became the predominant image of the suburban dream. Great shopping centers, served by new highways, emerged at key locations and became centers for distribution of consumer goods as well as for recreation. Public transportation, never feasible in areas of low density, was not planned. Public policy in the form of VA- and FHA-insured loans (amortized for long periods), real estate and mortgage interest tax deductions, highway construction, land use policy, and development of public services all supported the rapid development of suburban areas. As the tax structures of the central cities eroded, difficulties arose in providing vital services: police and fire protection, education, and public transportation. Preservation of the housing stock took place primarily with federal intervention and assistance.

Energy supply was one key element in the process. Others were rapid increase in real per capita income, rapid diffusion of the automobile, development of beltways and expressways at the expense of public transportation, and planning policies that encouraged low density residential development.

Since 1973, five major factors have changed patterns of metropolitan development: (1) recessions, (2) high inflation and interest rates, (3) continuing decline in the size of households, (4) new environmental and land use controls, and (5) rising energy costs and uncertain energy futures. It is difficult to separate out energy as the *one* factor which, all other things being equal, will affect metropolitan development. Energy use and production are major sources of environmental pollution. Energy price increases contribute directly to inflation and reduce real income growth. The developments of 1973-75 have already lead to certain consequences for metropolitan areas:

- Poorer households have reduced energy consumption whereas higher income households have not.
- Locations remote from metropolitan areas have experienced rapid population growth.
- There has been a sharp decline in housing production, particularly of free-standing, single-family houses.
- A number of metropolitan areas are undertaking capital developments in public transportation.
- New highway construction in metropolitan areas has been virtually halted.

While rising energy costs have not determined all of these changes, they have been a major contributing factor. So far, they have had a direct impact primarily on low-income families. However, the forces behind metropolitan development have undergone a basic shift, which, if continued, will deflect the pattern of growth and lead to a new shape for the metropolitan community. That shape will be influenced by energy futures, but not absolutely determined by them. Public policy may serve to mitigate some hardships on the poor and the elderly.

This paper attempts to assess some of the tendencies in metropolitan development based on alternative energy futures, to better understand the role of energy price and availability. Our focus here is primarily on consumption. The recent history of metropolitan development has led to particularly high energy consumption. Patterns of community development, housing types, and transportation systems have resulted in more, rather than less, energy use. The physical structure of metropolitan areas is relatively durable. In the short term, changes in energy supply will occur within the existing physical structure. Hence, a major part of our analysis predicts how behavior and consumption within the existing physical plant will change given alternate energy futures. Secondarily, this paper identifies the forces governing new construction that will change the physical shape of the future metropolis.

Assumptions of the Analysis

Energy futures cannot operate in isolation from socioeconomic development. For this exercise in social impact prediction during the period until 2010, we have made some basic assumptions about the economic and demographic millieu. We assume a moderate rate of economic growth and personal disposable real per capita income to be rising at 1 to 2 percent per year. These rates are somewhat less than those prevailing from 1950 to 1973 (excluding the 1974-75 recession) (Executive Office, 1976, Table B-17). They will not lead to low levels of unemployment. We assume unemployment will not fall below 5 percent a year. Inflation will be high by historical standards but not in comparison to recent years, fluctuating between 4 percent and 7 percent. Because of this rate of inflation, interest rates will probably not fall much below 8 percent for conventional home mortgages. With regard to demographic trends, birth rates will stay near their present levels, about 15 per 1,000 population. Household size will continue to drop, and the number of singles will continue to rise (Morrison, 1979). Furthermore, the number of persons in their prime working years (20 to 64) will continue to climb rapidly (Executive Office, 1973, Chart 8/10).

Background: Metropolitan Energy Consumption

Data on metropolitan energy consumption for different types of households were collected for 1972 and 1974, before and after the oil embargo of 1973. Derived from a national household sample of consumers, actual energy use, and costs of utilities, these data portray existing urban consumption patterns and the responses of different kinds of households to accelerated energy price increases.[1]

Table 1 displays the average household consumption of electricity and natural gas for selected groupings of households. Central city households consumed approximately three-fourths as much energy as suburban households. Reasons for the lower consumption of central city households include:

- lower proportion of single-family houses than in suburbs
- lower average household consumption in apartments
- lower incomes in central city areas
- fewer appliances in central city homes.

Data from the 1973 survey show that the average central city household consumed 31 percent less energy for appliance use than the average suburban household. Single-family houses with exposure to weather on all sides, combined with larger space, increase suburban consumption. Even though suburban houses were better insulated and had more storm windows, they consumed more energy than most city homes.

The differentials are also true for gasoline consumption, as seen in Table 2. Suburbanites owned more cars and drove more miles on the

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[1] A description of the 1973 survey is provided in Newman and Day (1975, Appendix A2). For the sample design of the 1975 survey, see Response Analysis (1976).

TABLE 1 U.S. Average Yearly Household Energy Consumption in Million Btu for Selected Social Groupings, 1972-74[a]

	Electricity			Natural Gas			Total Consumption		
Characteristics	1972	1974	% Change	1972	1974	% Change	1972	1974	% Change
Central City	77.1	71.4	- 7.4	123.6	119.4	- 3.2	200.7	190.8	- 4.9
Suburb	109.3	106.0	- 3.0	154.1	151.2	- 1.9	263.4	257.2	- 2.4
Rural--Non-SMSA[b]	88.4	102.4	15.8	146.2	138.3	- 5.4	234.6	240.7	+ 1.0
Apartments	39.9	39.0	- 2.3	79.3	76.3	- 3.8	119.2	115.3	- 3.3
Single Family	101.5	104.8	+ 3.3	150.3	147.6	- 1.8	251.8	252.4	0.2
Over 65	64.9	60.1	- 7.4	128.7	119.8	- 6.9	193.6	179.9	- 7.1
45 - 64	98.7	101.7	3.0	142.7	143.5	0.6	241.4	245.2	1.4
Black Central City	61.6	59.1	- 4.0	136.5	121.2	-11.2	198.1	180.3	- 9.1
All Households	93.1	94.2	+ 1.2	141.8	136.3	- 3.9	234.9	230.5	- 1.8

[a] Data collected May 1973 and May 1975. Derived by MetroStudy from Household Energy Consumption Surveys of the Washington Center for Metropolitan Studies, Washington, D.C.

[b] SMSA refers to the Standard Metropolitan Statistical Area, as defined by the U.S. Bureau of the Census.

TABLE 2 Average Yearly Gasoline Consumption Per Household, in Million Btu, by Area, 1972

Area	Consumption
Central City	78.2
Suburb	139.6
Rural, Non-SMSA	96.4
Black Central City	41.2
All Households	106.4

SOURCE: Derived from printouts from the 1973 Lifestyles and Energy Survey, Washington Center for Metropolitan Studies. See Newman and Day (1975, Appendix A2).

average than did city dwellers. This is a function of income, distance to jobs and services, and availability of public transportation.

The overall movement toward energy conservation was small--1.8 percent over the two years (1972-74). As seen in Table 1, a reduction was found in apartments, but not in single-family houses, and among the aged rather than middle-aged households. The greatest reduction was in black central city households, in which average consumption fell by over 9 percent. The savings were generally greater for natural gas than for electricity, reflecting a reduction in space heating by the poor and the elderly. Hence, urbanites who used the least energy made the greatest reduction in consumption during the first two years of the energy crisis.

The rapid energy price increases of 1973-75 raise the specter of increased hardships on the poor and elderly unless public policies are consciously devised to mitigate these effects. Such policies could include subsidies to poorer households and their landlords for installing insulation and other energy-conserving materials or devices; changes in the rate structure; energy allowances; or income subsidies in general. Judging from the experience of the last two years, suburbanites resist changing their life-styles to save energy. It is ironic that those who can save the least have, in fact, saved the most.

Great potential exists for energy conservation by adding energy-saving features to housing units. A large proportion of both central city and suburban units lacked storm doors and storm windows; some households had no insulation or did not know whether they had it or not (Table 3). While the potential for improvement may be high, few households made insulation or storm window-door improvements in response to the energy price escalation of 1973-75 (Table 4). In the two-year period, in fact, more households added air conditioning than made conservation improvements.

TABLE 3 Percent of Housing Units without Selected Energy Saving Features, Central City and Suburb, 1973

Feature	Central City	Suburb
No Storm Doors	52	34
No Protected Windows	60	42
Central Air Conditioning	13	21
No Basement (Single Family)	64	44
No Insulation (All Units)	22	13

SOURCE: Derived from printouts from the 1973 Lifestyles and Energy Survey, Washington Center for Metropolitan Studies. See Newman and Day (1975).

TABLE 4 Percent of Households Who Added Storm Windows or Doors, Insulation, or Air Conditioning Between 1973 and 1975, Central City and Suburb

Feature	Central City	Suburb
New Storm Windows or Doors	5	8
New or More Insulation	5	9
New Window or Central Air Conditioning	9	10

SOURCE: Derived from printouts from the 1973 Lifestyles and Energy Survey, Washington Center for Metropolitan Studies. See Newman and Day (1975).

The dependence of metropolitan area workers on the automobile is nearly total. In 1973, 88 percent of the workers living in the suburbs went to work by car, as did 81 percent of central city dwellers. Only 8 percent of the former and 13 percent of the latter used public transit (Newman and Day, 1975, p. 83). Moreover, the average one-way commute was a substantial 7 miles for urbanites and 11 miles for suburbanites.[2]

In summary, suburbanites used a lot more energy than urbanites, averaging about 40 to 50 percent more. These differences can be traced to contrasts in types of housing and automobile use. What enables these differences to exist? Much of the answer is income. It takes more money to achieve an energy-intensive suburban life-style. Conservation efforts have apparently been minor, especially for suburbanites, and it is unlikely that price changes alone are going to bring about greatly reduced consumption.

METHODS AND DEFINITIONS

This chapter describes how we relate four different energy scenarios to various social groupings and to their conditions of housing, settlement pattern, employment, and transportation. Changes in the condition of housing, settlement pattern (land use), and employment are referred to collectively as metropolitan trends.

Scenario Development

The device used to integrate effects on metropolitan trends, social groupings, and the interactions between them is scenario analysis. In this paper, scenarios are reasonably likely energy futures that enable the researcher to see how those energy futures affect the metropolis in selected ways. Each scenario specifies prices and availability of energy along with an expected amount of technological change. We have selected four energy scenarios:

- Business as Usual: moderate supply growth and moderate, steady price increases
- Conservation Incentives and Mandates: little or no supply growth and sharp price increases
- Acute Shortage: short-term, acute supply shortages and sharp price increases
- High Electricity: rapid electrical energy supply growth and price stability.

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[2] Derived from printouts from the 1973 Lifestyles and Energy Survey, Washington Center for Metropolitan Studies. See Newman and Day (1975).

Once the scenarios are specified, their influences on group behaviors, the physical structure of the metropolitan area, and various levels of interaction between behavior and structure can be made explicit and analyzed. This device generates a fairly large but manageable set of outcomes that can serve as a basis for policy making.

The outcomes show the degree of impact that the posited energy scenario has on each social group for each metropolitan trend. For example, whereas most analyses examine the effects of energy on income groups or housing, scenario analysis leads one step further--to specify the effect of energy situations on various income groups and on the housing for those groups. As we relate housing, land use, employment location, and transportation to income, residential location, race, age, and family size, we gradually build up a detailed picture of the probable outcomes of different energy futures. This process seeks to integrate the social and physical dimensions of the metropolis. Since public policy is intertwined with both dimensions, an analytical technique which integrates them is considerably more helpful than techniques which treat social or physical aspects separately. The following section describes the elements of the four metropolitan trends to be used in our scenario analysis. The succeeding section defines the various social groupings to be used.

Metropolitan Trends

Housing.

- Availability: the degree of tightness in the housing submarket where the social or economic group in question is active
- Housing mix affecting energy consumption: the continuum of types (from least to most energy-conserving) from single-family (free-standing) to townhouse, low-rise multifamily, and high-rise multifamily[3]

A distinction is made here among energy-conserving structures, energy efficiency, and energy conservation. Multifamily or townhouse units, due to their structure, size, and fewer exposed exterior walls, use less energy and are energy-conserving structures. Energy efficiency refers to how effectively energy is used within a heating system, motor or energy-using device. Energy conservation measures may either increase the efficiency of energy-using devices, reduce the requirements of energy use through such improvements as insulation, or change behavior to curtail energy-using activities. For example, lowering thermostats or driving fewer miles will affect actual energy use by households. Lower income households are likely to live in energy-conserving units; their

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[3] Apartments generally use less than half the electricity and somewhat more than half the natural gas of single-family homes, even when the income of the occupants is controlled for (see Table 1).

energy-using devices are likely to be less efficient, though they have fewer of them; and in the event of price increases, they will be forced to curtail their use of energy-consuming equipment.

Land Use.

- Intensity of use: the number of units per acre and variety of land uses
- Property values: particularly, trends in cost of property by area, residential land and buildings

Employment.

- Change in job location: the shifts in the spatial distribution of jobs in response to changes in the energy situation

Transportation.

- Travel distance to work: the changes in distance of the commute
- Shifts to public transit: the increase in the use of public transportation

Social Groupings

For purposes of analysis, the population of households is broken down by five variables: income, location, race, age, and family size.

- Income--low, middle, high: low income refers to household income below about $7,000 per year (in 1975 dollars) adjusted for family size and differential costs of living between metropolitan areas; high income refers to income in excess of about $20,000; middle income brackets the $7,000 to $20,000 range.
- Location--urban, suburban: urban refers to central city as defined by the U.S. Bureau of the Census; suburban refers to that part of the SMSA, as defined by the Census Bureau, that is outside the central city. The central city is characterized by an older building stock and a larger proportion of multifamily housing than the suburbs.
- Race--black, white: energy survey data are from black and white respondents only; other racial groups were not sufficiently represented in the sample to provide a basis for inferences.
- Age groups--old, young: old refers to households with heads over 60 years old; the young are households in which the heads are under 30.
- Family size--small, large: small family size refers to singles or couples without children, operationally defined as having one or two persons; family groupings with three or more are defined as large.

Types of Impacts

Impacts follow three general paths of change through time: gradual, accelerated, and exponential (Figure 1). The gradual and accelerated changes are straightforward. In response to a stimulus--say a gradual price rise or even more abrupt price changes--one can imagine a strengthened trend that would persist at a constant rate (conservation of heating fuel, for instance).

The exponential adjustment process is not a common one but may occur in the areas we are covering. Essentially, it describes change that will be slow in the short run, and get progressively faster in the long run. This is likely to happen whenever there is a great deal of fixed investment relative to new investment and the costs of altering the fixed investment are high. Increased insulation of new buildings and retrofitting of old buildings are good examples. If all new buildings are insulated more thoroughly, the fact that new construction is small relative to the existing stock of buildings means that the effects in the short run will be small but will grow more rapidly over the years, as the newly constructed, insulated buildings make up a greater proportion of the housing stock. In the case of retrofitting, few owners are likely to undertake this costly process at first, but more and more will do so if energy becomes more expensive or incentives are provided. Likewise, in transportation, people might invest in more efficient cars and/or switch to public transit modes in increasing numbers over time if put under increasing price or policy pressures.

This analysis does not attach a specific number of years to the concept of long and short run. Rather, the distinction is between adjustments or changes that can be made without substantial alterations in the stock of fixed investment (capital) and adjustments that involve such substantial alterations. For example, a short-run change in housing could be an energy conservation improvement which can be achieved in a relatively short time, like installation of storm windows. A long-run change would be a significant alteration in the mix of housing units toward more apartments than currently exist. This could take place only over a long period, through new construction and demolition. In transportation, a short-run change would be increased carpooling or increased use of public transit. A long-run change would be a substantial increase in fuel economy which could take place only as older cars are replaced by more fuel-efficient ones.

Long and short runs are, then, specific to characteristics of the fixed investment (stock of capital) in the particular area under discussion. The actual number of years will vary with the speed at which significant modifications of that stock can be made.

Another way to conceptualize changes brought about by the different energy scenarios is to think of behavioral and capital alterations. A behavioral change is one that can be made largely or entirely by modifying household energy consumption habits. People could set their thermostats back during the night, join carpools, or forgo pleasure drives. A capital change is one that modifies some physical, nonhuman, energy-using asset. Old habits may continue even after the capital change has been made and may either counteract or reinforce the capital change.

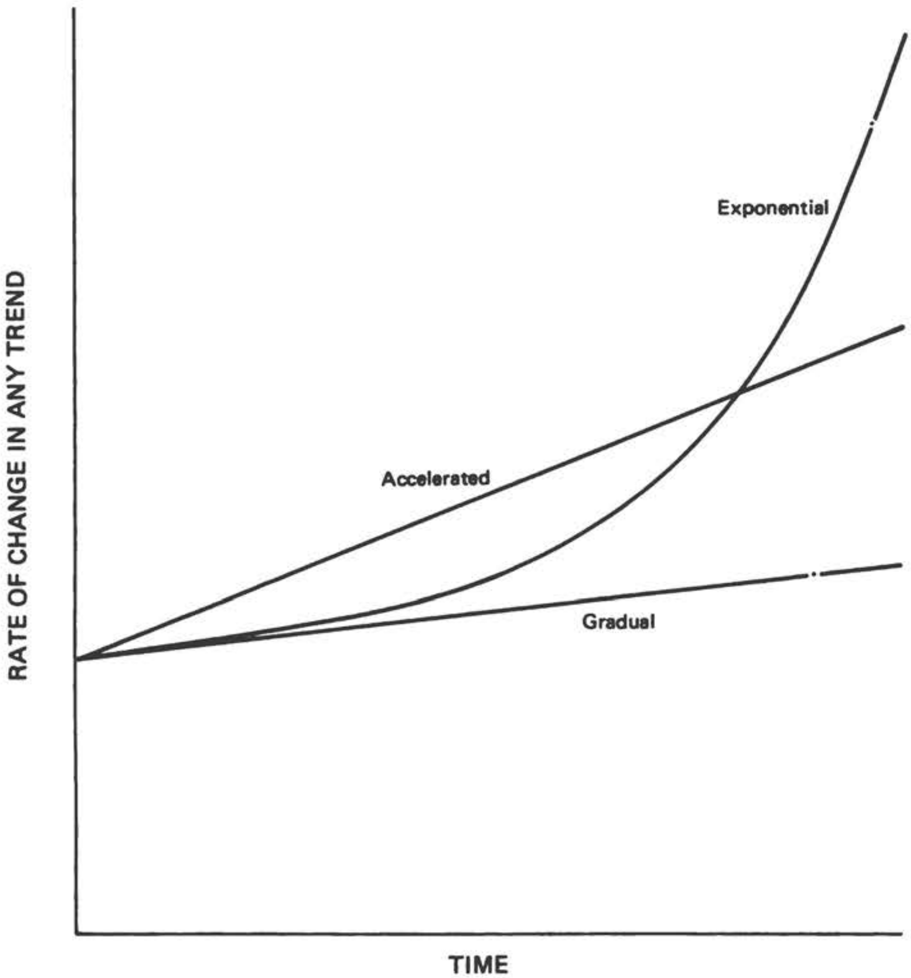

FIGURE 1 Three general paths of adjustment to changes in prices and energy policy.

Such changes include increasing insulation in one's home, buying a more fuel-efficient car, or putting up storm windows. Some actions involve both kinds of change. For example, one could switch to public transit (behavioral) and then dispose of an unneeded second car (capital).

Behavioral changes typically cost little or nothing, but may be quite inconvenient. This inconvenience may prevent most people from changing their life-style until cost pressures become very great or until changes are made mandatory (such as limiting parking privileges to persons in carpools). Similarly, the high cost of changing the structure of one's home or buying a more efficient car also makes these capital changes unlikely without considerable stimulus.

There is no particular correspondence between the two kinds of changes and the short and long runs. Changes that are relatively costless and convenient, whether behavioral or capital, will be made more often in the short run, while the more costly and inconvenient will come about more slowly.

THE BUSINESS AS USUAL SCENARIO

Overview

The rate of inflation in petroleum prices has moderated since the winter of 1973-74 and, along with electricity price inflation, has now established a relatively gradual upward path (Figure 2).[4] The Business as Usual scenario is partially predicated on the continuation of these rates of price change and not on historic trends. (Relative energy prices declined almost constantly throughout this century until 1973.) Since the trend of prices is so recent and is based on noneconomic scarcity, reliably predicting its continuance or change is difficult. The BAU scenario is only a framework within which to arrange hypothetical impacts; it is not a prediction or projection, but rather an analytical device.

In any case, the BAU scenario specifies regularly rising prices for all fuels and their continued availability under the same general conditions as at present.

The BAU scenario assumes that heating oil, gasoline, and other petroleum products will not be cut off by embargo or similar actions and that their prices will rise moderately as OPEC tailors the world price to a moderate rate of world inflation. New natural gas prices will either be decontrolled or allowed to rise progressively. As the price rises, new gas will make up a progressively larger part of the total gas marketed and the price to end users will climb accordingly. As in the past several years, few new customers will be added, and while curtailments

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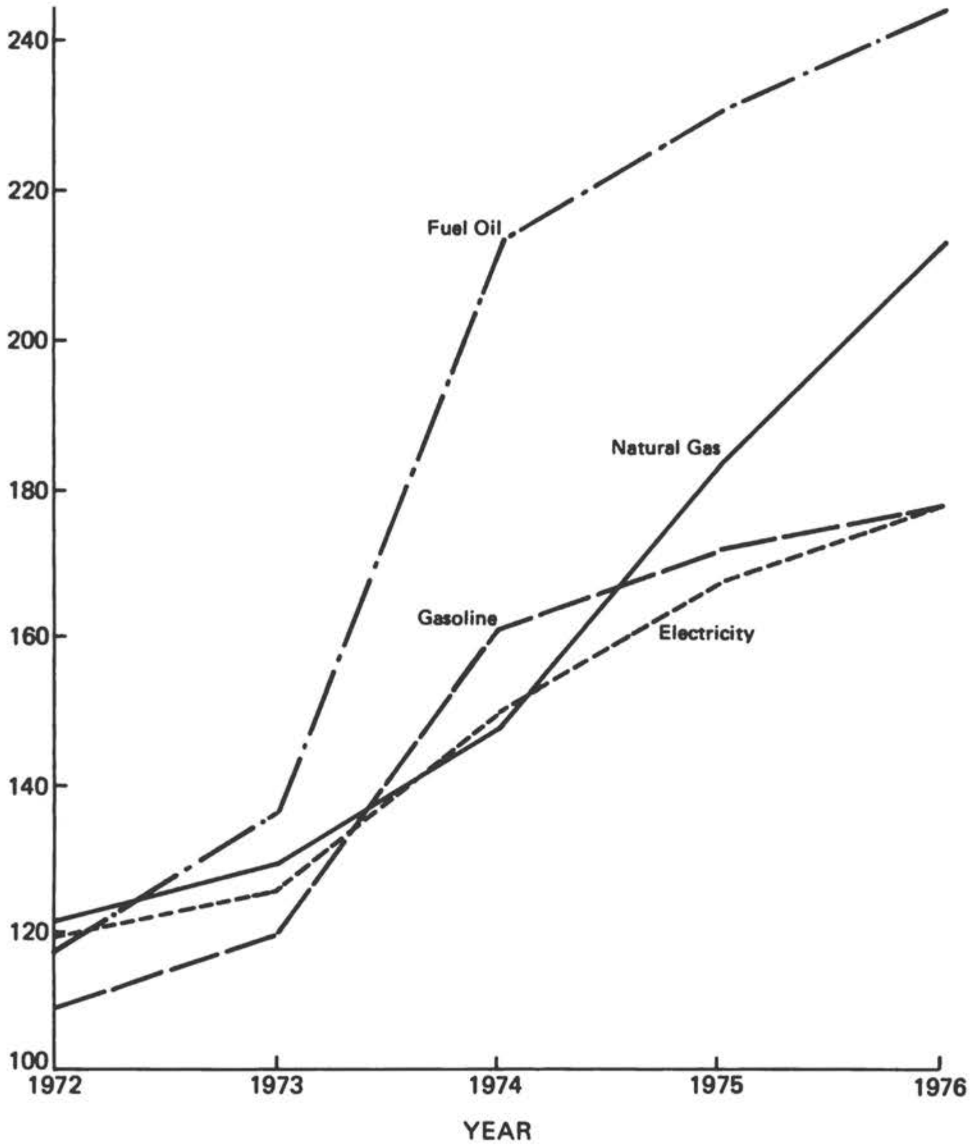
[4] The trend in natural gas prices has been different from that of petroleum products and electricity. It is in the same general range, however, and we assume that it will rise in the future at about the same rate as the others.



SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Consumer Price Indices.

FIGURE 2 Fuel price indices.

will be troublesome, they will cause no serious disruptions in the industrial, commercial, or residential sectors. Coal will be subject to gradual rising demand for both electricity generation and conversion to gaseous and liquid fuels. These demands, plus general price increases for the Btu equivalents of other fuels, will cause coal prices to rise. The price of electricity, produced primarily from coal, oil, and natural gas, will rise and increasing costs of capital and environmental controls will spur the increase. Supplies of coal, oil (increasingly imported), and electricity will be readily available.

There will be little dramatic technological change under BAU conditions. Such change is often stimulated either by rapid price increases, which increase innovation and make such innovation economic, or by crash government programs; both of these are ruled out in the BAU scenario. Conservation is also postulated to be minimal, at least in the short run. As energy becomes relatively more expensive in the longer run, however, conservation should also increase as its benefits increasingly outweigh its costs. Price increases will not be very steep; hence, capital-intensive conservation measures (retrofitting buildings, public transit expansion, etc.) will likewise be moderate. Personal energy-use habits will stay largely unchanged in the short run but should later change more significantly. Government will do little to encourage conservation directly (mandatory and rigorous energy efficiencies for autos, appliances, and buildings) or through tax-subsidy policies (taxes on large autos and parking, tax deductions, or incentives for insulation and other home conservation investments).

The BAU conditions represent an extrapolation of present trends and conditions, and provide a baseline for the analysis of alternative energy futures. In Figure 3, the magnitude of these effects for metropolitan trends in housing, land use, employment, and transportation is shown for social groupings by income, location, race, age, and family size. The matrix may be read in the following way: "The impact of (*BAU*) conditions on the (*housing available*) to (*high-income households*) is (*low*)." The reader inserts the scenario, area of impact, social group, and severity of impact appropriate in each case. A more detailed description of the entries in Figure 3 follows.[5]

Impact on Metropolitan Trends

Housing

BAU conditions will generally have little effect on housing availability. Increasing energy costs will cause both the price and operating costs of housing to rise, but this trend should not be particularly strong,

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[5] Detailed rationales for each impact described in Figure 3 are included as an appendix to the original final report from which this paper is derived. Rationales for Figures 4 and 5 are available from MetroStudy, Washington, D.C.

Metropolitan Trends	Social Groupings										
	Income			Location		Race		Age		Family Size	
	High	Med.	Low	City	Sub.	Black	White	Old	Young	1-2	3+
Housing Availability	□	□	■	▨	□	■	□	■	▨	□	□
Mix of Energy Conserving Units	□	▨	▨	▨	□	□	□	▨	□	□	□
Land Use Density and Intensity of Use	□	▨	□	□	□	▨	□	▨	▨	▨	□
Property Values	□	□	□	▨	□	□	□	□	□	□	□
Employment Job Location	□	□	□	▨	□	□	□	□	□	□	□
Transportation Distance to Work	□	▨	□	□	▨	□	□	□	□	□	□
Shifts to Public Transit	□	□	□	□	□	□	□	□	□	□	□

■ High
▨ Medium
□ Low

FIGURE 3 Business as Usual (BAU) scenario. Magnitude of effects on metropolitan trends (housing, land use, employment, transportation) for selected social groupings.

especially in comparison with demographic[6] and economic changes.[7] The impacts will be quite minor for high-income people and suburbanites. Housing markets for lower income people and blacks are likely to be increasingly tight because their units tend to be centrally located and centrality will become more desirable as energy costs rise; their structures tend to be energy conserving, which will also make them desirable; and increasing costs of construction and operation will affect most heavily those with the lowest levels of income.[8] Neighborhood preservation efforts in inner city areas will continue, putting additional pressure on low-income housing markets.

BAU conditions should cause a moderate shift toward more energy-conserving units. This trend should continue since new construction will generally be more conserving, and, as time goes on, will make up a larger part of the housing stock. This trend will generally affect all groups except for high-income people, whose incomes will permit them to remain overwhelmingly concentrated in single-family, free-standing homes, and young people, who largely live in multifamily housing already.[9]

One noteworthy trend toward more energy-efficient units will take place around employment/transportation centers in the suburbs. These nodes have many of the same advantages as the central city--easy access by public and private transit as well as concentration of diverse economic activities. BAU conditions will reinforce these advantages and should lead to considerable multifamily housing construction near these nodes, but not always *at* the nodes, since people often want separation between themselves and commerce and industry. White suburban residents will find such housing attractive both because of its energy efficiency and its proximity to places of employment.

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[6] The most important demographic change is the trend to small families and the increasing number of singles and childless couples. The fertility rate dropped from 122.9 per 1,000 women aged 15 to 44 in 1957, to 73.4 per 1,000 in 1972 (Executive Office, 1973, Table 8/5). Household size has dropped from 3.52 persons in 1950, to 3.01 in 1973 (U.S. Department of Commerce, 1974, Table 50).

[7] See the Introduction for a discussion of assumed economic trends. Such trends should lead to moderately strong overall housing demand.

[8] Median prices of new, private, nonfarm, one-family homes sold between 1970 and 1974 went from $23,400 to $35,000, an increase of 50 percent (U.S. Department of Commerce, 1974, Table 1189).

[9] This movement has been under way for some time. Multifamily housing starts were 35 percent of all starts in 1965 and 45 percent in 1973 (U.S. Department of Commerce, 1974, Table 1187). Two-thirds of all households live in single-family housing. Only 44 percent of young households (male-headed, less than 25 years old, wife present) live in single-family housing (U.S. Department of Commerce, 1972, Table B-7).

Land Use

Changes in residential density will generally follow the move toward energy-conserving units. Increasing land costs, due to scarcity as well as inflation, will result in a continued trend toward more new townhouse and multifamily construction. The trend to smaller households will provide increased market demand for the multifamily units, which will promote higher density, particularly at suburban nodes. Apart from these nodes, built-up suburban areas will change little in density, due to rigidity of land use patterns. Overall density in central cities will change little. Movement of middle-income families into restored neighborhoods will reduce the number of housing units. New apartments in the central business district will increase density.

Residential property values will not be significantly affected by BAU conditions. These energy influences will be overshadowed by other factors which have governed property values over the past 30 years, including suburbanization, population growth, new household formation, and transportation development. Land has steadily increased in value over this period and will continue to do so.

The one differential effect caused by BAU conditions could be a relative strengthening of urban property values because of their central location. While there may be some movement in this direction, it will not be strong enough to overcome the low values in many blighted areas. Due to their increasing desirability, there will probably also be a relative strengthening of values around suburban nodes.

Employment

There is little reason to believe that there will be a significant shift of industry and/or commerce to the central city under BAU conditions. Increasing energy costs will marginally improve the competitiveness of the city (perhaps resulting in a weak but noticeable trend of employers to move to central city locations), but the many long-term forces that have led to the economic decline of the central cities will continue to outweigh the impact of rising energy costs.

There is also no indication that the energy changes of BAU will result in significant alterations in the types or amounts of jobs available to the various socioeconomic groups.

Transportation

Since there will be no major changes in either residential or job locations, the length of the work trip will not change significantly. Suburbanites and middle-income people may exhibit a mild tendency to shorten trips. Middle-income people may become fairly sensitive to constantly increasing costs of transportation and so may try to move closer to jobs. The same may happen for suburbanites if employment opportunities tend to concentrate around nodes with good transit facilities, especially rail transit. Overall, however, there should be little change.

There will be little overall shifting to public transit under BAU conditions. The 1973 oil embargo and subsequent price boosts amply demonstrated the deep-seated loyalty that Americans have for their cars. Given such a strong preference, significant shifting to public transit is highly unlikely without a strong combination of both very high costs or gasoline rationing and strict anti-auto regulations.[10] More shifting may occur in those few cities with good subway and other commuter rail systems. These facilities are much superior to buses in both comfort and speed, and they may be the beneficiaries of the high costs of private transportation.

Impact on Social Groupings

Income

Since high-income people will be able to afford their traditional way of life under BAU, they will exhibit few life-style changes. There will probably be relatively minor or gradual changes in the lives of middle-income people as the gap in relative costs of their traditional life-styles and more energy-conserving life-styles widens. Many of these modifications will be seen as inconvenient and undesirable by middle-income people, and because of the gradual nature of the BAU conditions, adjustments will occur slowly. As the proportion of townhouses and multifamily units increases, there will be some increase in the proportion of middle-income families living in energy-conserving units. This will lead to increased housing density and shorter commuting distances for these households.

The impact of BAU on low-income people will be fairly large. There will be hardship but little change in behavioral patterns due to tightness in the low-income housing market and the relatively limited variety of jobs open to low-income people. There will be some movement of low-income people to deteriorating sections of the inner suburbs as housing markets tighten.

[10] According to the Washington Center for Metropolitan Studies Energy Consumption Surveys, 85 percent of all employed heads of household used private transportation--mainly the car--to go to work. On the average, bus riders and other public transit commuters take twice as long to get to work as car commuters. More than two-thirds of those who commuted by private transportation said that public transit was not available.

Two studies of driving habits during the oil embargo in 1974 concluded that demand for gasoline was not price responsive; and the only means to reduce consumption was by constrained availability through controls. See Skinner (1975) and Peskin, Shofer, and Stopher (1975).

Location

Cities may gain in certain areas from BAU conditions. There may be an increase (or at least a slowing of the decrease) in the number of jobs, and there may be new residential and commercial development which will benefit the tax base.[11] On the other hand, urban housing markets are likely to get tighter and low-income residents are likely to be displaced, resulting in increased hardship for them unless they derive greater benefits from economic growth or public policy.

The forces that have shaped the suburbs for the past 35 years will continue, only marginally affected by changes in the energy situation. The most likely effect will be a relative concentration of housing and employment opportunities at suburban transportation nodes which share the advantages of easy access to already developed commercial and industrial facilities.

Race

To the extent that this group overlaps with low-income urbanites, the BAU scenario will have largely negative effects. Housing opportunities will deteriorate and transportation costs will rise. To the extent that blacks overlap with suburbanites and middle- to high-income groups, so will their experiences.

For whites, there should be little effect on housing, and little effect on employment or travel. The most probable trend will be toward denser, more energy-conserving housing, but the overall movement will be minor above and beyond the current trend, which is caused by demographic shifts such as smaller households and more singles.

Age

The fundamental problem in all areas for the elderly will be the further erosion of fixed (or nearly-fixed) incomes due to energy price increases. This movement will put pressure on housing, causing the elderly to give up increasingly costly single-family homes. Similarly, it will become increasingly difficult for elderly drivers to own and operate cars. All in all, the relative position of elderly persons will deteriorate under the BAU scenario.

The effects on young people will be fairly minor since they are already largely concentrated in multifamily housing. Probably the

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[11] The effects here are likely to be very diverse because of the varied growth and development of cities. In many newer and smaller cities, especially in the Sun Belt, growth is vigorous. Growth is slow or nonexistent in many older northern cities. Redevelopment in the older cities is likely to be harder because of a more deteriorated central housing stock and tight municipal budgets which may not have the resources to support extensive renovation and rehabilitation.

strongest effect will be the continuing drift toward pricing young families out of the single-family home market. There should be relatively little effect on jobs or transportation.

Family Size

The effect on small families will be minor. Such households already tend to live in smaller, energy-conserving units, and there probably will be some continued movement in that direction. Otherwise, there will be little effect on transportation or employment location. For larger families, effects should also be minor except for the rising cost of energy. The preferences for suburban location and single-family homes are strong and will respond only to great pressures.

THE CONSERVATION INCENTIVES AND MANDATES SCENARIO

Overview

The Conservation Incentives and Mandates (CIM) scenario is an intermediate case between Business as Usual and Acute Shortage. In this scenario we assume no serious general fuel shortages, although significant shortages in individual fuels may occur. The basic determinant of the CIM scenario is a rapid and sustained rate of price increase. These increases are likely to arise through strong OPEC action on oil; decontrol of natural gas, which may have a low price elasticity of supply; and lack of dramatic breakthroughs in coal or nuclear technology.

Given rapid price escalation and lagging expansion of supplies, the various levels of government will establish means for reducing consumption to conserve supplies and to protect employment and the balance of payments. They will provide incentives for conservation through the tax system and mandate certain practices through legislation and regulation.

The most pervasive incentives, and probably the most effective, will be the price increases themselves. Beyond this, governments may, for example, provide financial incentives by:

- giving tax breaks for home insulation, installation of storm doors and windows, installation of heat pumps in electrically heated homes, and other readily instituted conservation measures
- giving tax breaks or special financing terms to those who install solar heating systems in new or existing buildings
- imposing a tax on autos by weight or size of engine, or both
- subsidizing public transit fares and improving service
- imposing a tax on commuter parking facilities
- imposing general energy taxes to further minimize fuel use.

Government-mandated performance and behavior standards might include:

- insulation and other energy conservation standards for new construction

- similar standards for upgrading existing buildings (probably in conjunction with some sort of subsidy to make the cost bearable)
- strict energy-conserving standards for autos (with the possible elimination of all autos over a certain size)
- compulsory carpooling of commuters as a condition for downtown parking
- strict appliance energy standards with possible elimination of certain high-energy-use machines (frost-free refrigerators, self-cleaning ovens, gas pilot lights)
- an intensive education effort to link conservation with the national purpose.

Figure 4 portrays the following CIM impacts on metropolitan trends and on social groupings.

Impact on Metropolitan Trends

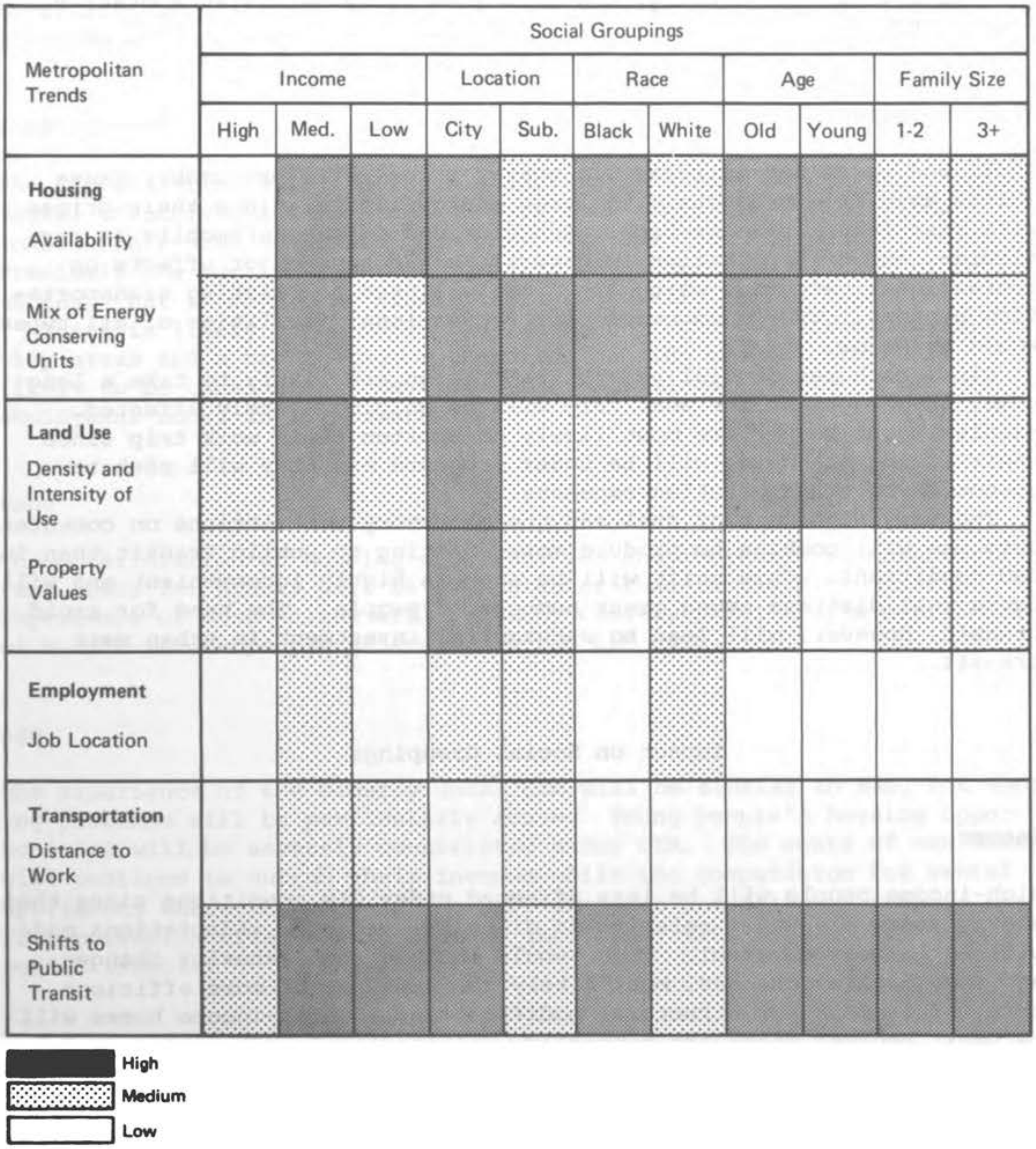
Housing

General trends under BAU conditions will probably accelerate under the price pressures of CIM. Direct and indirect energy inputs into new housing, as well as strict energy conservation requirements (insulation, etc.), will drive up prices. All this will cause a general slowdown in new residential construction and will tighten the market. All centrally located areas and energy-conserving units will be in great demand. Considerable development will be channeled into these areas, probably causing displacement of poor people through demolitions and renovation. The prices of energy-conserving units will rise rapidly, leading to some crowding and displacement.

There will be considerable pressure to shift to energy-efficient units, although the pressure will be less on high-income people. How successful this will be will depend largely on the responsiveness of the multifamily market to increased demand. Generally, the pressures will be stronger than those outlined in the BAU case.

Land Use

The same general movement toward land-use intensity exhibited in the BAU scenario will take place under CIM, but with more strength because of greater cost pressures. The basic economic and demographic trends which have operated in metropolitan areas since World War II will continue to push property (especially land) prices higher. There will be a strong upward push on the values of areas that have location advantages, that is, central city properties and suburban properties with good transportation access, concentration of employment, and high residential density. Conflict over zoning and other development rights is likely to occur to the extent that these newly desirable locations do not correspond to the development pattern that has been historically determined.



Metropolitan Trends	Social Groupings										
	Income			Location		Race		Age		Family Size	
	High	Med.	Low	City	Sub.	Black	White	Old	Young	1-2	3+
Housing Availability	□	■	■	■	▨	■	▨	■	■	▨	▨
Mix of Energy Conserving Units	▨	■	▨	■	■	■	▨	■	▨	■	▨
Land Use Density and Intensity of Use	▨	■	▨	■	▨	▨	▨	■	■	■	▨
Property Values	▨	▨	□	■	▨	□	▨	▨	□	▨	▨
Employment Job Location	□	▨	□	▨	▨	□	▨	□	□	□	□
Transportation Distance to Work	□	▨	▨	□	▨	□	□	□	□	□	□
Shifts to Public Transit	▨	■	■	■	▨	■	▨	■	■	■	■

■ **High**
▨ **Medium**
□ **Low**

FIGURE 4 Conservation Incentives and Mandates (CIM) scenario. Magnitude of effects on metropolitan trends (housing, land use, employment, transportation) for selected social groupings.

Employment

CIM conditions should cause a more noticeable movement back to the city and to the other key suburban locations than BAU conditions. This movement will continue as energy costs progressively outdistance other business costs.

Transportation

Rapid and sustained increases in energy prices will presumably cause shifts away from products with large energy inputs, since their prices will rise faster than average. Restrictions on the automobile in particular, and transportation in general, could have major effects on recreational patterns, which are closely linked to existing transportation systems. The consequences for recreational facilities of all types would be major.

Since both residential and job relocation are likely to take a long time, the length of the work trip will be only moderately affected. Middle-income people are most likely to shorten their work trip since their living standards will be under pressure and they will seek to economize on transportation expenses.

The very high cost of fuel and the mandatory restrictions on commuter auto use will combine to produce more shifting to public transit than in BAU conditions. This shift will be seen as highly inconvenient and will cause real distress among great numbers of people. The need for rapid transit, however, will lead to substantial investment in urban mass transit.

Impact on Social Groupings

Income

High-income people will be less affected under CIM conditions since their energy costs are small relative to disposable income. Adaptations made will be largely marginal. These would include some behavior changes and some capital changes, most likely the purchase of more efficient cars. The amount of structural modifications in high-income homes will be small because these are generally well insulated and protected already. There will be some shifting to high-priced condominium apartments and townhouses and some limited use of public transit.

The impact on middle-income people will be more serious. Changes imposed by family budget and public authority will be considerable and will force modifications in both housing and transportation styles. A significant squeeze on incomes and life-styles will be widespread.

CIM conditions will further disadvantage poor people. They will be caught in a housing bind as their homes are sold for renovation or torn down for new housing they cannot afford. For those units which survive, the rents and ownership costs will escalate rapidly. The results will be crowding, displacement and less money to spend on nonhousing goods and services. There will be considerable shifting to public transit; where that is not available, increasing auto costs will further erode take-home pay. It may be that some low-paid workers will no longer be able to afford the costs of the work trip by private car, especially when combined with parking charges.

Location

The CIM scenario, with its rapidly increasing energy prices and governmental incentive-mandate package, will make central city locations considerably more desirable than they have been for the past 30 years. Precisely how much movement of commerce and industry will take place is unclear, but it should be significant, especially in the long run.

There is likely to be major displacement of the poor from central city areas and a tightening of the urban housing market. There is likely to be considerable development of all kinds at transportation/employment nodes in the suburbs.

Race

The deterioration of housing opportunities and increases in transportation costs for blacks will be even greater than in the BAU scenario. The experience of most whites will probably closely parallel the experience of middle-income people generally in the CIM case.

Age

The experience of the elderly under CIM will be similar to BAU, but housing problems will be particularly acute. Young people's housing opportunities will be severely constricted under CIM. The costs of new homes will continue to outrun their incomes while the competition for rental apartments where they are living will increase and drive up rents. Transportation effects will be less important, with some shifting to public transit.

Family Size

Small households will be affected by the general impacts of CIM, but there should not be any areas where those impacts are especially severe. To the extent that larger families live in single-family homes in the suburbs, the effects of CIM on their economic well-being will be serious. Saddled with energy-inefficient homes and large transportation needs, they will be subjected to major impacts. The shrinking number of large urban families will face a tighter housing market and escalating housing costs.

THE ACUTE SHORTAGE SCENARIO

Overview

The Acute Shortage (AS) scenario revolves around a severely constricted energy supply. Prices are assumed to increase as rapidly as they did during the 1973 embargo, but, as during 1973, the basic problem will be availability.

This scenario differs from the previous two in several important ways. First, the acute phase is conceived as a short-term phenomenon resulting in some long-term reduction in energy consumption. If society adapts to, and learns to live with, such a shortage, it cannot be acute by definition. In that case it merges into the CIM scenario. There is, of course, another possibility: society does not adapt to acute shortage and the economy grinds to a halt. There would than be a generalized crisis somewhat like that of the early 1930's. What would be done in such an event is a matter for imagination rather than the type of analysis we are attempting here. Consequently, we must rule out this latter case as too complex and too speculative for meaningful discussion within our framework. We assume, therefore, an acute shortage of relatively short duration, not accompanied by economic collapse.

The second basic difference in the AS scenario concerns the expectations of the socioeconomic groups we have defined. We implicitly assumed in the other cases that people see, understand, and expect the given conditions in the BAU and CIM cases. In a period of acute shortage this assumption is clearly unreasonable. Under AS conditions great uncertainty would undoubtedly prevail, and under such uncertainty people are likely to be reluctant to make any but the most obvious and least costly changes. They may well try to "ride out the storm." Consequently, even though financial and other pressures on households may be greater than in the CIM case, the actions taken, especially when they involve heavy or long-term investments of money or time, may well be less, due to increased uncertainty. Thus, uncertainty itself is a major social constraint under AS.

The response to AS conditions will be imposed by government; it will be mandatory and strict. Such actions are likely to include all those in the CIM scenario, in more rigorous forms and on a shorter timetable. Beyond these, the program would require fuel rationing.

Any number of rationing schemes are practical. It is important to distinguish between gasoline and home heating/cooling fuels (fuel oil, natural gas and electricity) because of the different ways these fuels are marketed. Gasoline is marketed at service stations; even though there are many service stations, they are few compared with the number of housing units and it is relatively easy to regulate their supplies and sales. Fuel oil is something of an intermediate case; the truck is a traveling service station. The other fuels are marketed directly to the home. Because of this difference, and because the provision of home fuels is a physical necessity for human life, the rationing plans for homes and cars will be somewhat different.

The gasoline rationing plan considered here would allow each licensed driver to buy a specified amount of gasoline at the stated price. No additional gasoline would be available to a driver beyond this weekly allotment. Exceptions would be made for persons with medical emergency needs or without alternative ways of getting to work. The extent of these additional allowances would be limited by two factors: the total supply of gasoline available, and the size of the basic allowance. The larger the supply or the smaller the allowance is, the greater the number of exceptions that would be possible.[12] While this plan has a great many faults, it does have the virtue of maximum equity. In an AS situation, such equity would be important because consumers would not cooperate in a system they felt was unfair.

Home heating fuel could not be rationed in the same way. It is quite costly to read meters constantly in order to check on people's consumption. If people go over their allotted amount it will be impossible to cut off their fuel supply since such an action could have disastrous health effects, especially in winter. The easiest way to ration home fuels is to inform people that they are limited to, say, 75 percent of last year's consumption and monitor their consumption as usual. If households exceed their ration, they could be fined and their names published in the local newspapers as people who were not "doing their part." While not strictly limiting the total amount consumed as in the gasoline case, the moral and financial pressures on households will be very great and the incentive to stay within the allotted amounts will be strong.

The home rationing system will be tied to the unit rather than to the people living in the unit. There are two reasons for making the system focus on the house rather than the occupants: it will give maximum incentive for behavior changes on the part of the residents, and for energy-conserving capital changes in the structure, especially if the latter is encouraged by a government tax-subsidy policy.

If the allocation were made by family size, on the theory that large families need more energy than small ones, the effects could be quite disruptive. There would be a great advantage in increasing the number of persons per room. This could be done by taking in more residents or moving to a smaller unit. Prices of small units would increase rapidly while prices of large units would fall. Conservation would be maximized

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[12] Another possible rationing plan was discussed widely during the 1973-74 fuel crisis. Each licensed driver would receive a coupon book which would entitle him/her to purchase the amount of gasoline represented by the coupons for that week. If a driver wanted to purchase more than the allotted amount, he/she could buy other drivers' unused coupons on the "white market." These coupons would be subject to supply and demand and would presumably carry a very high price. Thus, people would have access to more than their direct allotments, but only at higher costs. This plan would still strictly limit the amount of gasoline consumed, but raises serious equity questions, since only those with higher incomes could buy additional fuel while those with moderate to low incomes would suffer hardships no matter how just their need for gasoline.

only where there were relatively few persons per room and so energy would be less efficiently used.

Allocation on a per-person basis would have immediate and growing implications for the relative value and utilization of city and suburban units. City units--on the whole smaller, more energy-efficient, and more centrally located--would increase in value more rapidly than suburban units. This would mean a historic shift in the relative desirability of city and suburb and would further complicate an already volatile situation. Here we need only note that while alternatives for home energy fuel rationing exist, they will have very different impacts. It would appear that tying the ration to the housing unit would be preferable.[13]

Figure 5 displays the AS impacts on metropolitan trends and on social groupings, as summarized below.

Impact on Metropolitan Trends

Housing

The high prices of energy will put more demand pressures on smaller units, occupied mostly by the vulnerable elderly, young, poor, and small families. The prices and rents of these units will rise, tightening the market further. The pressures are not likely to be extreme, since effects will be short run, as are all effects in the AS case. However, the uncertainty may lead to less housing development and a tighter housing market.

The short-run nature of AS will also limit shifts toward energy-efficient units, since there cannot be significant additions to the stock of housing. Given that little such housing will be produced, the total amount of shifting will be limited.

Land Use

Without substantial new construction--which is ruled out in this case--there can be little movement toward higher density. However, there may be substantial short-run doubling up in existing housing. The effects of AS conditions on property values are likely to be moderate or low because of the uncertainty associated with an acute shortage. One exception to this should be centrally located urban properties, which will be at a premium because of their accessibility.

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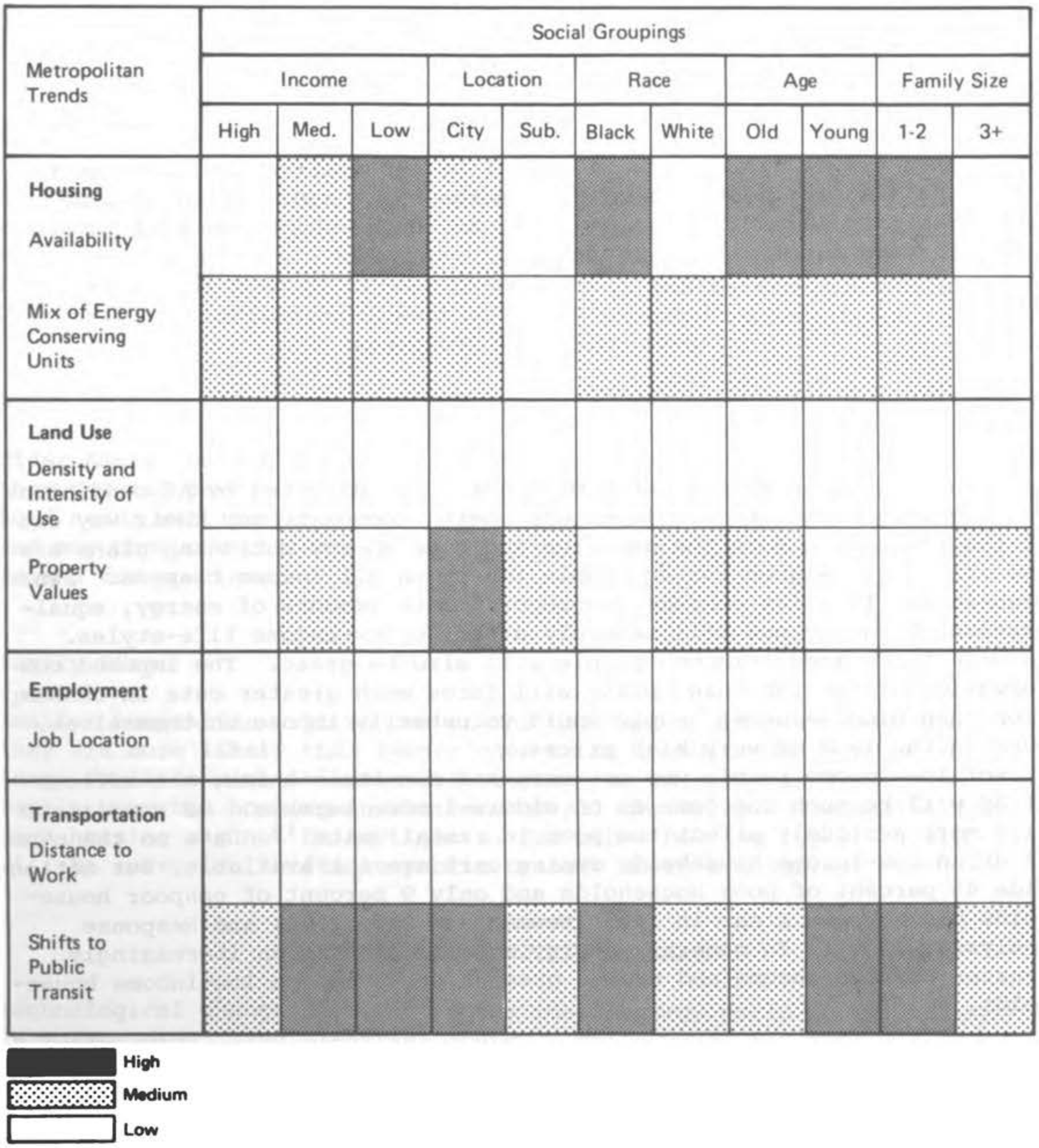
[13] A similar problem arises in gasoline rationing where either cars or drivers could receive entitlements, but on practical grounds this would be a much less serious problem.



Metropolitan Trends	Social Groupings										
	Income			Location		Race		Age		Family Size	
	High	Med.	Low	City	Sub.	Black	White	Old	Young	1-2	3+
Housing Availability	□	▒	■	▒	□	■	□	■	■	■	□
Mix of Energy Conserving Units	▒	▒	▒	▒	□	▒	▒	▒	▒	▒	□
Land Use Density and Intensity of Use	□	□	□	□	□	□	□	□	□	□	□
Property Values	□	▒	□	■	▒	□	▒	▒	□	□	▒
Employment Job Location	□	□	□	□	□	□	□	□	□	□	□
Transportation Distance to Work	□	□	□	□	□	□	□	□	□	□	□
Shifts to Public Transit	▒	■	■	■	▒	■	▒	▒	■	■	▒

■ **High**
▒ **Medium**
□ **Low**

FIGURE 5 Acute Shortage (AS) scenario. Magnitude of effects on metropolitan trends (housing, land use, employment, transportation) for selected social groupings.

Employment

Shifts of jobs to easier access areas will be minor since businesses will hesitate to commit themselves to new development. There will be some pressures on members of the work force to seek housing closer to work.

Transportation

Effects on travel distance to work will be generally minor since there cannot be much residential shifting in the short run. There will be heavy shifting to public transit under AS conditions because of gasoline rationing and automobile restrictions.

Impact on Social Groupings

Income

High-income people will be much more seriously affected by AS conditions because they will not be able to use their incomes to buy their way out of the shortage. Both the gasoline and home energy rationing plans are specifically designed for equitable impact on all income classes. Since high-income families consume disproportionate amounts of energy, equalization of energy use will severely affect upper-income life-styles. AS effects on middle-income people will also be great. The imposed conservation of the rationing plans will force much greater cuts in consumption than middle-income people would voluntarily impose on themselves, even in the face of very high prices.

For low-income people who use cars and own their homes, the effects of AS will be much the same as on middle-income earners. AS conditions will more seriously affect the poor in rental units.[14] Data on the number of urban low-income households owning cars are not available, but nationwide 45 percent of poor households and only 9 percent of nonpoor households did not own a car in 1973 (Newman and Day, 1975; and Response Analysis, 1976). In general, energy costs will take an increasingly greater part of income and create greater pressures on low-income households.

Location

The cities may be helped somewhat by AS, especially through the much greater use of their public transit facilities. There may be higher

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[14] Fifty-eight percent of metropolitan households with incomes under $4,000 in 1968 rented, compared to 35 percent with incomes over $4,000 (U.S. Department of Commerce, 1972).

property tax receipts through the reassessment of property which has been made more valuable because of its central location, but this will probably not be very great.

Those suburban families most dependent on the automobile will be most affected by AS conditons. Following restrictions on automobile usage, there will be extensive shifting to carpooling or public transportation. Properties farthest from public transportation may decline in value.

Race

Additional pressures will be imposed on black households in the inner cities due to greater pressure on central city housing unmitigated by housing construction. Additional crowding may result. More white households will seek housing closer to work or to public transportation. There will be increasing demand on energy-conserving housing units.

Age

Older Americans who own their own homes may become less able to maintain them and may move to apartments, already in tight supply. Younger household heads will seek more housing in convenient inner city locations, and may postpone childbearing. They will be a source of increasing demand for apartments.

Family Size

Smaller households will encounter the tightest housing market, since they are more likely than larger ones to be in multifamily housing. Large families with children will attempt to maintain their single-family suburban housing in the face of all obstacles. The market for such housing may not be as tight as for other housing types. There will be extensive shifts to public transit where available.

THE HIGH ELECTRICITY SCENARIO

Technological change may lead to the ideal energy world in which there is cheap, clean, and plentiful energy. While we do not expect such a development over the next few decades, we should like to make a few comments on possible implications of abundant energy.

Technological Base

The technologies could be deployed in two alternative modes, centralized or decentralized, which present radically different social futures in an HE economy. While the two are not really mutually exclusive, an examination of their extreme forms points up significant differences.

The centralized HE technology is most familiar, being similar to what we now have. Advanced coal and nuclear technologies will generate electric power at large central stations and use the present distribution system for delivery to consumers. The organization of the industry and the manner in which electricity is sold will remain essentially unchanged, although there will be greater dependence on centrally produced and distributed electricity. From the point of view of supply rather than of demand HE resembles BAU in these respects.

The decentralized HE technology will revolve around the household or housing cluster as the primary energy producing and storing unit (e.g., as in Modular Integrated Utility Systems [Shostak, 1978]). Commercial and industrial units could perform similar functions. Coupled with passive and active solar thermal applications (e.g., space conditioning), the super-battery and an economical photovoltaic system would make the individual household virtually energy self-sufficient. If super-batteries can be charged from a building's solar energy system, the total demand of a household or business for utility-produced electricity will be eliminated.[15]

Metropolitan Impact

The first three scenarios discuss the constraints and complexities that result from increasing costs of energy and limits on the available supply. Since energy uses have become a necessity within our metropolitan structures, constraints and escalating costs lead to hardships that will force government to intervene to maintain a sense of fairness. Intervention or mandatory conservation measures have an immediate impact on transportation systems, which are in turn closely related to metropolitan patterns of development and land use.

While the plentiful energy scenario of HE brings a broader range of development possibilities than do the first three scenarios, it does not eliminate many of the social and economic problems that we have today. The inequitable distribution or scarcity of other resources--housing, land, desirable jobs, and material goods--will still be a source of contention and conflict under HE.[16]

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[15] Even if super-batteries were used largely by utilities, their effects would be beneficial. By storing power, the utility would free itself of the need to maintain large amounts of generating capacity for use only during periods of peak energy demand.

[16] Indeed, the scarcity of other resources would tend to undercut the basis of the HE scenario itself. For instance, HE assumes substantially increased technological developments. If the technology is based on coal, the problems of air pollution will remain, and the technology for preserving air quality is expensive. If it is based on nuclear power, there may be grave problems of wastes, contamination, or risks of terrorism or explosive accidents. In this discussion, however, we exclude these considerations; the limiting assumption will be that energy is both abundant and benign.

Although we assume that resource constraints will not limit the availability of electricity under HE, we do find that these same constraints will tend to counteract the expansionary impetus that cheap, abundant electrical energy otherwise gives to metropolitan trends. For instance, abundant electrical energy implies increased personal mobility: electric cars, more roadways, and more suburbanization. It also implies more congestion. Plans for urban development will continue to operate under a variety of environmental constraints: water and sewer limitations, rising land values, and preservation of open space or farmlands. Growing energy supplies also imply increased levels of affluence and leisure, which increase both the demand for, and pressure on, parklands and recreational resources.

Because development of new housing will still be limited by rapidly increasing land costs and attempts to limit growth, greater equity in housing will be only moderately affected by HE conditions. Industrial and commercial facilities will continue to spread into suburban areas, to the extent allowed by land use controls and environmental protection. Such development will bring further pressures on the central city tax base and lead to a renewed deterioration of central business districts. In that sense, the pattern of development in the two decades after World War II could be taken as a base model. Variation of the model would be a function of local planning and policy.

POLICY IMPLICATIONS

Policy implications that emerge from this paper refer to the first three scenarios, where energy supply is limited. Demands on energy systems will result in substantial price increases, a sense of scarcity, and concern over the environmental degradation that has emerged from current energy use patterns. Given shortages of energy and energy demand limits imposed by price, hardships necessarily fall upon the low-income population, who must use larger portions of limited income for necessary energy use.

The preeminent policy consideration involves mitigating hardships caused by energy scarcity on the poor. Four ways of assisting poor households are: price controls and rationing, energy consumption subsidies, energy conservation subsidies (e.g., for weatherization), and energy conservation by those who consume the most. Price controls to hold down energy costs have worked poorly, failing to discourage energy use and resulting in restrictions on the sale of energy and probable eventual use of rationing with its attendant problems of administration and fairness. Energy-conservation subsidies are somewhat better than energy consumption subsidies since they would directly save energy. Energy consumption subsidies have the opposite effect; they increase energy use. Policy could also focus on reducing energy consumption by those households and industries that consume the most. Besides saving energy, this would cut demand and so reduce upward pressure on prices.

- *Reduce Waste and Inefficient Use Through Conservation*

Present consumer incentives to conserve energy are insufficient and ineffective for reducing the energy consumption of those who consume the most. In the Business As Usual scenario especially, but also under Conservation Incentives and Mandates and Acute Shortage, those who have the least suffer the greatest hardships in the course of reducing energy use. Greater equity in energy consumption is achieved in the High Electricity scenario, where energy conservation is not a major issue. A massive conservation effort aimed at eliminating wasteful and inefficient use of energy may lessen overall demand as well as pressures for price escalation. Reduction of energy consumption also mitigates environmental effects.

- *Decrease Energy Requirements in Transportation*

Transportation systems, particularly the automobile, are especially vulnerable to shortages of oil. Policy decisions must (1) provide alternate transportation modes using other forms of energy, (2) increase the efficiency of energy use in mobility, and (3) ensure that future metropolitan growth is oriented toward reduction of energy requirements in transportation. This could include strengthened gas mileage requirements for new cars, combined with gasoline taxes, tolls, and parking taxes or bans. Increasing the population density around suburban nodes served by electric rapid transit is one method of maintaining personal mobility while reducing energy consumption.

- *Rehabilitate Housing Stock With Emphasis on Energy-Efficient Retrofitting*

Government intervention in the rehabilitation of housing has been oriented toward neighborhood preservation, with no emphasis on energy conservation. As a result, many rehabilitated houses are now no more energy efficient than before. Rehabilitation of housing requires less energy use than building new buildings, but neighborhood rehabilitation programs should provide subsidies for weatherization and other measures to make the houses themselves more energy conserving.

- *Change Structure of Energy Prices*

Energy should be priced so as to achieve maximum end-use efficiency. Electricity should be priced with time-of-day rates, oil at import cost, etc. This could be achieved either through tax policy or deregulation measures. The measures adopted should be governed by the principle of replacement (marginal) cost pricing. If replacement cost pricing is not adopted, inverted rate structures would be next best, since they encourage conservation among those who use the most energy.

- *Establish Construction and Appliance Standards*

In order to minimize enregy waste, a set of standards should be instituted so that both new and rehabilitated construction will meet certain energy-efficient criteria. Appliance and construction standards should be both rigorous and achievable. The use of nonrenewable energy such as oil and gas should be supplemented by solar energy to the extent practicable, and tax or other subsidies may be used to increase solar desirability. Such energy standards are particularly important to low- and moderate-income families so that they may reduce energy costs while maintaining a reasonable level of comfort.

These policy recommendations are only illustrative. Our most important recommendation is that policy proposals be evaluated in terms of differential impacts on social groups. The framework suggested in this paper is one possible way to analyze such effects and, what is often as important, the interactions between groups and metropolitan structures.

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DEMOGRAPHIC TRENDS IMPINGING ON ENERGY USE

by

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PREFACE

This paper draws on research at the Rand Corp. that was sponsored by the U.S. Energy Research and Development Administration (now part of the U.S. Department of Energy). Views expressed in this paper are the author's own, and are not necessarily shared by Rand or its research sponsors.

INTRODUCTION

The use of energy, and policies intended to affect its availability, are woven into a broad socioeconomic context. Although this context eludes precise definition, loosely speaking it has to do with people's consumption patterns, how and where they live, where they work and how they get there, their incomes and their tastes and preferences--all of which bear on the matter of energy consumption. Demographic shifts compose one part of the context and are more readily measured and understood than other elements. These shifts include changes in the size, structure, composition, and spatial distribution of energy-consuming units (households and families, most notably).

The following sections of this paper--*Patterns of Growth in Energy-Consuming Units*, *Growth of Multiworker Families*, and *Changing Patterns of Population Settlement*--lay out this context of demographic change and point toward its possible linkages with energy use.

PATTERNS OF GROWTH IN ENERGY-CONSUMING UNITS

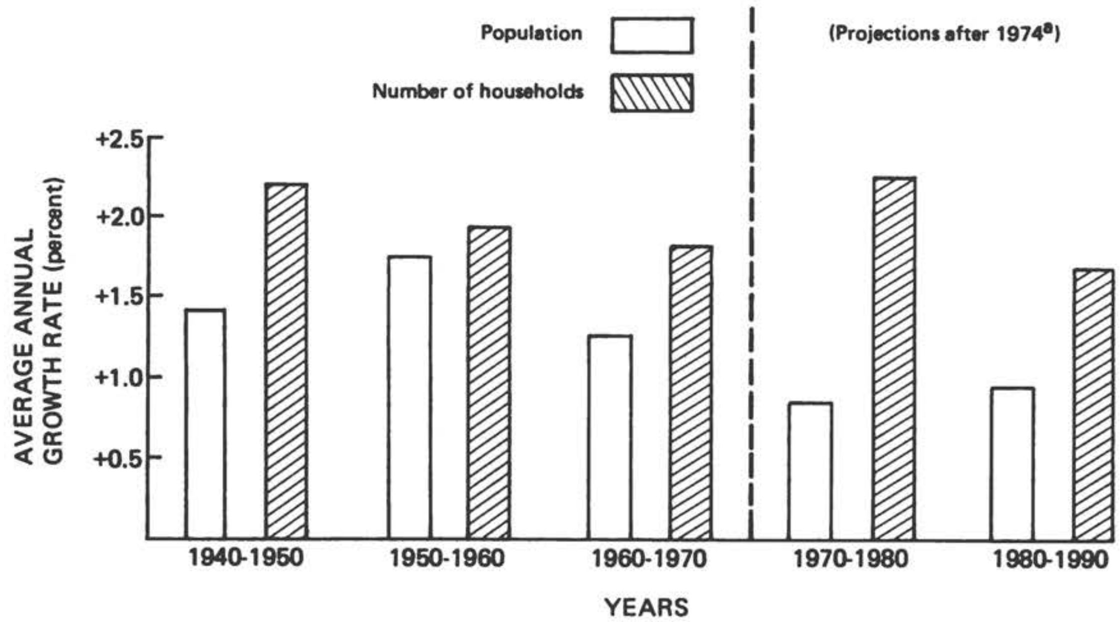
This section explores two demographic trends on the current American scene that create or strongly affect many social and economic problems, including energy consumption:

1. With the sharp decline in annual numbers of births, U.S. population growth has slowed.
2. The growth rate in the number of households, in contrast, has accelerated and will remain high, reflecting (a) the unusually large cohorts of young adults who were born during the baby-boom after World War II and are now in the prime household-forming ages, and (b) the increasing fractions of young and old people who choose to occupy separate living quarters as non-family households.

Together, these trends underscore the need to distinguish between two types of energy-consuming units--people and households--and their quite dissimilar growth trajectories (see Figure 1). American households have become increasingly fragmented into smaller clusters of persons who share the same living quarters. Average household size has declined since 1965 and is expected to shrink further in coming years. A typical household's pattern of energy use has a high fixed-cost component; consequently, living arrangements stand out as an important mediating factor between sheer numbers of people and the energy they consume.

Growth of the Population

U.S. population growth has moderated recently, and the outlook is for continued slow growth. Nationally, population increase averaged 2.8 million each year between 1955 and 1965. Since then, average annual



aPopulation projection: Census Series II
Household projection: Census Series C

SOURCE: U.S. Department of Commerce (1975a, b).

FIGURE 1 Annual growth rates in population and number of households, 1940-1974, and projections to 1990.

increase has diminished to 1.9 million (and below since 1971). As of late 1978, the most reasonable conditional forecast in light of current birth-expectation data is the Census Bureau's series II projection (associated with an ultimate completed cohort fertility rate of 2.1 births per woman).[1] That projection indicates a slight rise to an annual increase of 2.2 million during most of the 1980's. Thereafter, the annual increase moderates to a range of 1.5 to 2.0 million during the 1990's and drifts lower in later years (see Figure 2).

Events can upset forecasts, of course. Future fertility, the principal determinant of population growth, is uncertain; future growth rates may be higher or lower than those in the "best guess" series II projection. For that reason, the Census Bureau also compiled a series I projection (higher fertility, associated with an assumed 2.7 births per woman) and a series III projection (lower fertility, associated with an assumed 1.7 births per woman). These projections, also shown in

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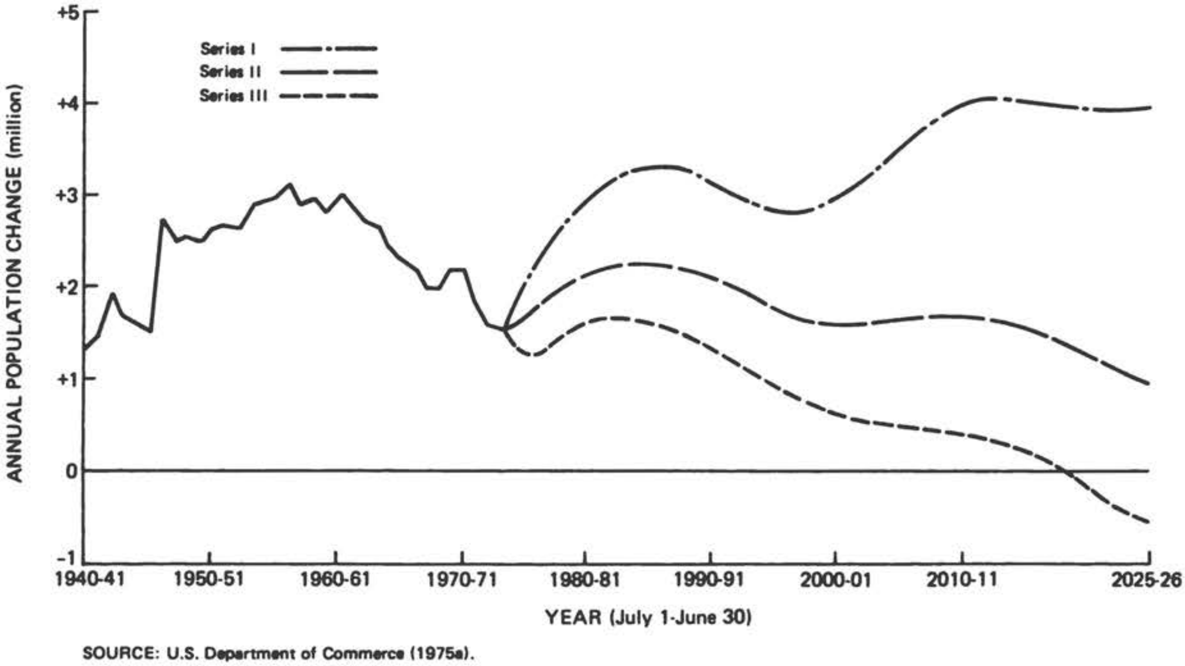
[1] In 1976, wives 18 to 24 years old expected a lifetime average of 2.1 births. When adjusted to include those women who have not yet married or who will remain single, the birth expectations data suggest, as of this time, that the average lifetime fertility of all women 18 to 24 will be about 2.0 births (U.S. Department of Commerce, 1976a).



SOURCE: U.S. Department of Commerce (1975a).

FIGURE 2 Estimates and projections of annual population change: 1940 to 2025.

Figure 2, bracket what most demographers would regard as a reasonable range of future possibilities.[2]

Growth of Households

While the growth of the U.S. population has slowed considerably, the growth in the number of U.S. households has not. The average annual rate of increase in households rose from 1.8 percent during 1955-65 to 2.3 percent during 1970-76. As Figure 1 shows, the dissimilarity in population and household growth trajectories is projected to persist in the foreseeable future (13 years).

[2] A substantial body of evidence exists on which an informed judgment about future fertility trends can be based. In my judgment, the long-term trend of future fertility (and hence population growth through natural increase) is very unlikely to rise above the level depicted in series I; it seems plausible, on the other hand, that fertility could fall below the level depicted in series III.

The current and impending surge of household formations is attributable largely to the massive cohorts of young adults born during the postwar baby boom, who are now passing through the prime household-forming ages (roughly speaking, 20 to 30). Other concurrent trends lend further impetus to this surge: (1) the tendency for unmarried young adults (whose ranks are increasing) to set up transitional, independent living arrangements after leaving their parental homes but before forming their own families; and (2) the increase in the number of "survivor" households (mostly elderly widows) who choose to occupy separate living quarters after their children have formed their own families.

All in all, American households have become increasingly fragmented into smaller numbers of persons who share the same living quarters. The trend toward smaller families, and the growth of nonfamily households among both the young and the old, have brought about a decline in average household size. The average number of persons per household hovered around 3.3 between 1955 and 1965, then began to decline and had fallen to 2.9 by 1976; it is projected to be in the vicinity of 2.5 to 2.7 by 1990, depending upon one's assumptions about the future rates of household formation.

There are, however, considerable grounds for uncertainty about the exact size of future households. A continuous interplay operates between two broad forces: the demographic and economic circumstances that shape the typical cluster of persons who live together as a household; and the social and cultural changes that have broadened the types of living arrangements and companionship that society condones. That interplay is difficult to forecast. Adults in various stages of the life cycle enjoy considerable latitude in choosing how they will cluster into social units for housing purposes. Insofar as their living arrangements are constrained by energy availability (chiefly, one would think, through price), those arrangements can be expected to change and adapt.

Household changes over the last three decades furnish ample evidence that affluence encourages separate living arrangements, with young adults departing from the parental home at an earlier age and elderly persons living apart from their adult children. But budget constraints can foster new social inventions, as cohabitation and communal living in the inflationary 1970's have demonstrated. For at least two reasons, such adaptations are bound to be easier in the future than they were in the past: (1) the younger age groups, having been exposed to a broad range of possible living arrangements, can be expected to retain a degree of flexibility in living arrangements throughout their lives; and (2) high incidences of marital dissolution will increase the "population at risk" for new kinds of arrangements.

Over the next decade, the sheer number of households will increase substantially faster than the population, owing to the baby boom's compression effect. The calculus of household formation, however, may change (Frieden and Solomon, 1977):

- Since large families will become far less common, individuals who in the past might have formed separate households will feel less compelled to do so in the future.

- Growth in real per capita income, which spurred formation of separate households during most of the 1960's, is unlikely to continue as strong.
- There will be growing mismatches between housing supply and demand, creating more incentive to consolidate. The supply of large houses will become more abundant (because of fewer large families) but middle-sized houses will grow scarce (because of more small families and low housing production).

These and other considerations complicate our view of the future, and it is by no means clear what their net effect will be. Frieden and Solomon (1977) foresee a slight decline in the incidence of new household formation through 1985, a departure from the previous 15-year trend; because their assumptions are not yet fully documented, however, it is difficult to judge their validity. Bureau of the Census projections (which by way of contrast rely on extrapolation of the 1960-74 trend) envision a continued rise in the proportion of adults who form separate households (U.S. Department of Commerce, 1975b).

Whatever the case may be, living arrangements will constitute an important mediating factor between sheer numbers of people and the energy they use. The dissimilarity in the growth trajectories of population and household blurs the effects of slowed population growth on energy use, for things can be said to be contracting or expanding, depending on whether people or households are considered the energy-consuming unit.

GROWTH OF MULTIWORKER FAMILIES

Energy Impact Summary

The proliferation of multiworker fmailies, and the life-style changes it engenders, can be expected to impinge on energy use both directly and indirectly:

1. The resultant higher family incomes will affect both the amount and the patterns of energy consumption.
2. Average family size may continue to decline as young wives' initial work experience either reinforces couples' prior inclinations to remain childless or discourages parents from further childbearing. Per capita income within families will tend to rise, because energy consumption tends to increase with income. Continuing decline of family size may further stimulate the consumption of energy; with smaller families, patterns of energy use may change as well.
3. Increases in multiworker families may necessitate more daily travel, since many such families will make two daily journeys to work instead of one.

4. The complex calculus whereby families form residential location preferences may be modified by a heightened need to live near their work.

Background

The traditional division of labor in the American family had the husband as the sole producer of earned income, while the wife contributed to the family's economic well-being largely through home production tasks. This family model of husband-breadwinner and wife-homemaker is being replaced by the multiworker family (in which, most typically, the husband and wife, but in some cases the husband or wife and another family member, are workers). This new division of labor and the changes it engenders will likely affect future patterns of energy use in a variety of subtle ways. To elucidate these changes and their potential energy-related effects, this section provides a factual base describing the historical and current levels of wives' participation in the labor force.[3]

The changing economic position of wives, whereby unpaid services in the home are transformed into paid employment outside the home, traces back to the time of the industrial revolution. At the turn of this century, approximately one in 20 wives were classified as "gainfully employed"; by 1910 that fraction had increased to about one in 10. Since midcentury (after the influx of women into the labor force induced by World War II), the labor force participation rate of wives has advanced from 23.8 percent in 1950 to 44.4 in 1975, and the closely related percentage of husband-wife families with 2 workers or more has risen from 36.1 to 48.7 percent (see Figure 3).[4]

LABOR FORCE PARTICIPATION AT EARLIER AGE

Underlying this long-term increase in the number of working wives has been an important shift in the age pattern of labor force participation: the increases in the proportions of working wives have been concentrated at progressively younger ages. The rise of working wives used to depend heavily on changes in wives' activities *after* childbearing and early childrearing; more recently, it has come about because of changes in women's activities *during* these stages of the family life cycle. As such, it is indicative of a basic shift in the way that young wives order their careers as mothers or income-earners. Traditionally, childbearing was accompanied by a complete withdrawal from the work force for a period

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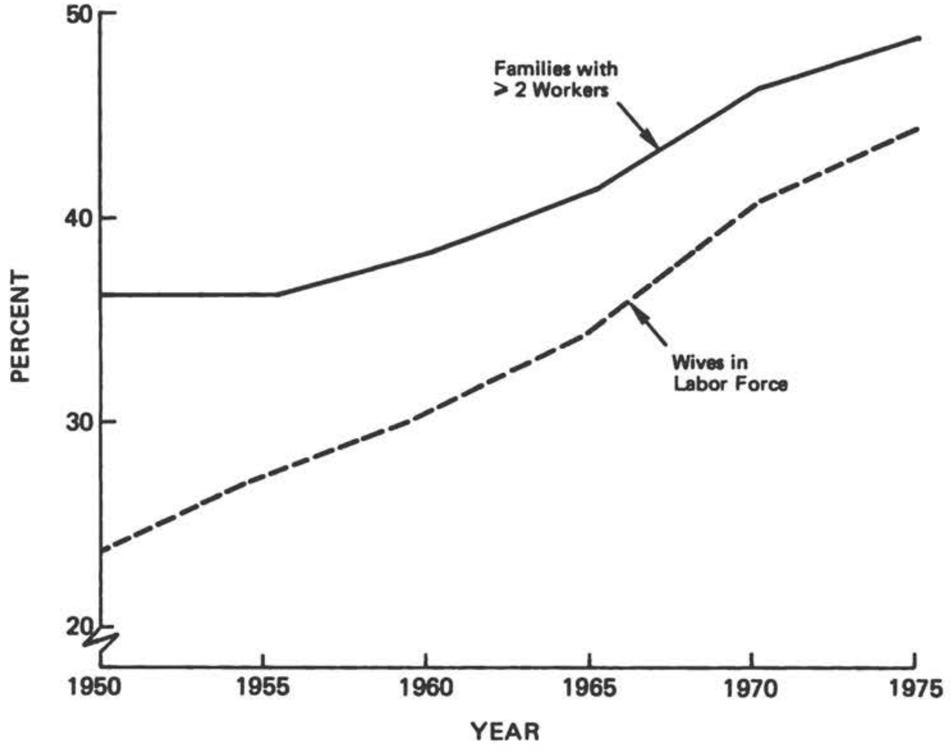
[3] This section draws heavily on Hayghe (1976) and Kreps and Clark (1976).

[4] The multiworker family is not identical to the working-wife family, since the second worker in some cases is another family member. Family members other than the wife have not contributed much to the increasing proportion of multiworker families, however. As of 1975, in only 16 percent of multiworker families was there an additional worker who was not the wife.



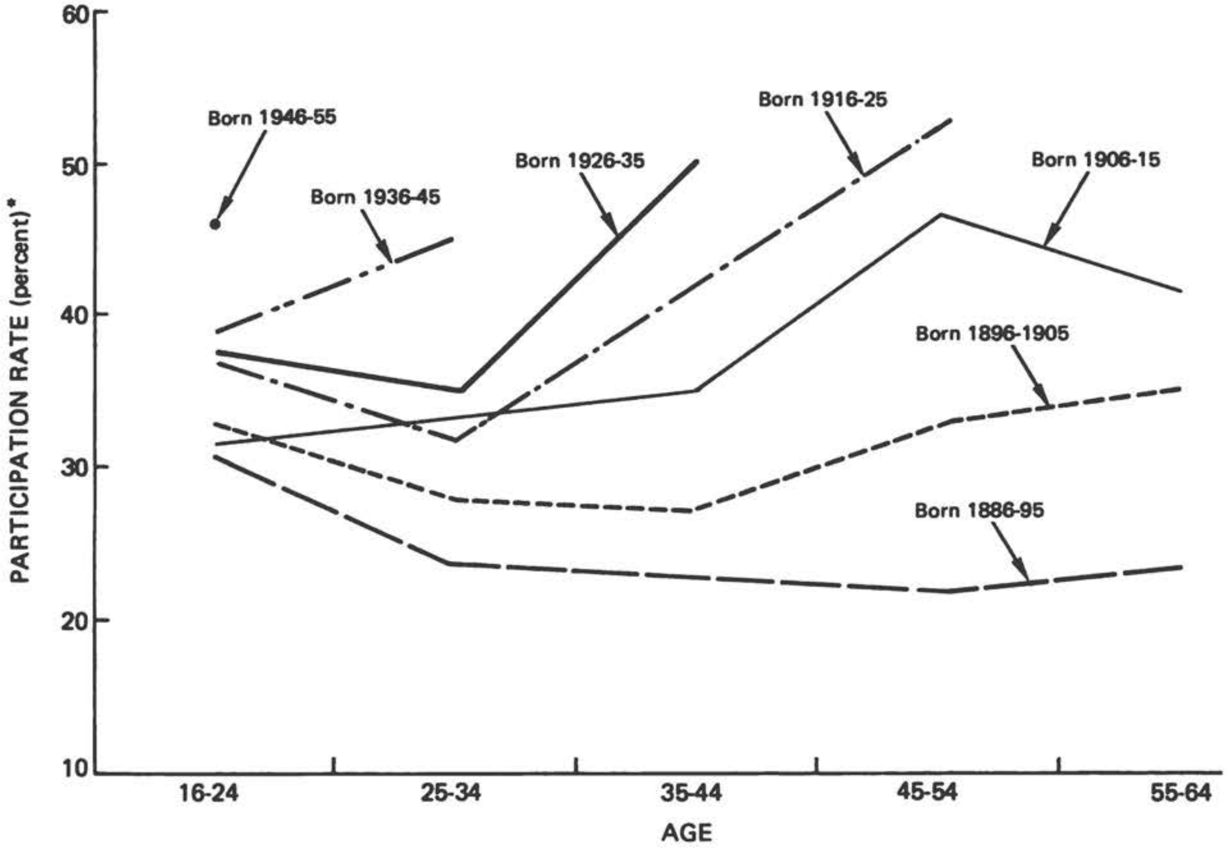
SOURCE: Hayghe (1976, Table 1).

FIGURE 3 Increase in percent of wives in labor force and percent of husband-wife families with 2 or more workers: 1950-1975.

of years (the time being extended by each successive child). Because such withdrawal covered those years in which job advancement is most rapid, women lost the opportunity to establish their careers or to gain seniority or experience before they withdrew. More recently, married women in their thirties and older, often with school-age children, are in the labor force, either because they have returned after a brief absence or because they never left.

A revealing perspective on this change can be gained from Figure 4, which compares the careers of different cohorts of women. Notice that labor force participation is higher for each successive cohort (i.e., the lifetime pattern of each lies above that of its predecessor). Especially noteworthy is the sharp rise in labor force participation at an early age among cohorts born after 1935. These inter-cohort changes foreshadow higher attachment of wives to the labor force in the future. In all likelihood, many more of today's young wives, compared with their counterparts a decade or more ago, will be working in their older years, and the proportion holding full-time jobs will be higher.

As a consequence, many more wives are working at younger ages, and concurrent with, rather than after, childrearing. Moreover, their attachment to the labor force is less often temporary or capricious compared with that of their counterparts a decade or two ago. For



*Total labor force as percent of total noninstitutional population in group specified.

NOTE: For women born between 1886 and 1915, the first age plotted is 14-24 years. Cohorts reach each age interval according to the midpoint of their birth years. Thus, the cohort born 1886-95 reached ages 25-34 in 1920 and ages 55-64 in 1950; the cohort born 1916-25 reached ages 25-34 in 1950 and ages 45-54 in 1970.

SOURCE: U.S. Department of Commerce.

FIGURE 4 Labor force participation over a working life of cohorts of women born in selected time intervals, 1886-1955.

example, even in families where preschool-age children were present, nearly two-thirds of mothers who worked in 1975 did so full time. That greater attachment, of course, makes for more advancement in careers, hence higher incomes.

Accordingly, the median income of families with working wives has increased faster than for families in which wives are not in the paid labor force. Women's rapidly increasing representation in higher paying professional occupations is likely to widen this income difference between families with two workers and those with only one.

In sum, several developments seem likely to make for the earlier initiation of a career by a wife and greater likelihood of her adherence to and advancement within that career.[5] The future worklives of men and women will likely come to resemble each other more and more, both in terms of occupational distribution and time spent in the labor force. The results will be increasing numbers of multiworker families, each with higher family income, in the years ahead.

As more families benefit from two incomes rather than one, and some curtail their childbearing, energy consumption is likely to grow and patterns of use will change. In a somewhat more speculative vein, it is possible that the proliferation of multiworker families will necessitate more daily travel, since for many such families there will be two daily journeys to work instead of one. Also, since multiworker families will place greater value on proximity to employment, this change in the division of labor within families could even feed back on residential settlement patterns, influencing where families choose to live in relation to major employment centers within a metropolitan area.

CHANGING PATTERNS OF POPULATION SETTLEMENT

This section explores two major population trends:

1. Regionally, the population is gravitating toward states in the South and West, and away from states in the Northeast and North Central regions. Continuation of these shifts should gradually alter uses of energy for climate control.
2. Locally, increasing numbers of metropolitan areas have ceased growing in population, and many nonmetropolitan areas--including those outside the range of metropolitan commuting--are experiencing unprecedented population growth. Although the long-term outlook for these local trends is uncertain, the present trends

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[5] The U.S. Department of Labor's Bureau of Labor Statistics projects a continued increase in female labor force participation rates, particularly among prime-age workers (ages 25-54). Participation rates for women in this age group, which averaged about 55 percent in 1975, are projected to rise to the 60 to 65 percent range by 1990 (Fullerton and Flaim, 1976).

carry with them important implications for patterns of daily commuting.

Population Settlement and Energy Availability

Two fundamental dimensions of population settlement bear on energy availability and use. The first is *regional location*, which determines the distribution of population among cold and temperate climates. Residential energy use varies by location, since climate control needs differ considerably from region to region. The second is *compactness of settlement* within urban centers and metropolitan areas, which determines the degree to which distance constrains daily interaction and face-to-face communication. Transportation energy tends to be a substitute for compactness of settlement (Edwards, 1975).

Cutting across these two dimensions of the population's distribution are issues of *equity*: embedded in settlement patterns are important age, racial, and other socioeconomic differentiations, and the local burdens that accompany changes in energy availability are not shared equally by all groups. The effects of alternative energy policies may vary across kinds of places, and particular groups that are concentrated in some types of locales may be acutely vulnerable to energy price increases or other pressures imposed by changing sources or availability of energy. For example:

- Large numbers of people depend heavily on the private automobile, and the closeness of available substitutes for the automobile depends on where they live.

To get to work, people who live in the open country and rural towns rely on commuting more than do people in small cities. (In 1970, about one in four such workers commuted to a job in another county, compared with one in 10 workers who lived in nonsuburban cities of 10,000 to 50,000 population.)[6] Where regular public transportation is lacking, the automobile is irreplaceable for giving people access to employment and services that may be an easy bus-ride away for the city dweller.

- Home-heating expenditures, as well as recent increases therein, vary greatly by regional location.

For example, the average cost of heating a typical five- or six-room single-family home with fuel oil would be about half again as high in Minneapolis as in Washington, D.C.; with gas, however, heating costs would be about 8 percent *less* in Minneapolis.[7] Climate, housing characteristics, type of fuel, and regional fuel prices are the principal determinants of such variation.

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[6] Hansen (1976); see also, Sharpe (1975).

[7] Prices are for July 1975. Based on data shown in Palmer, Todd, and Tuckman (1976); also see Barth, Mills, and Seagrave (1974).

With these general cateogries of effect in mind, the following discussion considers regional and local trends in population distribution that are impinging on these dimensions of change.

Trends in the Regional Location of Population

Regional population trends have changed significantly since 1970 as compared with previous periods (Figure 5). The South's 5.1 million population increase in the first five years of this decade represents a sharp departure from the experience of other recent five-year periods. The Northeast, in contrast, has embarked upon an era of virtual population stasis, and the North Central region's population increase has slowed considerably.

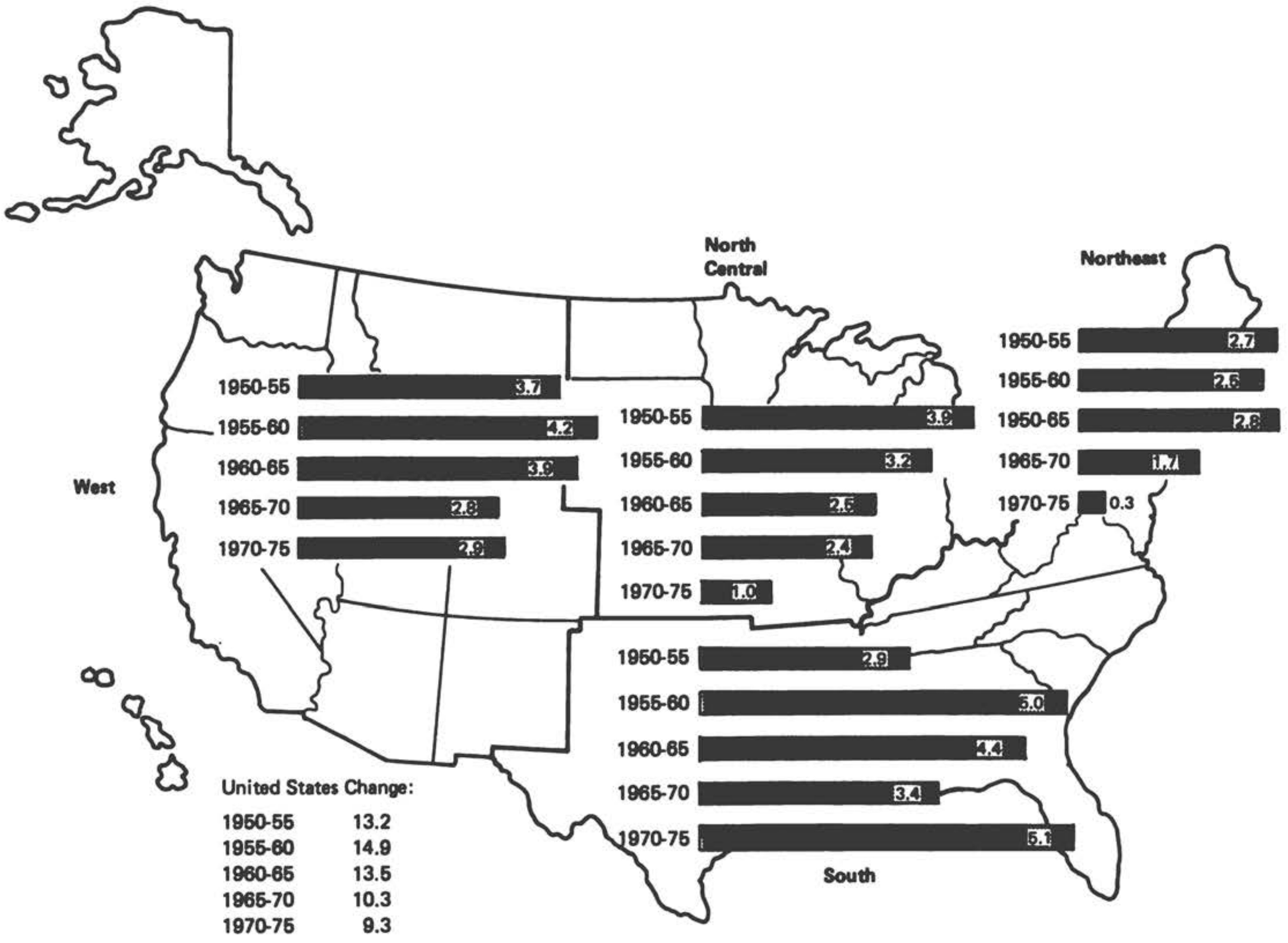
Two demographic shifts in combination have brought about these changes (Table 1). One is a continuing drop in the birth rate, which has reduced natural increase everywhere; nationally, the population gained 12.0 million between 1960 and 1965 through this component of demographic change, but only 6.8 million between 1970 and 1975. The other shift is a transformation of regional migration patterns, which has drawn people away from the Northeast and North Central states and toward the South and, in lesser degree, the West.

In the Northeast, for example, net migration has changed from nominal gains of several hundred thousand in preceding five-year periods to a sizable loss of 700,000 between 1970 and 1975. This regional migration loss has been more severe since 1972 and has affected the three Middle Atlantic states (New Jersey, New York, and Pennsylvania) worse than those in New England (which compose the remainder of the Northeast). Between 1970 and 1976, for example, 851,000 more persons migrated away from the Middle Atlantic states than migrated to them, resulting in a 2.3 percent loss of their 1970 population. In conjunction with very low natural increase, this loss has virtually halted population growth.

The five East North Central states (which surround the Great Lakes) provide an interesting contrast. They have experienced migratory losses comparable in severity to those of the Middle Atlantic states, especially since 1972; however, somewhat higher rates of natural increase in the former have staved off a halt in population growth there.

The sharply increased streams of migrants out of some of the nation's colder regions have been gravitating south and west, especially into the South Atlantic and Mountain states. A massive influx of migrants into Florida has added 22 percent to its population between 1970 and 1976. What is more important, however, is that migratory growth has diffused throughout the South and West in this decade. Prior to 1970 the large numbers of in-migrants to Florida offset what was in fact a migratory loss for the rest of the South (Table 2). Since 1970, Florida's ballooning net in-migration has been matched by an equally large in-migration to the rest of the region. This migration into the other southern states is noteworthy, since it foreshadows a future wave of growth throughout the region.

The nation's other fast-growing region, the West, shows a comparable diffusion of migratory growth. California's migratory experience no



SOURCE: U.S. Department of Commerce (1976b).

FIGURE 5 Population change for five-year periods by region: 1950 to 1975. (Periods beginning July 1. Change expressed in millions.)

TABLE 1 Population Change, in Millions, by Component for Each Region: Five-Year Periods, Beginning July 1, 1950 to 1975

	Natural Increase					Net Migration				
		Region					Region			
Period	United States	Northeast	North Central	South	West	United States	Northeast	North Central	South	West
1950-55	12.1	2.3	3.5	4.5	1.9	1.0	0.4	0.4	-1.6	1.9
1955-60	13.2	2.6	3.9	4.7	2.2	1.7	0.0	-0.7	0.3	2.0
1960-65	12.0	2.3	3.3	4.2	2.2	1.5	0.3	-0.8	0.3	1.7
1965-70	8.7	1.6	2.3	3.0	1.7	1.7	0.1	0.1	0.4	1.1
1970-75	6.8	1.0	1.8	2.5	1.5	2.5	-0.7	-0.8	2.6	1.4

SOURCE: U.S. Department of Commerce (1976b, Table B).

longer dominates the West's regional migration growth as it did prior to 1965 (Table 2). Between 1970 and 1975, the other 12 states in the West gained 1.0 million through net in-migration (more than twice California's share), compared with only 0.2 million (less than one-seventh of California's share) between 1960 and 1965.

Overall, these regional trends are departures from the past, and low natural increase in no small part contributes to their manifestations at the local level. The course these migration trends will follow in the future is difficult to forecast, however, because the coincidence with an economic depression makes this an atypical period.

Compactness of Metropolitan Settlement

At the local level, changes are under way in population redistribution that have major implications for energy use. Many metropolitan areas that grew during the 1960's are now declining. In the nonmetropolitan sector, many of the more remote areas--traditionally the sources of rural-urban migration--are now experiencing unprecedented growth in population. (Nonmetropolitan areas that are less remote, i.e., within commuting

TABLE 2 Net Migration for Selected Areas: Five-Year Periods, 1950 to 1975

Period	California	Rest of West	Florida	Rest of South
	In millions			
1950-55	1.6	0.3	0.7	-2.3
1955-60	1.7	0.4	0.9	-0.6
1960-65	1.5	0.2	0.6	-0.4
1965-70	0.5	0.6	0.7	-0.3
1970-75	0.4	1.0	1.4	1.2
	As percent of beginning population			
1950-55	14.7	3.0	24.8	-5.3
1955-60	12.3	4.4	24.9	-1.3
1960-65	9.7	1.8	12.8	-0.8
1965-70	2.7	4.1	11.7	-0.5
1970-75	2.1	6.7	19.9	2.1

SOURCE: U.S. Department of Commerce (1976b, Table C).

range of existing metropolitan centers, continue to grow rapidly as in the past through "spillover.")

The underlying demographic structure of these shifts is suggested by the data shown in Table 3, which compares the direction of population change in the decade of the 1960's with those for 1970-75, the latest period for which these data are available. Notice in particular the reversal of net migration for the counties with little commuting. Clearly, the migration reversal cannot be explained away semantically as just more metropolitan sprawl or spillover, for it is affecting distinctly remote nonmetropolitan areas as well as those adjacent to metropolitan centers. For now, at least, nonmetropolitan areas have become more attractive, both to their residents and to outsiders, whereas metropolitan areas have become less so.[8]

Without going into details on why these trends are occurring, an important point should be underscored here.[9] The causes underlying these new trends are diverse and only partly understood: any single explanation invariably seems simplistic when one attempts to fit it to the disparate array of changes going on in different sections of the country. It is virtually certain that multiple causes are at work, and in different ways in different places. One causal factor that is clear is the energy-related industrial development spurred by the revaluation of coal and oil. Certain parts of the country, most notably the Northern Great Plains and the coal regions of Appalachia, have registered a strong revival of nonmetropolitan growth as the result of newly created jobs in mining, which have also induced many former residents to come home again. Colorado, Montana, New Mexico, North Dakota, Utah, and Wyoming will shortly become significant sources of coal, synthetic petroleum liquids, and natural gas. Typically, these energy-supply areas are sparsely populated and lack the full array of legal and institutional structures for coping with their new growth. There are major uncertainties about the extent and permanence of the new growth that is occurring there, however, for the actual future exploitation of these resources may be far less labor-intensive in the future than is the immediate process of building the facilities for doing the exploitation.

Several important energy implications hinge on whether the trend toward nonmetropolitan growth continues. The compactness of population settlement systematically determines the amount and mode of personal travel: high density within urban areas reduces the number of nonpedestrian trips, while low density requires a higher percentage of automobile trips.[10]

If large numbers of people decide to work and live in smaller nonmetropolitan cities (less than 50,000 population), then growth of

[8] Whether this reversal will be temporary or long term is unclear, for the shift coincided with, and may be due in part to, the severe economic recession of the past several years. If so, a resumption of metropolitan growth would be expected concurrent with improvement in the economy. Although the latter has now occurred, thus far the former has not.

[9] An explanation of these trends is given in Morrison and Wheeler (1976).

[10] A review of evidence on this point is given in Keyes (1976).

TABLE 3 Population Change, in Percent, Metropolitan and Nonmetropolitan Counties: 1960-70 and 1970-75

Population Category	Provisional 1975 Population (000's)	Annual Population Change Rate		Annual Natural Increase Rate		Annual Net Migration Rate	
		1960-70	1970-75	1960-70	1970-75	1960-70	1970-75
United States Total	213,051	1.3	0.9	1.1	0.7	0.2	0.2
Metropolitan Counties							
Total, all SMSA's[a]	156,098	1.6	0.8	1.1	0.7	0.5	0.1
>1.0 million	94,537	1.6	0.5	1.1	0.6	0.6	-0.2
0.5 - 1.0 million	23,782	1.5	1.0	1.2	0.8	0.4	0.3
0.25 - 0.5 million	19,554	1.4	1.3	1.2	0.8	0.2	0.5
<0.25 million	18,225	1.4	1.5	1.2	0.8	0.2	0.7
Nonmetropolitan Counties							
Total, all nonmetropolitan counties	56,954	0.4	1.2	0.9	0.6	-0.5	0.6
In counties from which:							
≥20% commute to SMSA's	4,407	0.9	1.8	0.8	0.5	0.1	1.3
10% - 19% commute to SMSA's	10,011	0.7	1.3	0.8	0.5	-0.1	0.8
3% - 9% commute to SMSA's	14,338	0.5	1.2	0.9	0.6	-0.4	0.6
<3% commute to SMSA's	28,197	0.2	1.1	1.0	0.6	-0.8	0.5
Entirely rural counties[b] not adjacent to an SMSA	4,661	-0.4	1.3	0.8	0.4	-1.2	0.9

[a] Population inside Standard Metropolitan Statistical Areas (SMSA's) or, where defined, Standard Consolidated Statistical Areas. In New England, New England County Metropolitan Areas used.

[b] "Entirely rural" means the counties contain no town of 2,500 or more inhabitants.

SOURCE: U.S. Department of Commerce, Bureau of the Census, Current Population Reports, Series P-20, various issues; and unpublished statistics furnished by Calvin L. Beale, Economic Research Service, U.S. Department of Agriculture.

energy use for commuting may be somewhat slower than it would be with continued outward extension of large metropolitan areas. If, on the other hand, the pattern of nonmetropolitan settlement is low-density and dispersed, transportation needs will expand. Present-day residents of nonmetropolitan areas consume considerably more energy per capita for transportation than do their metropolitan counterparts, since the former must travel farther to work and to obtain essential services such as health care.

CONCLUSIONS

Virtually all of the demographic shifts described in this paper can be delineated with precision; some can be forecast with confidence. Our understanding of how these changes will interact with energy availability to shape future energy use patterns is far less exact. The proliferation of sophisticated models and simulation studies should not obscure the importance of exercising judgment about the developing trends in, and diversification of, American styles of living. Models translate judgment (or whatever substitutes for it) into numbers, which then take on an aura of mathematical authority. But the columns of numbers should not obscure the uncertainty which surrounds the necessary assumptions on which they rest. The delineations of this demographic context, and interpretation of the trends that compose it, are intended to sharpen judgments about where these trends may be leading and how they may shape the use of energy in American styles of living.

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ENERGY BOOMTOWNS:
A SOCIAL IMPACT MODEL
AND ANNOTATED BIBLIOGRAPHY

by

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INTRODUCTION

One of the effects of the energy development currently under way in the United States is the emergence of boomtowns--the rapid and extreme growth of population and the consequent changes in the social, economic, and cultural systems of the communities affected. The boomtown phenomenon can occur whenever a large industry locates in a community and there is a significantly large in-migration of work force and related services. Based as it is upon labor-intensive power plant construction and mineral extraction, the current technology of energy development is an especially powerful source of rapid growth when it is suddenly introduced in a community. The vast stores of mineral resources in the sparsely populated Rocky Mountain and Northern Plains states of Arizona, Colorado, Montana, New Mexico, Utah, Wyoming, Nebraska, North Dakota, and South Dakota make the communities located near these deposits especially susceptible to the boomtown phenomenon.

Current estimates indicate 25 emerging boomtowns in Colorado alone and over 200 such communities in the Rocky Mountain/Northern Plains region (Rocky Mountain News, 1977). These estimates refer to those small, rural communities ranging from a few hundred to a few thousand in population. The boomtown label can also fit the larger cities of Denver, Billings, Casper, and Bismarck which, as regional service centers, are experiencing rapid growth as a result of energy development in the region. From the macro level of analysis one might argue that few persons living in the western region are unaffected by the boomtown effects of western energy development. Valuable state resources in the form of tax dollars and government services are being spent to mitigate the negative aspects of boomtowns as well as to encourage the positive economic benefits to communities where energy development is occurring. Moreover, the visibility of boomtowns, in addition to the real social problems inherent in them, is enhanced because the phenomenon is taking place in communities where there has been little social change for many decades. The boomtown is also an especially thorny problem for policy makers in a region where the attraction of industry, population, and economic development has been the major goal for over a century. We have attempted to discuss the sociological significance of these conflicts with relation to the boomtown issue in general elsewhere (Cortese and Jones, 1977) and will not dwell upon that here.

Aside from arguing for the importance of the boomtown effect of energy development, the above discussion should also serve to point out that the evaluation of impacts is hardly straightforward. We use the term "impact" in a nonevaluative sense; where we feel there is general agreement that particular impacts are good or bad, we use the terms "positive impact" or "negative impact." Our reserach in boomtowns has made us clearly aware that various groups view and evaluate the same impact differently. The purpose of our work thus far has been to *identify* impacts. The much greater task of *evaluating* impacts remains to be done.

Purpose

There are several places one might search for information on boomtown impacts. First, the history of the American West is largely a history of boomtowns (Griswold and Griswold, 1958). The gold rush of the late nineteenth century, the uranium boom of the 1950's, and the recreational and ski industry boom of the 1960's have all created boomtowns. The major difference from earlier counterparts is that energy-related boomtowns are, for the most part, long-established, relatively stable agricultural communities which, like Craig, Colo., have grown more than 200 percent in seven years.

Second, the literature of classical sociology, most notably the works of Durkheim, Toennies, Marx, and Weber, stemming as they do from the social changes wrought by the Industrial Revolution, remain a rich source of theoretical knowledge on the impact of industry on the community. Carnes and Friesema (n.d.) have done a remarkable job of summarizing this literature and relating it to the impact of energy development on the growth and urbanization of the Northern Plains region.

Third, there is the "community studies" literature of sociologists, political scientists, and anthropologists, parts of which should provide insight into the phenomenon in question (see, for example, Bell and Newby [1972]). Also, there is the literature on modernization, which some have found lacking in useful information on the transition process itself (Freudenburg, 1976); and the literature of human ecology, which contains much about the adjustment of rural migrants to urban settings (Killian, 1953; Stein, 1973) but almost nothing about the adjustment of rural natives to the in-migration of urbanites.

We expect and hope that researchers will continue to probe these sources for more information. We, for the moment, have chosen another direction. The focus of this report is the information contained in the vast amount of current research being done as a result of energy development--a wealth of paper distinguished primarily by the poverty of its publicity and accessibility.

Social impact assessments are multiplying faster than proposed energy exploration and extraction projects themselves. Conferences are held in business, governmental, and scholarly circles where information on the boomtown phenomenon is shared. Universities, regional commissions, independent scholars, planning and research firms all have contributed to studies of boomtowns. The local press in the region frequently reports on new developments or carries stories by journalists who have visited these communities and reported their observations.

This literature is not all research in the conventional sense. Some reports are detailed statistical descriptions, some are ethnographies, some very impressionistic personal accounts; they are extremely varied in quality.

The purpose of our research was to organize systematically what is currently known about the boomtown aspect of community and regional impacts of energy development projects, focusing specifically upon (a) the less widely available literature, (b) on the western United States, and (c) on fossil fuel development. Our work has involved two major tasks:

1. developing a model which incorporates the wide range of variables and relationships inherent in the boomtown phenomenon;

2. locating, synthesizing, and documenting available literature on boomtown impacts in order to augment the model with what we have chosen to call, somewhat inaccurately, "propositions."

Some of these propositions are actually research findings of a scientifically or methodologically acceptable nature. Some have been verified empirically, either statistically or through rigorous participant observation techniques. Other propositions are just that--statements of hypothesized relationships based on some degree of observation or derived from the application of bodies of theory. Still others (e.g., many of those found in journalistic accounts and symposia proceedings) rank in the more unscientific realm of superficial observation and "expert" opinion. Many of our propositions are, in actuality, hypotheses in search of better data to support them.

Nevertheless, the statements which we have incorporated, regardless of the degree of scientific rigor in their origin, represent the knowledge about the boomtown aspect of energy development that is contained in this literature. Further and more accurate testing of many of these propositions should be a major focus of future research.

Sources of Propositions

Citations supporting the propositions in this report refer to sources which:

- provided a cross-section of types of material being collected
- were amenable to review within the time available
- yielded rich, qualitative social impact descriptions.

The *Construction Worker Profile* (137)[1] was used to provide the core propositions since the model employed came from those data.

The Bibliography

The selected annotated bibliography contains approximately 200 titles. Almost twice this many sources were uncovered in our search; sources selected for inclusion were those which appeared most relevant to the task at hand. This does not mean that our selected bibliography might not contain titles whose contents shed little or no light on the boomtown phenomenon. Some reports were inaccessible to our research team but

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[1] The number in parentheses refers to the number of that source in our bibliography. Items in the bibliography will be referred to accordingly throughout.

were included because references to them in other reports strongly indicated their relevance.

We regret that the reader of our bibliography will find many occasions where the citation gives little indication of where one might obtain a copy of the document. While we have provided as much identifying information as was available, the reader is left in many cases with only sketchy information. In these cases, discovering where to obtain a copy will take some ingenuity. We considered providing such information but the task proved too great. Beyond the usual limits of time for such a task, the place where we located a particular document in many instances would be unable to satisfy requests for copies or to provide information regarding where copies might be obtained.

Despite this limitation, we believe the bibliography provides a current and extensive compilation of literature on boomtowns. In addition, the annotations provide at least a general sense of applicability of many of the sources. While some sources contain no annotations, many are referred to in the propositions contained in the expanded discussion of the model. Still others, at this point, remain neither annotated nor cited in our explication of the model. Some of these either are easily accessible, are widely known, or provide adequate indication of content in their title alone.

THE MODEL

Figure 1 illustrates the relationships among the main elements of our social impact assessment model. The model was developed from an earlier version (Jones and Cortese, 1976) with additions from models developed by others (Olsen and Merwin, 1976; Wolf, 1974; Leistritz, 1975; Finsterbusch, 1976; Gold, 1974). The following outline amounts to an "opening" of each of the five boxes in our model. We have attempted to provide an organized list of the various categories of conditions on which positive or negative impacts depend and within which various impacts occur. Within the outline below, an asterisk denotes those characteristics for which we have provided propositions from the literature. The propositions, along with some discussion, are listed at the end of the outline.

Explicated Model

I. Nonlocal context
    *A. Official policy declarations, laws, regulations[2]
        *1. Federal
        *2. Regional
        3. State
        *4. Corporate

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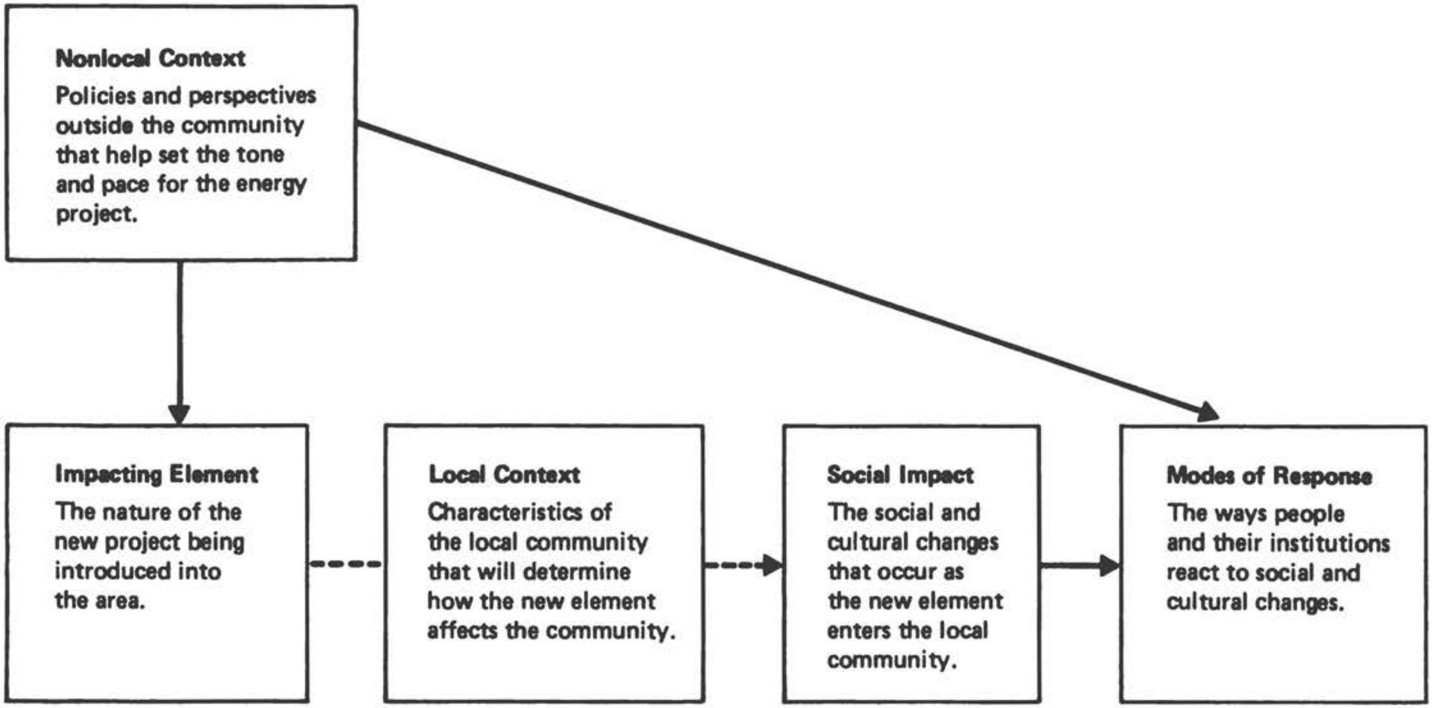
[2] Asterisks denote characteristics for which propositions from the literature are provided.



NOTE: The dotted lines linking Impacting Element to Social Impact are meant to indicate that the Impacting Element "filters through" the Local Context, and, thus shaped by the Local Context, determines the Social Impact.

FIGURE 1 Social impact assessment model.

- B. Alternative perspectives (interest group positions)
    - 1. Current declarations
    - 2. Current credibility and attention received

II. Impacting element (new project characteristics)

- A. Public vs. private sponsorship
    - 1. Public or private ownership or operation
    - 2. Public or private land utilized
    - *3. Environmental impact statement and other control implications
    - *4. Impact assistance implications
    - *5. Tax revenue implications
- *B. Type of energy-related activity
    - 1. Extraction
        - a. Mining
            - (1) Strip mining
            - (2) Deep mining
        - b. Damming
        - c. Other
    - 2. Power generation
        - a. Coal and coal gasification
        - b. Steam-electric
        - c. Hydroelectric
        - d. Nuclear
        - e. Solar
        - f. Geothermal
    - 3. Energy processing
        - a. Petroleum refineries
        - b. Electrochemical industries
        - c. Nuclear fuel cycle facilities
    - 4. Transmission
        - a. Transmission lines
        - b. Ground or waterway shipment
        - c. Pipelines
        - d. Aquaducts, tunnels
- C. Type of non-energy-related activity
    - 1. Recreational
    - 2. Military
    - 3. Highway/transportation
    - 4. Industrial/manufacturing
- D. Scale
    - 1. Large or small
    - *2. Labor intensive vs. technology intensive
    - *3. Physical or symbolic presence
    - 4. Concentration or dispersal of facilities

- *E. Stage of development
  - *1. Planning and speculation
  - *2. Acquisition
    - a. Lease
    - b. Purchase
    - c. Both
  - 3. Construction
    - a. Mine
    - b. Plant
    - c. Other (processing, transmission facilities)
  - 4. Operation and maintenance
  - 5. Close-down/slow-down
  - 6. Departure
- F. Timing of project
  - *1. Duration
  - *2. Phasing (sudden/drawn out)
  - *3. Simultaneous projects
  - *4. Relations with host community
- G. New population
  - *1. Size relative to host community
    - a. Smaller (minority)
    - b. Equal
    - c. Larger (majority)
  - *2. Socioeconomic status
    - *a. Similarity/dissimilarity to host population
    - *b. Homogeneity/heterogeneity
    - c. Income
  - 3. Settlement patterns
    - a. Live in host community
    - b. Commute to and use host community facilities
    - c. Combinations
  - *4. Mix of labor force
    - *a. Mostly local and regional
    - *b. Mostly nonlocal or nonregional
    - *c. Construction/operating multiplier effect
      - (1) Absolute numbers
      - (2) Ratios
    - *d. Boomtown people
    - *e. New professionals
    - *f. Returning natives

III. Local context (host community characteristics)

- *A. Location of community
  - 1. Rural
  - 2. Urban
  - 3. Suburban
  - 4. Exurban

- *B. Community size
  - 1. Few hundred
  - 2. Few thousand
  - 3. Many thousand
  - 4. Demographic characteristics
    - a. Population trends
    - *b. Population density
    - c. Existence of special population groups
  - 5. Socioeconomic characteristics
    - a. Income
    - b. Social stratification
    - *c. Homogeneity
- *C. Regional stature
  - 1. Dominant in region
  - 2. Subdominant in region
- D. History of community and current status
  - *1. Previous experience with rapid growth and fluctuations
  - 2. Ascending/declining
  - *3. Efforts to attract/avoid growth
  - *4. Economic base
- *E. Institutional types and development (politics/government, economy, education, religion, recreation, helping services, family, media)
  - 1. Number of institutional agencies
  - 2. Size
  - 3. Complexity/bureaucracy
  - 4. Specialization of function
  - 5. Planning capabilities
  - 6. Adequacy of present performance
  - *7. Horizontal and vertical linkages
- F. Readiness to change
  - *1. Information availability
  - 2. Projected changes without project
  - *3. Capacity of community institutions to deal with rapid change

*IV. Social impact

- *A. Institutional impacts
  - *1. Family
    - a. Functions
      - (1) Socialization
      - (2) Social control
      - (3) Sustenance (as a unit of production)
    - *b. Family cohesiveness
    - c. Familial dependence

- *d. Conjugal relationship
    - *(1) Sex roles
    - *(2) Employment of women
    - (3) Divorce, separation, abuse
- *2. Economy
    - *a. Equity
    - *b. Modernization
    - *c. Economic base
    - *d. Cost of living
    - *e. Prosperity
    - *f. Increased competition
        - *(1) Chains and franchises
        - *(2) Jobs
    - *g. Availability of housing, goods, and services
- *3. Government/politics
    - *a. Provision of services
        - *(1) Quantitative
            - (a) More personnel
            - (b) More equipment
            - *(c) More funds
        - *(2) Qualitative
            - (a) Different personnel (turnover)
            - (b) Different positions
            - (c) New technologies
    - *b. Political alterations
- *4. Helping services
    - a. Quantitative
        - (1) More personnel
            - (a) Turnover
            - (b) Additions
        - (2) Facilities
        - (3) More funds
    - *b. Qualitative
- *5. Recreation
    - a. Indoor
    - b. Outdoor
- 6. Religion
    - *a. Growth
    - *b. Importance
    - *c. Functions
- *7. Education
    - *a. Physical facilities
    - b. Turnover
        - *(1) Students
        - *(2) Teachers, administrators, and staff
    - c. Standards
    - *d. Programs
- 8. Media
    - a. Newspapers
        - (1) Local
        - (2) Regional

        - b. Radio
        - c. TV
        - d. Cinema
        - e. Libraries

- *B. Social structural impacts
    - 1. Role differentiation
    - 2. Role creation
    - 3. Role definition/redefinition
    - 4. Role succession
    - *5. Community integration
    - *6. Social stratification

- *C. Cultural impacts
    - *1. Nonmaterial culture
        - a. Beliefs
        - b. Values
        - c. Norms
    - *2. Material culture (physical impacts)

V. Modes of Response

- A. Resources available
    - *1. Corporate
    - *2. Local
    - 3. State
    - 4. Regional
    - 5. National (private)
    - *6. Federal (public)

- B. Nonlocal response
    - *1. Corporate
    - 2. State
    - *3. Regional
    - 4. National (private)
    - 5. Federal (public)

- *C. Local response
    - *1. Personal
    - 2. Organizational
    - *3. Institutional

PROPOSITIONS

I. *NONLOCAL CONTEXT*

The energy projects which can create boomtowns are not generated in a vacuum. Instead, energy companies operate in an environment formed through governmental actions (legislation, regulations, policy statements), other corporate actions (profit considerations, competition), and interest group actions (environmentalist suits, protests, publicity). Such actions, taken outside the local community, shape the kinds of developments that occur. They set the pace, establish priorities between forms of energy resources development, and dictate the conditions under which energy development must occur.

If the current national controversy over the relative merits of coal vs. nuclear energy is resolved in favor of greater emphasis on coal, more boomtowns can be expected in the western states since coal-fired plants are being located adjacent to coal fields. At the federal level, a national energy policy that de-emphasizes energy conservation and the development of alternative energy sources, or considers such approaches unworkable, will require more energy projects of the type with which boomtowns are usually associated. Also, federal research and development expenditures and subsidies, with regard to energy choices and priorities, will be a major determinant of the number of boomtowns that can be expected to develop in the West. At all levels of government, new regulations can suddenly alter the stated intention of an industry to stay in the impacted community for a long period of time. Such reversals lead to rapid and unexpected boom and bust fluctuations.

At the regional government level, interstate governmental organizations are capable of playing a major role in determining the nature, extent, and timing of major energy projects of the type which spawn boomtowns. Furthermore, to the extent that technologies for energy development emerge faster than methods for social and environmental protection, rapid energy development will lead to more boomtowns with little mitigation of ensuing social problems.

A. OFFICIAL POLICY DECLARATIONS, LAWS, REGULATIONS

Proposition: Licensing and permit requirements play a major role in initiation of major energy projects. Licenses, permits, and approval may be needed from either federal (e.g., Federal Power Commission), state (e.g., water use permits), or local (e.g., rezoning) governing units. (150, p. 123)

1. *Federal*

Proposition: There is a clearly emerging national policy to promote economic growth in nonmetropolitan areas of the United States. (31)

2. *Regional*

Proposition: Actions by local governments with regard to taxation of power plants and other related facilities help determine the incidence of boomtowns. (86)

4. *Corporate*

Proposition: The interlocking directorate ownership patterns of the energy companies cause uncertainty for a community already impacted or soon to be impacted by energy development. Companies' interests in numerous energy sources can alter decisions about which source to develop and when and where to develop it. (37, p. 5)

Proposition: A national arrangement of power, in which the influence of large energy companies on public policy making far exceeds that of small western communities, will give rise to the kinds of energy projects with which boomtowns are usually associated. (37)

Proposition: Changing profit considerations with regard to the type of energy sources to be developed, the timing, and the locations can suddenly alter the impacting industry's stated intentions of remaining in the impacted community for some time; such reversals lead to boom and bust cycles. (37, p. 4)

II. *IMPACTING ELEMENT (NEW PROJECT CHARACTERISTICS)*

The characteristics of a new project vary according to whether the project or the land being utilized is public or private. The type of activity is another factor in predicting different outcomes. In general, whether the project is energy-related or not plays a part in public attitudes and governmental response. The size or scale of the project, its stage of development, and the timing of development are all variables considered in the literature. Differences in the demographic and cultural characteristics of the new population are important, as are their settlement patterns. Generally, such factors as the size of the new population in relation to the host community, its similarity to the host community's population, and its origin all act to mediate or compound problems of assimilation.

A. PUBLIC VS. PRIVATE SPONSORSHIP

3. *Environmental impact statement and other control implications*

Proposition: A major construction project which is publicly funded and operated will allow the impacted community to bring more political pressure to bear on the project to meet environmental and social goals than would be the case for a privately funded project. (137)

4. *Impact assistance implications*

Proposition: A major construction project which is publicly funded and operated is likely to allow the impacted community to obtain more federal funds to deal with the ensuing problems than would a privately funded project. (137)

5. *Tax revenue implications*

Proposition: A major construction project which is privately funded and operated will generally create more tax revenues for the impacted communities' governments than would a publicly funded project. (137)

B. TYPE OF ENERGY-RELATED ACTIVITY

Proposition: The nature of the project which creates a boomtown situation can be instrumental in determining residents' perceptions of how severe the impacts are. The more environmentally disruptive (land use, air, water, noise pollution) the project, the more likely is the project to generate public interest. (137)

Proposition: The nature of the project will be the major determinant of the size and mix of required labor force. (137)

Proposition: Substitute gasification plants and oil refineries have the most rapid buildup of employees. Coal-fired electric and nuclear plants require slightly fewer employees, but employ them for longer periods of time. Coal export mines and platform fabrication facilities require few construction workers, but generate larger numbers of operations employees. (184, p. 3)

D. SCALE

2. *Labor intensive vs. technology intensive*

Proposition: The physical scale of a major construction project will determine the size of the labor force. (137)

Proposition: Commonly, plants that will employ about 100 persons will be built by a construction force of nearly 1,000. (68, p. 4)

3. *Physical or symbolic presence*

Proposition: The physical scale of a major construction project will determine the social image of the project. (137)

Proposition: Disruption will depend upon the intrusiveness of a new development--including its audibility, visibility, proximity to population, in addition to size--and upon the sensitivity of the host community. (68; 138, p. 5)

E. STAGE OF DEVELOPMENT

Proposition: There is generally little overlap in personnel or skill requirements between the construction phase and the operations phase. (68, p. 4)

1. *Planning and speculation*

Proposition: After the construction phase is under way, residents often perceive the energy company as having employed devious tactics (secrecy, rumor spreading) for acquiring land and mineral rights. (146; 137; 82)

Proposition: During the planning and acquisition phase, as rumors of land acquisition by the energy company circulate, landowners experience anxiety about whether or not their property will be purchased. (82; 137; 146)

2. *Acquisition*

Proposition: The shortage of housing due to influx of work force is further aggravated by the acquisition, demolition, or fencing of housing and farms by the energy company for uses associated with the energy project. (137)

F. TIMING OF PROJECT

1. *Duration*

Proposition: Some negative impacts of the boom-bust cycle may be alleviated if the project company establishes itself as a permanent or long-term entity in the impacted community. (52, p. 95; 63, p. 65)

2. *Phasing (sudden/drawn-out)*

Proposition: A rapid buildup of incoming employees associated with a major project will lead to more negative community impacts than a gradual buildup. The corresponding relation will pertain for the phaseout of a project. (137)

3. *Simultaneous projects*

Proposition: Social impacts associated with a series of major projects taking place simultaneously or over a number of years will be greater in magnitude than those stemming from a single project. (137)

4. *Relations with host community*

Proposition: Although other factors are also important, the greater the amount of preproject town resistance, the more likely it is the project company will assist the community with front-end planning activities. (162)

Proposition: Ability of a community to plan effectively to meet the needs of both its permanent and temporary problems is only as effective as the information it receives from the sources of growth. (63, p. 129; 52, p. 88; 93, p. 5)

Proposition: Social impacts in a small boomtown community will be intensified if communications between the impacting project and the community are either lacking or inadequate in terms of thoroughness and timeliness. A community cannot cope with a situation for which it has no time to prepare. (52, p. 88; 109)

G. NEW POPULATION

1. *Size relative to host community*

Proposition: The larger the number of newcomer employees relative to the host community's population, the greater the social impact upon the community. (137)

2. *Socioeconomic status*

Proposition: During construction periods, anywhere from 50 to 75 percent of the construction workers will bring their families with them, compared to 80 to 90 percent of operations personnel who will eventually live in the community with their families. (93, p. 7)

a. Similarity/dissimilarity to host population

Proposition: The greater the cultural differences the host population sees between itself and the newcomer population, the greater the cultural and social impacts. If the host community is generally resistant to change or to the new project, any cultural difference will be viewed as a major disruption. (137)

b. Homogeneity/heterogeneity

Proposition: The larger the number of newcomer employees, the greater the chances of heterogeneity among that labor force, leading to diversification of the host community's population. (137)

Proposition: To the extent that the project requires large numbers of diverse new employees, existing social delineations among them will be made sharper. (137)

4. *Mix of labor force*

Proposition: Impact will be directly proportional to the number of new (unemployed) persons entering a region and will vary directly with the unemployment rate outside the region and the general notoriety of the project outside the region. (68; 136, p. 18)

Proposition: New jobs created by industrialization generally require special skills; consequently, the industrial growth has little effect upon the unemployment rate of local residents. (31; 166)

Proposition: The higher the skill level requirements of the new project, the greater the disruption. (68, p. 17)

Proposition: Plants which primarily employ men will generate more growth than those which primarily employ women since few families will migrate so that the wife can find employment. (31)

a. Mostly local and regional

Proposition: A major construction project whose labor needs can be met by the native population will create fewer social impacts on a small community than one which requires the importation of large numbers of new employees. (68, p. 17; 93, p. 7; 137)

b. Mostly nonlocal or nonregional

Proposition: A major construction project whose labor needs can be met by the native population will create fewer social impacts on a small community than one which requires the importation of large numbers of new employees. (137)

c. Construction/operating multiplier effect

Proposition: During construction periods, each new construction job will generate from 0.3 to 0.9 secondary jobs; that ratio increases during the operations phase to 1.1 to 2.3 secondary workers per basic worker. (184, p.5)

Proposition: In small traditional western towns, short-term construction workers will be assimilated into the community. The permanent operating force will eventually be most successfully assimilated. (137)

Proposition: Integration into a boomtown community will be less difficult for wives of management-level project employees than for wives of construction workers. The former are more likely to have met each other in prior boomtowns, may have a special recreational facility, and will have available the societal roles generally fulfilled by a woman of that social status (volunteerism, civic activity). (137)

d. Boomtown people

Proposition: A boomtown will attract a group referred to as "boomers," relatively transient workers or entrepreneurs in search of ever more profitable business or short-term employment opportunities. (137)

e. New professionals

Proposition: To the extent that newly created professional-level jobs cannot be filled by the host community's population, professionals will be attracted to a boomtown. (137)

f. Returning natives

Proposition: Boom growth in a small community will offer the native resident who has left the community to find adequate employment an opportunity to return and find work. (137)

III. *LOCAL CONTEXT (HOST COMMUNITY CHARACTERISTICS)*

Each community prefers to think of itself as unique. While it is true that different communities react differently, there are patterns in characteristics of communities which help explain how a particular community reacts to becoming a boomtown. These characteristics can be categorized generally as location, community size, stature in the region, history, level of institutional and economic development, and readiness to change. The community's proximity to the project and to other populations will be one determinant of the kinds or intensity of impacts it will receive. Its position in the hierarchy of ecological dominance is also important. Whether a community is dominated by a nearby large city or is the major center within a wide region will determine, among other things, the amount of influence it exerts and the amount of impact it will share with other towns. The size and structure of the host population could likewise modify the impacts. Whether the community has had previous experiences which would enable it to deal more effectively with the boom is important, as is the level of experience and training of institutional leaders.

A. LOCATION OF COMMUNITY

Proposition: The geographic location of a community in relation to a major urban center is one determinant of the community's level of institutional development and, therefore, is one determinant of the extent to which the community will be impacted by a major construction project. (137)

B. COMMUNITY SIZE

Proposition: The largest community in the region of a major construction project will attract the largest population influx, even when smaller communities are much closer geographically. (52, p. 93; 137)

4. *Demographic characteristics*

b. Population Density

Proposition: Given a particular development, the lower the population density of the host region, the greater the disruption. (68, p. 15)

5. *Socioeconomic characteristics*

c. Homogeneity

Proposition: Rural people in the Great Plains are not socioculturally homogeneous and their towns do not function as tightly knit communities. Rather, the people are distributed into various "minority groups" based upon occupational status, such as cattleman, sheepherder, dryland farmer, townsman, etc. (29, p. 7)

C. REGIONAL STATURE

Proposition: The geographic location of a community in relation to a major urban center is one determinant of the community's level of institutional development and, therefore, is one determinant of the extent to which the community will be impacted by a major construction project. (137)

Proposition: Communities which enjoy greater influence in their region and state will have more resources available to them for coping with social impacts of a boom. Such resources have to do largely with vertical relations with organizations outside the community. (137)

D. HISTORY OF COMMUNITY

1. *Previous experience with rapid growth and fluctuations*

Proposition: If a small community has been declining, it will welcome the arrival of a major project, though it may later regret the decision as impacts become evident. (71; 136)

Proposition: A town which has experienced a good deal of fluctuation in the past will be less likely to suffer trauma from a given development than a town which has had a stable existence. (68, p. 19)

3. *Efforts to attract/avoid growth*

Proposition: A recent poll of small town leaders in the United States indicates that the majority feel that lack of industry is the major economic problem of their communities. (31)

Proposition: Many communities support growth to stop the outflow of young people but studies show that with growth young people continue to leave at about the same rates. (31)

4. *Economic base*

Proposition: Variations in economic and cultural factors are responsible for regional fluctuations in attitudes toward development. (2; 82; 120)

Proposition: Persons in agriculture are more disapproving of development than any other occupational group. (22, pp. 39-43; 132, p. 831)

E. INSTITUTIONAL TYPES AND DEVELOPMENT (POLITICS/GOVERNMENT, ECONOMY, EDUCATION, RELIGION, RECREATION, HELPING SERVICES, FAMILY, MEDIA)

Proposition: Roughly correlated with the size of a community is the level of institutional development. When a town experiences a boom period, the effect is to pressure the community into becoming more institutionally developed. (137)

Proposition: If other factors about communities near a major construction project are approximately equivalent, the most institutionally developed community will attract the most newcomers. (52, p. 93; 137)

7. *Horizontal and vertical linkages*

Proposition: Communities which enjoy greater influence in their region and state will have more resources available to them for coping with boomtown social impacts. Such resources have to do largely with vertical relations with entities outside the community. (137)

F. READINESS TO CHANGE

1. *Information availability*

Proposition: As the current era of rapid energy production continues, towns about to be impacted by major projects will take steps to deter negative social impacts before the project begins. (65)

3. *Capacity of community institutions to deal with rapid change*

Proposition: Antiplanning values in some small towns will impede efforts to cope with boomtown problems. (63, p. 89; 71)

Proposition: Boomtown problems occur due to lack of concern (value differences) and lack of knowledge and experience in dealing with such community issues. (58, p. 69; 128; 150)

IV. *SOCIAL IMPACTS*

Our model holds that the nature of social impacts is a function of the kind of community impacted and the kind of project mounted. Strictly sociological impacts will occur in community institutions --its local economy, government, helping services, and school system. As social institutions change, so do the ways in which people relate to one another--the social structure. Thus, one will see shifts in the roles people are playing, the ways roles relate to one another, and the way the community holds together, if indeed it does so.

In addition, the community's nonmaterial culture--its beliefs, values, and norms--undergo alterations. Finally, with growth and new construction, the physical aspects of social life (material culture) are also modified. (18; 24; 41; 49; 51; 66; 72; 93; 100; 112; 144; 155: 203; 202)

Proposition: Although quality of life does not always decline, the more rapid the growth rate, the more likely an area is to suffer degradation in the quality of life. (52, p. 92)

A. INSTITUTIONAL IMPACTS (82; 97; 187; 137; 202)

Proposition: Newcomers tend to be less satisfied with local serivces than oldtimers. (72; 137; 140)

Proposition: At a 15 percent annual growth rate, many service-providing institutions will start to break down and will be unmanageable without advance planning. (52, p. 95; 65)

1. *Family* (29; 76; 137; 151; 178)

Proposition: The temporary nature of material cultural items provided the newcomer family (mobile home, inadequate utilities and roads) will influence the family's perception of itself as (1) unwanted and (2) transcient. (137)

Proposition: Friendship ties will be between individuals and not families, and these ties need not converge or overlap between family members. (29, p. 13)

b. Family cohesiveness

Proposition: When organization and industrialization appear with the promise of more jobs, the need for family communalism decreases and nuclear families become the modal institution. (29, p. 14)

d. Conjugal relationship

Proposition: Both husband-wife and parent-child relationships will be affected by increasing individualism. (29, p. 13)

(1) *sex roles*

Proposition: Female newcomers appear to be particularly vulnerable to alienation and are thrown back on their own resources to cope with any or all of the following conditions: loneliness; inadequate shopping, entertaining, and socializing opportunities; severe weather; and barren surroundings. (52, p. 95; 178, p. 1)

Proposition: Personal impacts are differently experienced by female and male newcomers. Women face a lack of viable community roles beyond familial ones and a lack of services. Men face job alienation and limited pursuits during nonwork hours. (63, p. 75; 137; 178)

Proposition: The increase in available services will free women from many homemaking activities, allowing them to carry more weight in both economic and political sectors, and eventually to gain a more substantial voice in the community. (29, p. 8)

(2) *employment of women*

Proposition: The number of roles open to women will increase, as will the employment of women as new jobs become available. That increase will be countered by values opposing expanded employment opportunities for women. (24, p. 168; 178, p. 4)

Proposition: To the extent that men formerly engaged in agricultural jobs take better-paying jobs with the impacting industry, farm management tasks will be assumed by women. (150, p. 133)

2. *Economy*

Proposition: Many personal and institutional decisions in a boomtown will hinge on major corporate and governmental decisions about present and proposed major projects. (137; 20)

a. Equity

Proposition: Economic impacts within the boomtown will vary according to the economic role in question. (137)

b. Modernization

Proposition: Persons making the shift from agricultural to industrial employment may experience problems adjusting to the regimentation of industrial work. (89, p. 22)

Proposition: After mines close, small boomtown communities will face a major problem of finding another economic base to continue their existence. (61, p. 34)

c. Economic base

Proposition: Community residents become concerned about increasing economic dependence on one industry. (52, p. 103)

Proposition: The role of agriculture near boomtowns is sometimes diminished by the acquisition of prime agricultural land by the energy companies. (82; 137)

d. Cost of living

Proposition: Persons most likely to experience initial economic losses are:

1. Persons whose fixed incomes cannot keep pace with the boom-induced inflation. (150, p. 133)
2. Small or marginal business people who cannot or will not expand and change fast enough, or cannot keep pace with the rising pay scales. (52, p. 103; 137)

Two groups who do not generally benefit from industrial development in small towns: the elderly and female heads of households. In fact, industrial development usually has a negative impact on these groups in terms of relative status and cost of living. (31)

Proposition: Since oldtimers are less likely than newcomers to be employed in the new projects' high-paying jobs and are more likely to be on fixed incomes, they are more likely to feel they are paying a disproportionate share of the costs of growth. (137)

e. Prosperity

Proposition: Persons most likely to make short-run economic gains are (137):

1. Local existing and incoming business people who provide needed goods and services and are financially and entrepreneurially capable of keeping up with changing needs;
2. Workers whose skills are sought by both new and existing employers.

Proposition: One positive economic impact for oldtime residents lies in the ready availability of part-time supplemental employment with the impact industry. (137)

Proposition: Opening a wide commuting field results in "leakage" of wages to areas outside the host community. (31)

f. Increased competition

Proposition: Persons most likely to experience initial economic losses due to increased competition are:

1. Persons whose fixed incomes cannot keep pace with the boom-induced inflation;
2. Small or marginal business people who cannot or will not expand and change fast enough, or cannot keep pace with the rising pay scales. (93, p. 5; 137)

Proposition: Ranchers, farmers, and existing merchants reevaluate their relationships as the merchants cater more to their new clientele, while ranchers and farmers become less important to them. (82, p. 41)

(1) *chains and franchises*

Proposition: During boom periods, small communities will experience the influx of national business chains which have the working capital to fill in the gaps between the new demands and the ability of the existing business to supply those demands. (137; 50)

(2) *jobs*

Proposition: Competition for employees will contribute to high turnover and subsequent losses in productivity. (52, p. 93; 72)

g. Availability of housing, goods, and services

Proposition: Development of retail and service establishments lags behind population growth and demand. (52, p. 93)

Proposition: Residents believe that normal free enterprise mechanisms will provide adequate supply of retail and service facilities to keep pace with increased demand. (52, p. 95)

3. *Government/politics* (29; 49; 76; 117; 137; 151)

Proposition: Negative municipal services impacts will be worsened if the impacted community does not lie within a county which is receiving the newly generated tax revenues. (61, p. 65; 150, p. 124)

a. Provision of services

Proposition: During times of rapid growth, local governmental entities in small communities will face increased demands on existing services and demands for new services. (137)

Proposition: The urgency of providing basic municipal services such as water to rapidly growing areas of a community may lead to a lowering of health standards. (199)

(1) *quantitative changes*

Proposition: Housing provided in the form of mobile homes on the edges of town makes new demands on services but does not contribute to the city tax base. (52, p. 93)

Proposition: One immediately evident impact on a boomtown's law enforcement system is the increased need for traffic control brought about by impact industry workers who commute to work. (93, p. 7; 150, p. 128)

(c) more funds

Proposition: Small communities which experience rapid growth face a lag between the time when new public expenditures are demanded and the time when the new population and industry start generating tax revenues. (61, p. 34; 93, p. 8)

(2) *qualitative*

Proposition: New local governmental functions demanded of boomtown governments will most likely involve vertical relations with entities outside the community. (137)

b. Political alterations

Proposition: Traditional rivalries between nearby communities will result in competition to serve newcomers and may result in duplication and waste. (52, p. 94)

Proposition: Some newcomers will become involved in the local political arena, thus altering the arrangement and distribution of power. (150, p. 134)

Proposition: The number of voluntary associations will increase in size and importance, and the composition of these groups will not be family-oriented. (27, p. 13)

4. *Helping services* (29; 63; 76; 137)

Proposition: Service agencies and organizations in small boomtowns will face increased demands for existing services and demands for new social services. (137)

Proposition: Small boomtown communities will experience an increased need for medical care, but will have difficulty obtaining it. (137)

b. Qualitative

Proposition: Health care impacts often include increased communicable social diseases brought about by increased population transiency and poor living conditions. (150, p. 129)

5. *Recreation* (29; 74; 76; 137)

Proposition: Although small boomtown communities will face increased demands for recreational opportunities, these needs will receive less public attention than needs of other community institutions. (109)

Proposition: Demand for an increase in organized recreation occurs with the influx of newcomers. (52, p. 95; 93, p. 7)

6. *Religion*

a. Growth

Proposition: Churches can be expected to increase in size, number, and variety during boom periods in small communities. (137)

b. Importance

Proposition: Church (denominational) rivalries become more subtle as competitive building programs are initiated. (29, p. 25)

c. Functions (29; 109)

Proposition: Religious organizations in boomtowns find themselves faced with new needs and may engage in new and varied forms of social ministry, in some cases for the first time. (137)

7. *Education* (29; 63; 76; 137)

Proposition: A severe impact on a boomtown school system will be the lack of adequate, accurate, and timely information about the school-aged children of newcomer families. (137)

a. Physical facilities

Proposition: The first impact a boomtown school system will face will be overcrowding of facilities. (137)

Proposition: School construction will lag behind residential construction by 1 to 2 years. (105, p. 70)

b. Turnover

(1) *students*

Proposition: High school students will be attracted to high-paying employment with the impact industry and some will drop out of school to work full time. (71; 137)

Proposition: School teachers in boomtown school systems will experience difficulties in establishing a sense of continuity among their classes due to the transiency of children of construction workers. (137; 178, p. 5; 199)

(2) *teachers, administrators, and staff*

Proposition: Lack of basic community services and facilities in small boomtowns make it difficult for municipalities and school districts to attract the personnel they need. (63, p. 88; 93, p. 5)

d. Programs

Proposition: Newcomer families from more cosmopolitan communities will place new demands on boomtown school systems for a more varied curriculum and the accompanying services and facilities. (52, p. 92; 93, p. 7; 136)

B. SOCIAL STRUCTURAL IMPACTS

Proposition: The rapid population influx and rapidly changing demands placed on boomtown institutions create various kinds of role changes, such as: (1) the creation of new roles; (2) the creation of more positions within existing roles; (3) the redefinition of old roles; (4) the replacement of oldtimers by newcomers in existing roles; and (5) the elimination of some old roles. (137)

Proposition: The social structure of boomtowns is overwhelmingly male-oriented. (178, p. 5)

5. *Community integration*

Proposition: Oldtimers in a small boomtown community are likely to experience less sense of community as they find themselves knowing a decreasing proportion of residents, witness poor intergroup relations, and see newcomers' difficulty integrating into the community. (137)

Proposition: Social integration of newcomers is unlikely to occur without outreach programs and volunteer activities. (52, p. 95)

Proposition: The gradual introduction of racially heterogeneous newcomers contributes to minimizing local racial problems and breaking some stereotypes. (52, p. 100)

Proposition: Achieving stable lasting friendships is difficult in the face of rapid population turnover. (178, p. 4)

Proposition: One major cause of population turnover in boomtowns is the unhappiness experienced by wives of male employees of the impacting industry. (178, p. 1)

6. *Social stratification*

Proposition: Subsidies and fringe benefits supplied by impacting industries to their upper-level executives will become evidence of increasingly delineated social stratification in boomtowns. (137; 155)

C. CULTURAL IMPACTS

Proposition: When a population boom occurs in a small community it usually has the effect of bringing in people who are culturally different from the native population. (137)

Proposition: The movement toward modernization and urbanization in small boomtown communities is condensed, with changes which normally take decades occuring within a few years. (137)

1. *Nonmaterial culture* (29; 63; 106; 137; 144; 151; 202)

Proposition: The prevailing cultural shift in small boomtown communities will be in the direction of modernization and urbanization. Some manifestations of this are increases in: (1) cultural diversity; (2) cosmopolitanism; (3) professionalism and respect for expertise; (4) specialization and bureaucratization; (5) the valuing of "bigness"; (6) centralization; (7) the profit motive; (8) reliance on institutions; and (9) demands placed on institutions. (137)

Proposition: Oldtimers often perceive the influx of engineers, technicians, and their families as bringing more sophistication and culture into the community. (52, p. 100)

Proposition: Newcomers, regardless of group affiliation, will bring with them new perspectives which threaten the oldtimers' views. (31, p. 17)

2. *Material culture (physical impacts)* (10; 63; 137; 179)

Proposition: As a small town grows during a boom period, more behavior settings are created, constituting more interaction opportunities. (137)

Proposition: Increased ambient noise levels and relative overcrowding in small boomtown communities are experienced by oldtimers as signs of urbanization. (137)

Proposition: Due to rapid population growth and unique institutional arrangements for the provision of housing (highly centralized control), the physical aspects of such communities start to resemble suburban communities. (137)

Proposition: One of the most common consequences of the construction of a new plant in a small town is the emergence of an extremely wide commuter field. In every case studied the auto was the major mode of transportation and car pools were uncommon. (31)

Proposition: As small communities undergo boom type of growth, the loosely controlled sprawl growth pattern encourages a high car-oriented land use pattern with many drive-in facilities, suburban-style shopping centers, and strip commercial developments. (137)

V. *MODES OF RESPONSE*

During and after the initial social impact phases, some forms of response--whether adequate or not--start to emerge. This section looks at what resources are available for responding (informational, legal, financial). The resources may lie with governments (e.g., new taxation schemes, special impact funds) or with the impact companies themselves (e.g., new construction, financial assistance). The response itself occurs within the community as individuals, organizations, and community institutions try to cope with the new social reality. However, some response may also come from outside the community in the form of state or federal governmental actions or corporate actions.

A. RESOURCES AVAILABLE

1. *Corporate*

Proposition: Community leaders in small boom communities will seek, and generally gain, some assistance such as buildings, funds, and technical expertise from the impacting industries. (93, p. 8; 137)

Proposition: Despite increased payrolls and other increases in local economic activity in a boomtown, the largest source of wealth created --the profits of the impacting industry--does not stay in the local area to become available for dealing with social impacts, but rather returns to corporate headquarters. (37, p. 5)

2. *Local*

Proposition: One person to whom impact communities may turn for assistance is the cooperative extension agent, a person with local sensitivities and extra-local contacts and experience. (150, p. 124)

6. *Federal (public)*

Proposition: Present federal legislation has no provision for dealing with social problems created by rapid energy development. (62, p. 46)

B. NONLOCAL RESPONSE

1. *Corporate* (177, p. 5)

Proposition: Community leaders in small boom communities will seek and generally gain some assistance such as buildings, funds, and technical expertise from the impacting industries. (137)

Proposition: One area of boomtown relief in which the impacting industry will become active is housing. The companies will often build hundreds of temporary and sometimes permanent housing units. (137)

Proposition: In an effort to cut costs and ease the process of clearing land after initial use, the impacting industry may choose not to own trailer homes but rather to rent trailer spaces on land they own. (146, p. 126)

Proposition: If the impacting industry chooses not to run the construction worker camp themselves but to contract out to another firm, this compounds impacts by introducing yet another set of actors into the boomtown. (150)

Proposition: The ameliorative actions of a project industry can create a modernized, less heavy-handed company town atmosphere. In company-built boomtowns that atmosphere is more readily visible. (137; 19)

Proposition: The scale, design, and quality of housing built by the impacting industry will become a constant reminder of sociocultural changes to the longtime residents. (137)

3. *Regional*

Proposition: Traditional rivalries between communities inhibit timely cooperation in meeting common problems associated with the boom. (52, p. 94)

Proposition: An increasing number of boomtown residents resent the publicity their towns are receiving. (177, p. 1)

C. LOCAL RESPONSE

1. *Personal* (93, p. 6)

Proposition: Increases in personal alienation and isolation will be seen in boomtowns--both on the part of unassimilated newcomers and disrupted oldtimers. (71; 137)

Proposition: Personal responses to boomtown social impacts take one of four forms: (1) making the adjustment to the changing community; (2) maintaining life-style as it was in the pre-boom period; (3) attempting to deny the social and cultural changes that are occurring; or (4) moving away from the community. (137)

Proposition: Personal responses to impacts upon the community are heavily influenced by financial situation; a good, high-paying job may offset many hardships. (137)

Proposition: Persons with lower socioeconomic status seem most likely to suffer psychological stress from changes due to boomtown growth. (55; 137)

Proposition: The oldtimers long for "the good old days" and the in-migrants miss their previous homes. (29, p. 9; 137)

Proposition: In responding to alienation, the female newcomer may:

(1) retreat into such traditional female activities as childrearing and family care;
(2) become involved in social clubs or community activities;
(3) develop mild forms of mental illness; or
(4) leave the community. (178)

Proposition: There is a slight trend for residents to be more unfavorable toward industrial development after such development has taken place.

In general, however, more people express satisfaction with industrial development than express dissatisfaction. (31)

3. *Institutional*

Proposition: In an effort to provide facilities for a growing population, town officials (e.g., city council, school board) will expand physical facilities. However, if the growth falls short of its expected levels the community will find itself overextended. Though it will have better facilities, it will also have a higher tax burden. (150, p. 25)

CONCLUSIONS

Our purpose has been to identify some of the social impacts pertaining to energy boomtowns that appear in the less widely available literature. Moreover, we have attempted to organize this information within a model that identifies many of the factors upon which differential impacts depend. At this point we are not able to summarize within a few paragraphs the many propositions we have listed. As mentioned earlier, many of these propositions are awaiting better data to support or reject them. From an evaluative perspective, many of these identified impacts have both positive and negative attributes. Some propositions directly conflict with others. Obviously the real work lies ahead and whatever we have accomplished here will, we hope, constitute a beginning.

Still, we feel that we have found that a great deal more is known about the boomtown aspect of energy development than is generally acknowledged. "The town has been studied to death" is a lament heard in every booming community in the West. Every planning official in these towns, likely to know full well what the impacts are, can point to a foot-high stack of "worthless" documents on the office table, while the researcher is often unaware of their contents. We have found that these documents contain considerable information on what the impacts are although little is available within them in the way of solutions the planning official seeks. There is little reason to continue producing case studies to determine the impacts of rapid development.

We feel it is time to make what is known more widely available and to begin a rigorous analysis of the net effects of boomtown development. Is the net social effect of the boom in Craig, Colo., to be judged by the thousands of people who have moved to Craig and found employment or is it to be judged by those like the former mayor who sold his business and left town? Before moving, this ex-mayor said, in testimony before a state legislative committee, "The highest toll exacted from boomtowns is the literal destruction of a community which in the past sustained and nurtured its people. The decline in the quality of life has stolen a community from its people" (Fradkin, 1977). It remains to be seen whether social scientists can assign appropriate weights to these two examples and whether such analyses can influence policy.

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83. __________. 1975. A Study of Social Impacts of Coal Development in the Decker-Birney-Ashland Area: Final Report. Helena, Mont.

84. _________. 1976. Trespasses and Other Social Impacts of Northern Plains Coal Development. Presented at meeting of the American Association for the Advancement of Science. Boston, February.

85. Graber, Edith. 1974. Newcomers and Oldtimers: Growth and Change in a Mountain Town. Rural Sociology, winter.

86. Gudaukas, George. 1976. Western Governors Mull Agency on Energy Policy. Denver Post, November 22.

87. Guenther, Sue. 1975. Kaiparowits New Town Project, Kane County, Utah. Washington, D.C.: National Association of Counties.

A brief, descriptive case study.

88. Hayen, Roger, and Gary Watts. n.d. A Description of Potential Socioeconomic Impacts from Energy Related Developments on Campbell County, Wyoming. Laramie, Wyo.: Resource Management Systems.

89. Helgeson, Delmer L., and Maurice J. Zine. 1973. A Case Study of Rural Industrialization in Jamestown, North Dakota. North Dakota Agricultural Experiment Station. Fargo: North Dakota State University.

A study of the economic aspects of rural industrialization, the report contains some useful discussion of the institutional and personal impacts of a community changing its economic base.

90. Heroux, Richard, and William Wallace. 1973. Financial Analysis and the New Community Development Process. New York: Praeger.

Pertains to new towns but analysis of "front end" money in community development process is useful.

91. Hough, Richard L., and Gene F. Summers. 1970. Structure, Stress and Psychological Impairments. Center of Applied Sociology, Working Paper RID 70.1. Madison: University of Wisconsin.

92. Hickok, Linda, and Douglas Samuelson. 1975. Economic Impact of Projected Energy Development: Craig and Moffat Counties, Colorado. Office of Minerals Policy Development. Washington, D.C.: U.S. Department of the Interior.

93. High Country News (Lander, Wyo.). 1974. June 7.

Complete issue devoted to boom problems in Rock Springs, Gilette, Hanna, Colstrip, and Lame Deer, Wyo. Includes statistics, impacts, and interviews with townspeople.

94. Human Resource Institute. 1976. Summary of Proceedings--Region 8--Energy Resource Development Research Conference. University of Utah. Denver, July 21.

Briefings on such subjects as coal conversion, water availability, energy conservation, and the manpower needed to meet the demands of these growing areas. A collection of presentations from persons active in the field, including Baker, Gilmore, Glazner, Leistritz, and McCool.

95. Humphrey, F. Charles. 1974. Oliver County, North Dakota, Attitude Survey. Fargo: North Dakota State University.

Report of November 1973 survey sponsored by Lions Club in a North Dakota impacted county. Included are data on needed public and private community services, as well as evaluative measures of such existing services. Data are from residents of impacted town (Center), residents of surrounding rural area, coal mine employees, and power plant employees.

96. Institute of Ecology. 1974. A Scientific and Policy Review of the Draft Environmental Impact Statement on the Development of Coal Resources in the Eastern Powder River Coal Basin of Wyoming. Environmental Impact Assessment Project. Washington, D.C.: Institute of Ecology.

97. Intermountain Planners, and Wirth-Berger Associates. 1974. Capital Facilities Study--Powder River Basin. Cheyenne: Wyoming Department of Economic Planning and Development.

A detailed analysis of existing facilities and services and the demands made on them. Information should make it possible for methods to be developed and information obtained that will help community leaders in the Powder River Basin. Includes material on schools, libraries, and the net fiscal impact of planned projects.

98. Ives, Berry, and William Schulze. 1976. Boomtown Impacts of Energy Development in the Lake Powell Region. Resource Economics Programs. Albuquerque: University of New Mexico.

99. James M. Bowers and Associates. 1974. Housing Report. Prepared for Colorado West Area Council of Governments. Denver: James M. Bowers and Associates.

Examines the regional housing impact and suggests a number of policies designed to enable the region to cope with projected growth. The region includes Garfield, Mesa, Moffat, and Rio Blanco counties, Colo.

100. __________. 1974. Moffat County Impact Report. Denver: James M. Bowers and Associates.

An individual case study of the boom area in Moffat County, Colo.

101. Jobes, Patrick, and Milton G. Parsons. 1975. Satisfaction, Coal Development and Land Use Planning: A Report of Attitudes Held by Residents of the Decker-Birney-Ashland Study Area. Helena, Mont.

102. Johnson, Maxine, and Randle White. 1975. Colstrip Montana: The Fiscal Effects of Recent Coal Development and an Evaluation of the Community's Ability to Handle Further Expansion. Office of Minerals Policy Development. Washington, D.C.: U.S. Department of the Interior.

103. Jones, Bernie, and Charles F. Cortese. 1976. Patterns of Boom Town Experiences: Implications for Future Work in the Field of Social Impact Assessment. Presented at annual meeting of the Society for the Study of Social Problems, New York, August.

Based upon data from one section of the Construction Worker Profile (137), consisting of detailed community studies in three towns in an effort to identify cross-community generalizations. Findings relate to impacts upon social institutions, social structure, local culture, physical community, and personality. Factors determining variations in patterns are also discussed.

104. Kohler, Lucille T. 1944. Neosho, Missouri, Under the Impact of Army Camp Construction: A Dynamic Situation. Columbia: University of Missouri.

An early social-impact study based upon interview and observation data on changes in a small community stemming from construction of an army base.

105. Kohrs, Eldean V. 1974. The Rocky Mountain States: Boom Areas, Problems and Solutions. Presented at annual meeting of the Federation of Rocky Mountain States, Denver, September.

106. __________. 1974. Social Consequences of Boom Growth in Wyoming. Presented at Southwestern and Rocky Mountain Division meeting of the American Association for the Advancement of Science, Laramie, Wyo., July.

107. Kutak Rock Cohen Campbell Garfinkle and Woodward. 1974. A Legal Study Relating to Coal Development, Population Issues. 6 vols. Prepared for the Old West Regional Commission. Springfield, Va.: National Technical Information Service (PB-293-148 through PB-293-153).

108. Lamont, W. n.d. Lead Time Problem: Energy Driven Boom Towns. Boulder, Colo.: Briscoe, Maphis, Murray, and Lamont.

"Creating communities, not just developing energy." Use of front-end money for capital facilities.

109. Lamont, W., A. Briscoe, J. Murray, G. Beardsley, J. Carver, D. Harrington, and J. Lansdowne. 1974. Tax Lead-Time Study: The Colorado Oil Shale Region--Fiscal Alternatives for Rapidly Growing Communities in Colorado. Prepared for the Colorado Geological Survey. Denver: Colorado Department of Natural Resources.

Concerns taxation, but also covers many of the social and political problems involved in boomtowns.

110. Langley, G. 1974. Colstrip Having Boom, But It's a Planned One. Billings (Mont.) Gazette, July 3.

111. __________. 1974. Plants Can Make Colstrip a Northwest Power Center. Billings (Mont.) Gazette, August 2.

112. Leholm, Arlen, Larry Leistritz, and Thor Hertsgaard. 1974. Local Impacts of Energy Resources Development in Northern Great Plains. Final Report. Department of Agricultural Economics. Fargo: North Dakota State University.

Statistics, profiles, and scenarios of change in areas related to North Dakota's coal and electric power generating areas. "The purpose of this study is to provide a detailed analysis of Mercer County, North Dakota, and the surrounding area in an effort to reveal the nature and magnitude of development impacts which will be experienced by local communities from various levels of coal development."

113. Leholm, Arlen, Larry Leistritz, and Thor Hertsgaard. 1975. Fiscal Impact of a New Industry in a Rural Area: A Coal Gasification Plant in Western North Dakota. Fargo: North Dakota State University.

Contains a "model" which reflects the interrelationships of business, household, and government sectors. Also considers cost and revenue timing. The model has two components: regional input-output analysis and a set of cost and revenue estimators. Contains a bibliography.

114. Leistritz, F. L. 1975. Will Bust Follow Boom? The Case of ABM Developments in North Dakota. Presented at conference of the Rocky Mountain Center on the Environment, March 19.

115. Leistritz, Larry, and Thor Hertsgaard. 1973. Coal Development in North Dakota: Effects on Agriculture and Rural Communities. North Dakota Farm Research 30.

116. Leland *et al.* 1974. Interim Summary of Recommendations Projecting Social and Municipal Service Needs and Cost and Revenue Calculation in Six Counties Where Major Coal Development is Anticipated. Bozeman: Montana State University.

117. Lemmerman, Kathe L. 1974. Columbus/Noonan Study: The Impact of Coal Development and Decline on Two North Dakota Communities. Denver: Northern Great Plains Resources Program.

A preliminary report done without time for top quality research, according to the author. Does include pertinent and worthwhile sociopolitical information. Study is concerned with a coal town when the mines or power plants close.

118. Lindauer, R. L., Jr. 1974. Solutions to the Economic Impact of Mineral Development on Local Governments. Denver: Federation of Rocky Mountain States.

A paper for the Natural Resources Council. Basically a public relations piece.

119. __________. 1975. Solutions to Economic Impacts on Boomtowns Caused by Large Energy Developments. Denver: Exxon.

A series of public relations speeches.

120. Little, Ron. 1976. Rural Industrialization: The Four Corners Region. Logan, Utah: Lake Powell Research Project.

121. __________. 1976. Some Social Consequences of Boom Towns. North Dakota Law Review 52(3).

122. Lucas, T. C. 1974. The Direct Cost of Growth. Denver: Colorado Land Use Commission.

123. Luken, R. A. 1974. Economic and Social Impacts of Coal Development in the 1970's for Mercer County, North Dakota. Washington, D.C.: Thomas E. Carroll Associates.

Case study, complete with growth projections, which emphasizes the advantage of planning.

124. Lund, Oscar M. 1974. Some Impacts on South Dakota of Coal-Related Development in the Northern Great Plains. Pierre: South Dakota State Planning Bureau.

Includes energy conversion, environmental effects on water resources, transportation, and socioeconomic effects.

125. Maitland, Sheridan T., and Reed E. Friends. 1961. Rural Industrialization: A Summary of Five Studies. Economic Research Service. Washington, D.C.: U.S. Department of Agriculture (Agriculture Information Bulletin No. 252).

126. Matson, Roger A., and Jeannette B. Studer. 1974. Energy Resources Development in Wyoming's Powder River Basin: An Assessment of

Potential Social and Economic Impacts. Water Resources and Research Institute. Laramie: University of Wyoming.

Contains an assessment of the population and employment impacts in the Powder River Basin of Wyoming due to energy development. The report is based on Northern Great Plains Resources Program specifications.

127. Mauer, Rich. 1976. North Fork Valley in Middle of Farm-or-Coal Dilemma. Denver Post, October 19.

Deals with citizens' attitudes toward development of Westmoreland mine in North Fork Valley, Colo. Asks, "Is coexistence of mining and farming possible?"--e.g., can water needed by agriculture be kept clean by the mining industry?

128. Meissner, Tom. 1974. Present and Projected Social Impacts Resulting from Coal Development in 17 Eastern Montana Counties. Glendive: Action for Eastern Montana.

129. __________. 1974. Two Problem Areas and Two Recommendations. Glendive: Action for Eastern Montana.

130. Miller, Jon, and Stanford Labovitz. 1973. Individual Reactions to Organizational Conflict and Change. Sociological Quarterly 14(autumn).

131. Monarchi, David, and C. Rahe. n.d. A Study of the Social and Economic Needs Created by the Proposed Craig Power Plant Installation. Business Research Division. Boulder: University of Colorado.

Deals mainly with economic growth and the resulting social problems.

132. Montana Department of Natural Resources and Conservation. 1974. Draft Environmental Impact Statement on Colstrip Electric Generating Units 3 & 4. 500 Kilovolt Transmission Lines and Associated Facilities. Helena: Montana Department of Natural Resources and Conservation.

133. Monteiro, Lois A. n.d. The Sojourning Family: Some Observations on American Women in Brazil. Brown University, Providence, R.I.

Concerns problems of wives of corporate executives and international scholars in adjustment to transiency and living in a foreign environment. Though not specifically a boomtown study, the problems faced by women are pertinent.

134. Moore, Keith. 1976. Financing Options for Communities Near Large Energy Developments. Prepared for Rocky Mountain Center on Environment, August.

Deals with conflicts between the old and the new and includes suggestions regarding how financing can help solve these problems.

135. Morrison, Denton E. 1974. The Environmental Movement: Conflict Dynamics. In Murch (1974).

136. Mountain West Research. 1974. Macro Site Selection and Socio-Economic Analyses for Potential Northwestern Colorado Developments. Denver: Mountain West Research.

Largely oriented to land use considerations but includes data from a community survey of residents' views about likely impacts from rapid growth.

137. __________. 1975. Construction Worker Profile. 10 vols. Denver: Mountain West Research.

An analysis of the impacts generated in small western communities by large influxes of construction workers associated with large-scale energy projects. Data are from surveys with residents, officials, and impact industry employers in over a dozen western communities. Includes mathematical models of economic impacts as well as of social impacts.

138. __________. 1975. Definition of Impact. Denver: Mountain West Research.

A theoretical paper which defines social impact within a socioeconomic perspective.

139. Murch, Arvin W., ed. 1974. Environmental Concern: Personal Attitudes and Behavior Toward Environmental Problems. New York: MSS Information.

140. Nellis, Lee. 1974. What Does Energy Development Mean for Wyoming? A Community Study at Hanna, Wyoming. Denver: Northern Great Plains Resources Program.

141. Nez, George. 1974. A Typical Boom Area in the Rocky Mountain Region: Its Problem for State and Industry Planning. Denver: Federation of Rocky Mountain States.

A hypothetical study of an area in which rapid growth occurs. The study contains population estimates and attempts to deal with land use and other problems. Very general.

142. Nicosan, W. 1976. Energy Related Community Development, Private Sector Risks and Public Sector Remedies. Prepared for the Federal Energy Administration, July.

143. Northern Great Plains Resources Program. 1974. Socioeconomic and Cultural Aspects: Work Group Report. Washington, D.C.:

U.S. Department of Agriculture and U.S. Environmental Protection Agency.

Topics include: coal mining, socioeconomic development, population, economic models, environmental impact, revenue, social change, local government, housing shortages, and project planning. Analyzes socioeconomic and cultural aspects in parts of Montana, Nebraska, North Dakota, South Dakota, and Wyoming. Presents models of population growth that may result from alternative levels of coal development. Discusses impacts of each alternative on social conditions, shifts in power structures, government revenues, public service facility and funding needs, nongovernmental services, and labor competition. Discusses methods of alleviating revenue needs, tax-revenues time gap, jurisdictional problems of assuring that revenues are returned to impacted areas, housing needs, and other problems of local governments.

144. __________. 1975. Effects of Coal Development in the Northern Great Plains: A Review of Major Issues and Consequences at Different Rates of Development. Denver: Northern Great Plains Resources Program.

Part 5 (The Economic, Social and Cultural Impacts of Coal Development in the Northern Great Plains) is most applicable.

145. Office of the Governor. 1974. Pipeline Impact: A Report on State Findings, Assumptions and Projections Regarding Construction of the Trans-Alaska Oil Pipeline. Division of Planning and Research. Juneau, Alaska: Office of the Governor.

Brief report touching upon anticipated problems of boom growth, especially in the small community of Valdez.

146. Ohio University. 1975. In the Shadow of the General. WOUB-WOUC-TV. Athens: Ohio University.

A film documentary about the social impacts resulting from the construction of a new coal mine and coal-fired generating plant in a small Ohio community.

147. Oil Shale Regional Planning Commission. 1972. Social Impact Assessment Handbook. Rifle, Colo.: Oil Shale Regional Planning Commission.

148. Old West Regional Commission. Energy Research Information System. 4 vols. Billings, Mont.: Old West Regional Commission.

Bibliography of ongoing research projects. Includes abstracts.

149. Parker and Associates. 1975. Interim Report No. 3: Community

Facilities and Public Utilities. Prepared for Green River Planning Commission. Denver: Parker and Associates.

150. Paxton, Marshall J., and Burl F. Long. 1975. The Impact of a Construction Community on a Rural County--Evaluating Impacts of Economic Growth Proposals: An Analytic Framework for Use with Community Decision Makers. Northeast Regional Center for Rural Development. Ithaca, N.Y.: Cornell University.

A study of likely social and economic impacts that can be expected in the Back Creek, Va., area in the wake of the construction of a dam and hydroelectric power plant. Projections are based upon analysis of a similar project in Oregon. An effort is made to identify the public and quasi-public expenditures created by the entrance of the construction worker community and to identify possible tax increases.

151. Planning Support Group. n.d. Indians in the Northern Great Plains: Anticipated Socio-Economic Impacts of Coal Development. Bureau of Indian Affairs (Billings, Mont.), in cooperation with the Tribes of the Northern Plains. Denver: Northern Great Plains Resources Program.

Discusses socioeconomic impacts on tribes, intercultural relationships, and the family. Anticipated social effects are included.

152. Polzin, Paul E. 1974. Projections of Economic Development Associated with Coal Related Activity in Montana. Bureau of Business and Economic Research. Missoula: University of Montana.

Contains background data concerning population, employment, and income for current residents (including Indians) in a seven-county area in southeastern Montana. Economic changes which will result from coal-related employment are projected to 1980, 1985, and 2000.

153. __________. 1974. Water Use and Coal Development. Bureau of Business and Economic Research. Missoula: University of Montana.

154. Prouty, Dick. 1974. Craig Grows in Center of Monumental Coal Boom. Denver Post, December 1.

155. __________. 1974. Northwest Colorado Changing. Denver Post, December 8.

156. Rapp, Donald A. 1976. Western Boomtowns, Part I: A Comparative Analysis of State Actions. Denver: Western Governors' Regional Energy Policy Office.

A listing of current legislation which governs the social, commercial, and governmental activities in boom communities.

157. Real Estate Research. 1975. Excess Cost Burden, Problems and Future Development in Three Energy Areas of the West. Office of Minerals Policy. Washington, D.C.: U.S. Department of the Interior.

158. Rio Blanco Oil Shale Project. 1975. Rangely: An Energy Development Alternative for Northwestern Colorado. Denver: Foundation for Urban and Neighborhood Development.

159. __________. 1976. Social and Economic Impact Statement for Tract c-a. Denver: Gulf Oil.

160. Rogers, George W., ed. 1970. Change in Alaska. Nome: University of Alaska Press.

161. Schneider, Richard J. 1974. Sweetwater Models Boom Town Malady. Rocky Mountain News (Denver), July 24.

162. __________. 1975. Planning Set for Town Faced with Oil Shale Boom. Rocky Mountain News (Denver), July 18.

163. Scott, John T., Jr., and Gene F. Summers. 1972. Problems and Challenges Faced by Rural Communities with Industrial Development. Center of Applied Sociology, Working Paper RID 72.9. Madison: University of Wisconsin.

164. Scudella, George. 1976. Remarks presented at the U.S. Energy Research and Development Administration Public Meeting on Creating Energy Choices for the Western Region, Denver, May 17.

165. Sitomer, Curtis J. 1975. Old West Towns Threatened by Massive Energy Recovery. Christian Science Monitor, November 4.

166. Smith, C. L., *et al*. 1971. Economic Development: Panacea or Perplexity for Rural Areas? Journal of Rural Sociology 36(2).

167. Southeast Idaho Council of Governments. 1975. Modern Western Boom Town. Pocatello: Southeast Idaho Council of Governments.

> An examination of Rock Springs and Green River, Wyo., done by Idaho officials in anticipation of a similar boom in Pocatello and Soda Springs, Idaho. In addition to text of report, a complete photocopied file of newspaper clippings centered around the Sweetwater County boom and new problems in the Pocatello/Soda Springs area is included.

168. Sterba, J. P. 1974. Worry Rises that Rockies Face Pollution and Crowds. New York Times, September 26.

169. Stevens, James T. 1973. Wyoming Housing Alternatives: Comprehensive Mobile Home Policy. Denver: Federation of Rocky Mountain States.

Study to determine alternatives to deal with low/moderate housing problems in Wyoming--primarily mobile homes.

170. Summers, Gene. 1973. Large Industry in a Rural Area: Demographic, Economic and Social Impacts. Center of Applied Sociology, Working Paper RID 73.19, University of Wisconsin. Prepared for the Office of Economic Research, Economic Development Administration. Washington, D.C.: U.S. Department of Commerce.

171. Summers, Gene F., and Frank Clemente. 1973. Rapid Industrial Development, Competition, and Relative Economic Status: A Study in Human Ecology. Center of Applied Sociology. Madison: University of Wisconsin.

172. Summers, Gene, *et al.* 1974. Industrial Invasion of Nonmetropolitan America: A Quarter Century of Experience. Final Report. Office of Economic Research, Economic Development Administration. Washington, D.C.: U.S. Department of Commerce.

173. THK Associates. 1974. Impact Analysis and Development Patterns Related to an Oil Shale Industry: Regional Development and Land Use Study. Prepared for the Oil Shale Regional Planning Commission and the Colorado West Area Council of Governments. Rifle: Colorado West Area Council of Governments.

174. __________. 1976. Oil Shale Bibliography. Prepared for Oil Shale Regional Planning Commission. Denver: THK Associates.

175. Time. 1974. Resources: Boom of Mixed Blessings. August 5.

176. Toman, Norman, Norman Dalsted, Arlen Leholm, Randal Coon, and F. Larry Leistritz. n.d. Economic Impacts of Construction and Operation of the Coal Creek Electrical Generation Complex and Related Mine. Fargo: North Dakota State Univeristy.

This study of socioeconomic impacts in McLean County, N.Dak., deals with changes in population, public revenues, and local public costs (education, highways, water, law, fire, libraries, recreation).

177. Trigg, Mary. 1976. Uranium Arm Wrestles with Growth. High Country News (Lander, Wyo.), September 10.

A short account of the history of the boom in Jeffey City, Wyo., and the role of the impact industry in trying to alleviate social impacts.

178. __________. 1976. Women Face Boom Town Isolation. High Country News (Lander, Wyo.), September 10.

First-hand account of severe social psychological problems faced by women, particularly newcomers, in small boomtowns. Includes many short case histories of the plight of particular women in Jeffey City, Wyo.

179. Twomey, James, and P. G. Kuh. 1974. Governmental Programs, Resources and Regulatory Powers Available to Assist Localities During Coal Development. Denver: Northern Great Plains Resources Program.

180. Uhlmann, Julie M., R. Kemble, and D. Throgmorton. 1976. A Study of Two Wyoming Communities Undergoing the Initial Effects of Energy Resource Development in the Powder River Basin: Buffalo and Douglas, Wyoming, 1975. Department of Anthropology. Laramie: University of Wyoming.

A descriptive study of the Powder River Basin. Includes demographic characteristics, employment, migration histories, community facilities, attitudes of newcomers and long-term residents.

181. University of Colorado. 1972. Economic Impact of Power Plant Installations in Routt and Moffat Counties (Colorado). Business Research Division. Boulder: University of Colorado.

An overview of current economic and social developments in two Colorado counties.

182. U.S. Department of Agriculture. 1974. Migrant Response to Industrialization in Four Rural Areas, 1965-70. Economic Research Service. Washington, D.C.: U.S. Department of Agriculture.

183. U.S. Department of Commerce. 1973. Economic Profiles of the Northern Great Plains Region. Regional Economics Division, Bureau of Economic Analysis. Washington, D.C.: U.S. Department of Commerce.

Concerned with how this region's economic view developed over time and how it is expected to change in the years to come. The projections do not reflect potential major developments of the region's coal resources. The analytical framework and an analysis of historical and projected economics of the Northern Great Plains compose the bulk of the report.

184. U.S. Department of Housing and Urban Development. n.d. Rapid Growth From Energy Projects: Ideas for State and Local Action, A Program Guide. Office of Community Planning and Development. Washington, D.C.: U.S. Department of Housing and Urban Development.

Designed to aid in "planning for and responding to energy project impacts." Includes sources of assistance, names, addresses, and type of information available.

185. U.S. Department of the Interior. 1974. Draft Environmental Impact Statement: Development of Coal Resources in the Eastern

Powder River Coal Basin of Wyoming. Bureau of Land Management. Cheyenne, Wyo.: U.S. Department of the Interior.

186. __________. 1974. El Paso Coal Gasification Project: Draft Environmental Impact Statement. Bureau of Reclamation. Washington, D.C.: U.S. Department of the Interior.

187. __________. 1975. Draft Environmental Impact Statement, El Paso Gasification Project, San Juan County, New Mexico. Bureau of Reclamation. Salt Lake City: U.S. Department of the Interior.

This is a standard federal EIS which contains a baseline description of Navajo reservation life-styles and anticipated social impacts upon those life-styles.

188. __________. 1976. Draft Environmental Impact Statement: Northwest Colorado Coal. Bureau of Land Management. Denver: U.S. Department of the Interior.

189. __________. n.d. Draft Northwest Colorado Coal Environmental Statement. Vols. 1-5, Maps and Appendices A, B, C, and D. Bureau of Land Management. Denver: U.S. Department of the Interior.

Comprehensive inventory of events in Colorado coal country.

190. U.S. Department of the Interior, and Montana State University. 1975. Anticipated Effects of Major Coal Development on Public Services: Cost and Revenues in Six Selected Counties, Final Report. Bureau of Reclamation, and Institute of Applied Research. Denver: Northern Great Plains Resources Program.

Summary version of a research report concerning impact of coal development on public services in the Northern Great Plains area.

191. U.S. Energy Research and Development Administration. 1976. A National Plan for Energy Research, Development, and Demonstration: Creating Energy Choices for the Future. Vol. 1: The Plan. Vol. 2: Program Implementation. Washington, D.C.: U.S. Government Printing Office.

Vol. 1 outlines the Ford administration's view of the energy problem and what must be done to cope with it; specific energy sources are discussed. Vol. 2 reviews the status of various forms of energy research and development projects considered solely from a technological perspective; short- and long-term recommendations are included.

192. U.S. Environmental Protection Agency. 1975. Series 5, Socioeconomic Environmental Studies. Office of Research and Development. Washington, D.C.: U.S. Environmental Protection Agency.

193. U.S. News and World Report. 1975. New Boom Towns Across the U.S.: Places with Energy to Spare. November 10.

194. Wali, Mohan K., ed. 1974. Some Environmental Aspects of Strip Mining in North Dakota. Bismarck: North Dakota Geological Survey.

> Includes eight papers presented at the 65th annual meeting of the North Dakota Academy of Science. Main areas include pollution, health effects, and aesthetic disruption.

195. Weissman, Myrna, and Eugene Paykel. 1972. Moving and Depression in Women. Society, July-August.

> Study of a group of depressed women in New Haven, Conn. Article classifies circumstances surrounding moves. Not specifically boom-oriented but problems facing women certainly apply in any move causing depression.

196. Wengert, N. I. 1974. Impact on the Human Environment of Proposed Oil Shale Development in Garfield, Colorado. Boulder, Colo.: Thorne Ecological Institute.

197. __________. 1974. Oil Shale County Fact Book: Garfield, Mesa, Moffat, and Rio Blanco Counties, Colorado--Colony Development Operation. Atlantic Richfield Co. Boulder, Colo.: Thorne Ecological Institute.

> Includes a section on each county and deals with education, health, transportation, etc. Lists of figures and tables dealing with the actual situations in each county.

198. Westisen, M. J., and G. T. Nelson. 1967. Kaiparowits Socio-Economic Study. Center for Business and Economic Research. Provo, Utah: Brigham Young University.

199. Whipple, Dan. 1976. Water Problems Plague Wyoming Boomtown. High Country News (Lander, Wyo.), October 8.

200. White, Warren G. n.d. Socio-Economic Impacts of Coal Development in Nebraska. Northern Great Plains Resources Program. Lincoln: Nebraska Office of Planning and Programming.

> Nebraska faces a unique set of socioeconomic impacts which are discussed in relation to the principal impact area--Dawson, Keith, and Lincoln counties in west-central Nebraska. The area has a population density which is lower than the state and national averages, and is rural in nature. Scenarios present possible impacts.

201. Williams, David C. n.d. Studies on Socio-Economic Impacts of Energy Resource Development. Denver: Federal Energy Administration.

202. Wolf, C. P. 1974. Social Impact Assessment: The State of the Art. In Social Impact Assessment, ed. C. P. Wolf, pp. 1-44. Milwaukee: Environmental Design Research Association.

203. Wolf, C. P., ed. 1975. Social Impact Assessment. Environment and Behavior 7(3).

Entire issue (seven papers) is devoted to special impact assessment. Most relevant to boomtown analysis are articles by Shields (an overview of the content of social impact studies) and Krebs (an analysis of different social impacts from deep and strip mining of coal).

204. Wyoming Coal and Gas Co., and Rochelle Coal Co. 1974. Applicants' Environmental Assessment for a Proposed Coal gasification Project: Campbell and Converse Counties, Wyoming. Casper: Wyoming Coal and Gas Co.

In addition to the EIS, this report contains the results of "extensive interchange between the owner, the engineer and the environmental consultant." Section 5, The Assessment of Potential Impacts, includes material on socioeconomic impacts, demography, social conditions (e.g., housing, medical services, education) and human interests.

205. Wyoming Department of Economic Planning and Development. 1974. Coal and Uranium, Development of the Powder River Basin: An Impact Analysis. Cheyenne: Wyoming Department of Economic Planning and Development.

Concentrates on four Wyoming counties: Campbell, Converse, Johnson, and Sheridan. Collects and consolidates plans of all energy companies with an interest in the area; develops a methodology for evaluating the implications of possible alternative development patterns. The purpose of the study is to help citizens deal with expected growth and the socioeconomic problems which will accompany it.

206. Wyoming Oil Shale Environmental Planning Commission. 1971. Environmental and Economic Report on Wyoming Oil Shale. Cheyenne: Wyoming Oil Shale Environmental Planning Commission.

Contains a selected bibliography.

STABILITY, DIVERSITY, AND EQUITY:
A COMPARISON OF
COAL, OIL SHALE, AND SYNFUELS

by

Peter D. Miller
SRI International

INTRODUCTION

Stability, diversity, and equity are three societal values that may be used to judge the feasibility and desirability of alternative energy systems. Stability means continuity, survival, permanence, security, and social cohesion. Diversity, as used here, represents the value inherent in variety, preservation of options, freedom of social choice, and enhancement of socioeconomic opportunities. Equity means justice, fairness, and a reasonably acceptable distribution of the burdens and benefits of development. Although there would undoubtedly be general agreement that all three in the abstract are valuable, they have not been applied specifically to the analysis of energy systems.

The analysis presented in this paper, which is intended to be illustrative rather than exhaustive, focuses on conventional coal systems, synthetic fuels from coal, and oil from oil shale. Each system's implications for stability are analyzed in terms of (1) certain cyclical characteristics of mineral industries, (2) the effects of energy development on localities in resource regions, and (3) the degree to which destabilizing influences can be mitigated. Their implications for diversity are analyzed in terms of (1) competition for scarce resources such as land, water, and capital, and (2) the flexibility of future options. Lastly, three equity problems associated with each system are analyzed: (1) local public finance, (2) occupational health and safety, and (3) federal investment in energy development.

STABILITY OF DEVELOPMENT

Overview

Like many resource-rich regions, the rural coal and oil-shale areas of the western United States have found energy development to be a mixed blessing. While many welcome energy development as an opportunity to bring jobs and modern times to the region, others fear it as a threat to traditional ways of life. Public concern in the Rocky Mountain and Northern Great Plains states stems from recent and historical experience with unstable development--the boom-and-bust cycles characteristic of mining and railroad towns, the difficulty of absorbing large numbers of immigrants, and the wide fluctuations in economic activity over short periods of time. Stability means, on the other hand, a reasonable assurance of continuity in local tradition, economic security, and social cohesion. Because these objectives are not always consistent with the incentives that govern mining, it is necessary to examine these incentives and consider how they might be modified to the benefit of both developers and residents of mining regions.

Rate of Extraction

The relationship between sovereign nations and extranational mining companies illustrates how the conditions under which mining occurs can be modified in the process of negotiation. By setting the terms and conditions appropriately, sovereign nations seek to insulate themselves from some of the uncertainties of mineral development. While state and local governments of the United States obviously do not negotiate as sovereign entities, they have interests that are similar to those of host jurisdictions in relation to foreign companies. In such circumstances the rate of resource extraction is always a prime consideration (Mikesell, 1973).

In general, mining is a risky business. Exploration may be fruitless, or may yield quantities below what is considered economically recoverable. Political conditions may suddenly limit the availability of the mineral. Once a new venture has been initiated, scale economics and capital intensity require producers to maximize the use of equipment. Except when a high rate of extraction would clearly depress prices, the producer seeks to maximize the rate of resource extraction. Producers do so mainly to minimize the time between an investment and the initial cash flow, but also to expand market share or improve their bargaining position with respect to competitors. The host jurisdiction may, on the other hand, want to limit the rate of resource extraction in order to gain from future price rises, or to minimize the need for expansion of urban services and infrastructure. The host jurisdiction may also indirectly limit output by imposing on the mineral producer certain levels of local employment and procurement.

Similarly, state and local governments in the United States may seek to control or influence the rate of resource extraction as a means of preserving what they regard as an acceptable degree of stability. The interest of local governments is not so much to maximize collection of revenue as to (1) generate a flow of revenue over approximately the same period of time as the need for expansion of urban services occurs (avoiding tax lag), (2) achieve steady and continuous employment, and (3) reduce economic vulnerability due to the adverse influence of one industry on another.[1] Although state and local governments do not usually negotiate directly with producers on these points, the governments can exert substantial influence on these factors through manipulation of tax rates, regulation of utility siting, allocation of water, control of growth, and (in the case of resources under federal lands) leasing restrictions.

Site-specific factors such as seam thickness, patterns of land ownership, and terrain also influence the optimal rate of resource extraction. The coal regions of the western United States favor high rates of

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[1] See Peelle (1976b) for a discussion of the dubious advantages of receiving windfall tax revenues from a nuclear power plant.

extraction because the coal typically occurs in thick seams under relatively thin strips of overburden, title to the land is held by only one or a few owners, and the flat terrain is suitable for the use of large walking draglines. Where coal seams are thin, or the land is broken up among many different owners, or the terrain is steep or uneven--as is often the case for Appalachian coal--the optimal rate of extraction is lower.

Boomtown Impacts During the Construction Phase

The impact of industrial plant construction activities depends on:

- the size and characteristics of the host community
- labor requirements
- the timing and scheduling of plant construction.

Small towns without previous industrial experience are usually the most vulnerable to disruption resulting from construction activity. Campbell County, Wyo., exemplified the dynamics of rapid industrialization and urbanization.[2] With the onset of the coal boom, the county experienced overcrowded schools, trailer-camp slums, inflated rents, inadequate services, alcoholism, and mental illness, all at unprecedented rates. The pace of urbanization outran the county's ability to provide even the most minimal services, such as municipal water supplies, sewage hookups, and electricity, not to mention education, public safety, recreation, public health, and welfare services.

Local governments can either anticipate the demand for public facilities and services or wait until the demand materializes. The second alternative generally prevails because local tax revenues lag behind the need for services. Tax revenues lag when (1) tax codes offer reduced rates in order to attract new industry, (2) industrial plants are built outside of jurisdictions where growth is concentrated, (3) local governments depend on state-rebated severance taxes, which are not received until full plant operation, or (4) assets or sales bases are undervalued for tax purposes.

Thus the fiscal effects of intensive energy development are not beneficial under some conditions; in fact, the experience has been that per capita expenditures have increased. A study of sample counties in Montana, Wyoming, and North Dakota that had been involved in energy development showed that per capita public expenditures actually increased faster than population (U.S. Department of the Interior, 1975). Among the causes of these rising expenditures were the following: (1) school expenditures (accounting for as much as 60 percent of all local government expenditures), (2) newly organized social, health, and welfare services, (3) lack of revenues or fiscal assistance from higher

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[2] See U.S. Department of the Interior (1975) and Miller (1976). Similar processes have been noted in other settings. See Kohrs (1974), and Gilmore (1976).

jurisdictions, and (4) failure to achieve economies of scale in the services and facilities provided. Increasing tax burdens for residents and in-migrants, insufficient tax revenues, lack of opportunity for planning, and uncertainty as to the desired scope of expansion typically characterize the period of rapid expansion.

The higher the *peak* labor force required for construction, the more severe the impact is likely to be on the host jurisdiction. One way of estimating the impact of a plant capable of producing 100,000 barrels of synthetic crude oil per day is to determine the total amount of labor (in person-years) required for construction, derive a figure for the peak labor force, and project the numbers of additional people represented by employees' families and by secondary businesses and services. Since a plant of this size typically costs more than $1 billion (1978), it is reasonable to assume a foreshortened construction period to reduce the cost of tying up capital. If the total amount of labor required were 7,300 person-years, the peak labor force might be 3,600. A conservative population multiplier (ratio of family members and secondary businesses and services to direct employees) of five would yield an additional population of 18,000. Surface coal mines by themselves do not require a large labor force. A typical coal mine in Wyoming or Montana, yielding 5 million tons a year, employs 200 people. Coal production sufficient to fuel a 100,000-barrel-per-day synthetic crude oil plant would employ only 720 people. Production of the energy-equivalent amount of Appalachian coal (324 trillion Btu per year or 13 million tons per year) would require a much larger labor force. Thus the option of mining western coal and transporting it elsewhere for processing is likely to produce less-severe impacts than locating synthetic fuels plants near the site of the resource.

The rate of population growth associated with construction of an oil shale plant capable of producing 100,000 barrels of oil per day is similar to the rate associated with construction of a synthetic crude oil plant of the same capacity. If we define the Piceance Basin of western Colorado, the area of the richest oil shale deposits, as the unit of analysis, we find that Garfield and Rio Blanco counties would experience an annual growth rate of 17 percent (starting from a combined population base of 23,500 (Miller, 1976). Local terrain would restrict residential settlement to only 12 percent of the two-county area, adding to the problems of achieving orderly growth (THK Associates, 1973). Scaling down the size of the plant by half would generate an annual two-county growth rate of 8 percent. By comparison, the fastest-growing counties in the United States during the years 1960 to 1970 added population at annual rates of no more than 6 percent.

Spreading the construction period over five or six years (instead of three or four years, as assumed in the previous examples) reduces the peak labor force and hence its associated population. For example, if the 7,300 person-years estimated for the construction of a 100,000-barrel-per-day synthetic crude oil plant were spread over five years, the peak labor force might be only 2,100 people. The result is a more smoothly rising and falling employment curve rather than one with steep rises and drops. In theory, levels of plant construction employment could be adjusted so that massive migrations into and out of the locality would not be necessary.

Centralization and Decentralization of Urban Development

Because of the adverse impacts associated with locating large industrial plants in rural areas, some planners have suggested locating them near existing cities or already urbanizing areas (Berkeley Planning Associates, 1975). Large or medium-sized cities are likely to have a pool of skilled labor and infrastructure already in place. Induced population growth rates would be less than those in sparsely populated areas because of the larger population base.

The per-capita costs of most municipal services decrease with centralization and concentration, to a point. Although planners and economists differ as to when that point of optimum population size is reached, probably one of the best estimates is that of Thompson (1965), who puts it at a minimum of about 200,000. The clearest advantages of centralization occur with those services and facilities that must cover a geographical area, such as streets and roads, utilities, and garbage collection. A road costs the same whether one person or ten use it (except for differences attributable to maintenance and congestion). Human services, such as education, hospital care, and welfare services, can also be centralized, subject to continued accessibility for their clientele.

Existing urban centers (having a population of at least 100,000) generally have a more diversified set of industries than do small towns, and are thus better equipped to ride out national business cycles. Urban centers are also better prepared to accommodate new industries and are less vulnerable to downturns affecting a single industry. Unemployment in one economic sector could in principle be absorbed by expansion of another sector, without requiring workers to move long distances in search of jobs.

The choice of attaching energy production facilities to existing urban centers is of course not available in the case of oil shale, which cannot be economically transported to off-site facilities. Coal presents a more flexible set of options with regard to the location of energy production facilities.

Consider only two options: the southern-Illinois/western-Kentucky area and the area between Denver and Billings, Mont. Plants located in the Illinois/Kentucky area could draw on the experience of an established coal industry and on the existing urban centers of St. Louis, Evansville, and Louisville. The area also has advantages as a distribution point for both the existing manufacturing industries of the Midwest and the developing industrial base of the South. In addition, in the case of coal gasification products, the southern-Illinois/western-Kentucky area is well positioned with regard to the existing natural gas pipeline network.

The Denver-Billings area, on the other hand, is currently developing in the decentralized pattern of urban sprawl. Although not favorably located for existing end-use markets, the area could eventually offer some advantages to energy-intensive industries such as ore reduction and production of metals. Concentration of development in a few urban centers in the Denver-Billings area could absorb most population growth without unnecessarily changing the scenic character of the area.

Fluctuations in Employment

A synthetic fuels plant or an oil shale retort capable of producing 100,000 barrels of oil per day would require an operating labor force of only 1,600 people, in contrast to the 3,600 workers needed during the peak of the construction period (Hughes and Steele, 1976). With plants in widely dispersed locations, this would mean some local unemployment and job displacement as the construction period phased into the period of plant operation, with little opportunity to coordinate labor shortages and surpluses among plants. However, if several different plants were concentrated within a particular commuting range, the timing of construction and operation could be phased to minimize the disruptions in employment levels.

Policies to Reduce Adverse Social Impacts

Preventing adverse impacts is preferable to attempting to mitigate them after they have occurred. One of the preventable reasons for the extremely rapid urbanization of Rock Springs, Wyo., as Cortese and Jones (1976) point out, was the fact that construction of the Jim Bridger power plant coincided with a sudden spurt in trona (soda ash) mining. When several construction projects occur in the same region at the same time, adverse boomtown impacts are likely to be multiplied. These are avoidable to the extent that projects in a multicounty or multistate region can be phased so that one starts up as another is winding down. In this way local fluctuations in employment can be reduced, and in particular the reduction from a typcially sized construction labor force to an operating labor force might be made more gradual. Such an approach would depend on a highly mobile labor force, access to quick and reliable information about new projects on the part of employees, and some way of coordinating site-location choices and construction scheduling among numerous companies.

Site-location decisions and construction schedules are, however, currently established by unrelated private decisions and modified by various regulatory requirements that are also largely unrelated to one another. Recently, however, a few utilities have undertaken ambitious efforts to smooth their entry into a community. Mitigation plans were prepared at the behest of federal and state authorities by the Tennessee Valley Authority and Washington's Puget Power and Light for nuclear plant development, and by Wyoming's Missouri Basin Power Project for a three-unit coal complex. The plans feature direct payments, technical assistance, resident training, and other aid, according to Peelle (1976a). Although the mode of administering these plans has not yet crystallized, they all operate within an existing regulatory structure (the Nuclear

Regulatory Commission in the case of nuclear plants, and the Wyoming Industrial Siting Commission in the case of the three-unit coal complex). There is, in contrast, no institutional structure currently capable of coordinating projects over multistate regions.

All three of the energy systems discussed here are currently considered transitional--options to get us through the next 20 to 50 years, when renewable energy sources such as solar and fusion power become available. All three therefore are likely to become obsolete when other energy sources are commercialized or if world energy prices decline. Exactly when either event might occur is not known, but the limited useful life of facilities built during a transitional period suggests the advisability of planning for their ultimate decline as well as for their current expansion. Fiscal assistance to areas during the rapidly expanding phase of energy development, to be effective, needs to be supplemented by planning and coordination of employment requirements. One example might be an information and relocation assistance network designed to allow orderly transfers of workers between labor-scarce and labor-surplus areas. Once the boom phase is over, however, cities run the risk of entering a period when population grows faster than job opportunities. This is the appropriate time, according to Rust (1975), to encourage young people to relocate. Otherwise, when their children enter the labor force, the city will have already entered a period of decline, while the older population will have less propensity to move. Multiplant companies, in particular, can play a useful role in transferring workers within the company away from declining areas.

Coal is best adapted to electrical, industrial process steam, and ore reduction uses. Viewing the situation at a national level, increasing use of coal implies an energy future with a relatively high degree of electrification. Liquid fuels, including the synthetics, are best adapted to the transportation and petrochemical markets. It would make little sense to develop expensive synthetic fuels plants for electrical uses, where conventional coal would serve just as well. Public policy may attempt to displace oil and natural gas away from industrial and electrical uses; if the coal industry could solve its substantial environmental, health, and safety problems, coal would have the greatest potential as a substitute for imported oil. Using coal more extensively in the electrical and industrial markets would free other domestic fuels for other uses and would thus reduce dependence on imported oil to that extent.

However, neither coal, oil shale, or synfuels nor any combination of them could produce complete energy independence without other gross dislocations in the economy and society. Without question, the actions of the Organization of Petroleum Exporting Countries have shaken national economic stability, but energy independence pursued by means of extreme conservation or development would be even more disruptive. Adjustments of diplomatic and trade relationships are likely to prove more effective. For example, oil companies could be encouraged to engage in additional worldwide (as well as domestic) exploration to diversify the sources of oil imports. The more divergent the interests of the nations that export oil, the weaker their collective determination will be to use oil as a weapon or instrument of diplomatic leverage. Conventional coal, the least uncertain of the three energy systems, seems to provide the most immediate opportunities for limited import substitution; even so, increased use of conventional coal depends on a slow process of increasing electrification, gradual displacement of oil and gas, and retrofitting or replacement of power plants and other facilities to burn coal.

It should be emphasized that, at a national level, the three systems are by no means mutually incompatible. Since the different fuels will enter different markets, the operative choices do not revolve about one system *or* another. Conventional coal will continue to supply power plants and some industrial processes, while oil and natural gas will continue to play important parts in the nation's energy supply (at increased prices) well into the next century. Synthetic fuels will probably find markets in the transportation and petrochemical sectors of energy use, if appropriate locations are found for production facilities. Major development of oil shale, the perennial bridesmaid of the energy industry, is unlikely except as a last resort.

DIVERSITY

Overview

Diversity, as used here, refers to the scope of options, resources, or opportunities available for future use. Alternative energy systems can affect the future availability of resources in different ways. To the extent that a given system precludes alternative uses of land or water, for example, that system would reduce future options. Energy development decisions affecting land and water use have an enormous bearing on the livelihoods, occupational choices, and other aspects of freedom of choice by the people who live in energy-producing regions.

Competition for Scarce Resources: Land

Agriculture and ranching on the one hand, and coal and oil shale mining on the other, compete for some of the same physical resources. Surface mining generally renders land unsuitable for agriculture or ranching at least during the period of mineral recovery and in many cases well beyond that period. Between 1930 and 1971, coal mining disturbed a total of 1.47 million acres of land (University of Oklahoma, 1975). About two-thirds of this was the excavated area itself, the remainder being used for waste disposal. After mining takes place, it is a matter of dispute how suitable the land can be made for subsequent agriculture and ranching.

To the extent that a community or region depends on land uses incompatible with surface mining, such as ranching, agriculture, tourism, and recreation, unsuccessful reclamation reduces the value of the land.[3]

Revegetation of surface-mined lands in the West depends for its success on the amount of precipitation and on the thickness of the topsoil in the reclaimed area. In the Rocky Mountain and Northern Great Plains Coal Provinces, precipitation varies from year to year and may not be enough in some years to allow revegetation of native grasses and shrubs without active irrigation and cultivation. In addition, seeds for many of the species may not be available. The best chances for successful revegetation are in the North Dakota lignite region, where annual precipitation averages between 20 and 30 inches and topsoil is thick. The worst chances are in parts of Wyoming and New Mexico, where the average annual precipitation is less than 16 inches, and topsoil is only a few inches deep (National Research Council, 1974).

Rainfall is generally plentiful in the East (Interior and Eastern Coal Provinces), but the steepness of slopes is a problem. Slopes steeper than 30° cannot be reseeded because seeds will wash down the hill; several Appalachian states have therefore prohibited surface mining in areas with such slopes. Waste disposal practices and acid drainage also limit Appalachian land reclamation. More severe than the physical limitations, however, have been the refusal of mine operators to adopt adequate reclamation practices, and the inability or unwillingness of states to collect high enough reclamation bonds (Caudill, 1963). Overall, it is the difficulty of regulating mining practices and enforcing adequate reclamation standards, rather than the availability or nonavailability of reclamation techniques, that seems to be the limiting factor.

Reclamation of oil shale lands mined by conventional methods presents even more serious problems than does the reclamation of either eastern or western coal lands. Oil shale currently under federal lease is located in the Piceance Basin of Colorado, the Uinta Basin of Utah, and the Washakie Basin of Wyoming. Reclamation problems originate in (1) the volume of spent shale, about 15 percent greater than the original rock, (2) lack of disposal sites for spent shale other than heads of canyons, and (3) leaching of saline water into streams and rivers. Using conventional surface and underground (room-and-pillar) methods

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[3] Surface mining of coal is accomplished by placing explosives in holes drilled into the earth above the coal, blasting this soil ("overburden"), scraping up and disposing of the overburden, excavating the coal, and transporting it to a storage site. On flat terrain, the cut is simply an area trench which may be refilled with overburden and topsoil after the coal is removed. In the steeper terrain where Appalachian coal is mined, the cut is usually a contour that follows the coal seam, or involves removal of entire mountaintops. This creates a series of benches and highwalls and substantial spoil piles that are usually pushed downslope. Although a number of reclamation techniques, such as shaping the spoil bank, backfilling the bench, and modifying block cuts, are available, their expense lessens the likelihood of their use.

of mining, and conventional retorting methods, the spent shale would amount to more than 100,000 tons of waste per trillion Btu of oil shale (University of Oklahoma, 1975). Disposing of this amount of spent shale by piling it in nearby canyons would probably be politically unacceptable. If water were to leach through spent shale piles to streams flowing into the Colorado River, it would increase the river's already high salinity (U.S. Water Resources Council, 1974), thereby violating Interstate Water Compact obligations to supply clean water downriver and violating treaty obligations regulating the supply of Colorado River water to Mexico. *In situ* methods of oil shale retorting, developed by a subsidiary of Occidental Petroleum and the Bureau of Mines, might provide a solution to the problem of spent shale disposal, but these methods are still in the experimental stage.

Competition for Scarce Resources: Water

Mining competes with agriculture and ranching for water as well as for land. Although water is not scarce in the Appalachian states, its pollution from acid mine drainage can be a problem. Both water quality and quantity are a problem in the western mining regions. As noted above, oil shale poses the most serious problems for water quality (except if mined by *in situ* methods) because, using known disposal methods, there is every likelihood that water leaching through the spent shale piles will increase the salinity of streams leading to the Colorado River.

Water has traditionally been "free" to those who first acquired it for "beneficial use" under western water appropriation law. If total water claims exceed water supplies, as now seems likely, there would be strong pressures to create a market in water. The cost of water under such a system would be a minor fraction of total costs of production to a mine operator, but would be enough to drive many farmers and ranchers out of business.

Officials of the Rocky Mountain and Northern Great Plains states have expressed concern about possible threats to their traditional economic base. North Dakota Governor Arthur Link asserted that his state "will not 'subsidize' the energy needs of the rest of the nation by bearing a disporportionate share of the social and environmental costs of massive energy production."[4] The Western Governors' Regional Energy Office (1975) resolved "to obtain timely assistance for local political entities which are affected by energy development impacts from such appropriate sources as the energy industry or state or federal government," and "to weigh the critical need for food production in the assessment of possible adverse impacts of energy production on top soil, water supply, water quality and air purity." Montana and Wyoming have demonstrated their intent to keep a measure of control by passing more stringent utility siting laws and increasing coal severance tax rates. The Rocky Mountain and Northern Plains states have also presented vigorous criticism of federal energy planning in regional public hearings, through their congressional

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[4] Link to U.S. Senate Interior and Insular Affairs Committee, May 15, 1974.

representatives, and by published reactions to environmental impact statements.

Water is in fact the chief limit on the operation of oil shale, coal liquefaction, and electric generating plants in the West. An oil shale retort capable of producing 100,000 barrels of oil per day would consume 16,000 acre-feet of water per year. (These and the following figures are consumptive uses--for example for cooling, process steam, or evaporation--and exclude recirculation.) A coal liquefaction plant of the same capacity, operating with a wet cooling system, would use 29,000 acre-feet of water per year. And a 1,000 megawatt electric generating plant would use 12,000 acre-feet of water annually (Northern Great Plains Resources Programs, 1974). The water situation is most critical for oil shale located in the Upper Colorado River Basin. With an estimated 5.8 million acre-feet of Colorado River water available annually, 3.7 million acre-feet per year allocated to present uses, and estimated increases in other uses of 2.8 million acre-feet, there will clearly not be enough water to go around, even without an oil shale industry (U.S. Department of the Interior, 1974). Current uses include the treaty obligations to Mexico to provide 1.5 million acre-feet of water annually and the interstate water compact obligations allocating water to Colorado, Utah, Arizona, New Mexico, and Wyoming. Current and future uses include irrigation, reservoir evaporation, municipal water supplies, and fish and wildlife habitat, as well as mineral and industrial uses. A decision to develop an oil shale industry would in effect be a decision not to expand and possibly not even to maintain other uses. The threat to irrigated agriculture, particularly if a market in water is developed, is clear.

The Missouri River Basin as a whole probably has enough water available for moderate synthetic fuels or conventional coal development, again provided some other future uses are forgone. However, the coal and the water are located far apart. The highest flows of the Missouri River are of course downstream, while the coal is located near the sparse headwaters. Moreover, the flows of the Yellowstone River and the aptly-named Powder River are extremely seasonal, peaking in late spring and dwindling rapidly in late summer. Both synthetic fuels plants and electric power plants would compete immediately with other uses for the water in these river basins. In theory, interbasin water transfers and reservoir diversions could fill some of the gap, but moves in this direction have already sparked litigation between South Dakota and Wyoming. Downstream users have an obvious interest in upstream water diversions and are not likely to relinquish their rights lightly. In addition, Indian claims to Missouri River Basin water, which are legally prior to many other claimed future uses, could prevent the water's use for purposes of energy development.

Of all the many uncertainties in energy development, the disposition of water rights will probably provide the key to future alternatives.

Federal water rights are clearly paramount in law.[5] Particularly in the public domain lands--lands that, held since before statehood, were never alienated from federal possession--the federal government has a claim prior to that of the states, based on the doctrine of appropriation applicable in the western states. Under the commerce clause of the Constitution, the federal government has the power to regulate navigation and to control all navigable streams. A stream is legally defined as navigable if improvements could make it so or if it is a tributary which affects the navigable capacity of the main stream. The federal government has also relied on the supremacy clause of the Constitution in relation to international water obligations, the war power, and the power to protect the general welfare. Some federal water rights could be exercised without compensation to the state in which the water lies, and others involve a compensable taking. While it is doubtful that the full extent of this impressive array of rights will be exercised, they are nevertheless a potent legal weapon in federal-state disputes. Without control over water, the western states would lose control over the scope and direction in which they wish to develop.

The Energy Crisis in Perspective

If fossil fuels are indeed a one-time bounty soon destined to disappear, then it makes sense to develop and consume fossil fuels as sparingly as possible. But is there really a crisis of absolute scarcity? Leaving aside the possiblity of new oil and gas discoveries, let us examine the domestic supply of coal. Total coal production in 1973 was 599 million tons, equivalent to 12 quadrillion Btu (12 quads). Coal reserves in the same year were identified by the U.S. Bureau of Mines as 434 billion tons.[6] The current reserve/production ratio, then, is 725; at current rates of coal production, reserves are sufficient to last 725 years. This projection of course ignores the impact of interfuel substitution such as would be facilitated by synthetic fuels production, and the desire or necessity to substitute coal for other fossil fuel sources. Assuming, however, that the entire 1970 U.S. energy input of 69 quads were to be supplied by coal, the 434 billion tons of coal reserves would last 122 years.[7] Higher levels of total energy demand would shorten the life time of domestic coal reserves. Total domestic coal resources (i.e., coal

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[5] Winters v. U.S., 207 U.S. 564 (1908) and Arizona v. California, 373 U.S. 601 (1963). The Federal Energy Administration sponsored legislation in 1975 that would have further excluded the states from participating in energy planning. The Energy Independence Act would have granted the federal government authority to disapprove state utility siting procedures and air quality standards and to preempt state public utility commission decisions. See Federal Energy Administration (1975) and Zink (1976, pp. 658-676).

[6] Reserves are defined as the quantity of coal in seams located by geological measurement or evidence and economically recoverable by present methods.

[7] Assuming an average heating value of 10,000 Btu per pound.

reserves plus coal not economically recoverable by present methods and quantities surmised but not located) are estimated to be sufficient to supply the entire U.S. energy input for 850 years (University of Oklahoma, 1975).[8] From a purely geological perspective, then, there is no energy crisis.

While these reserves are economically recoverable, however, they may not be recoverable at acceptable costs in human health and safety, environmental impact, and community impact. Differing implicit estimates of these limits account for the current uncertainty over how much of future energy consumption will be based on coal, despite its apparent abundance.

Nonetheless, the coal figures demonstrate that fashionably apocalyptic predictions are baseless. There will undoubtedly be supply bottlenecks, price adjustments, further political instability in the Mideast, and wasteful consumption, but these problems in no way justify the assumption that we are running out of energy. Natural gas is the only fuel being used up faster than the rate of new discoveries, and that is largely because it is the cheapest, cleanest, and most convenient fuel for a wide variety of applications. Otherwise the notion of absolute physical depletion of world supplies regardless of cost and price is absurd, in terms of short- and medium-term energy alternatives. There may be good reasons to develop systems of renewable energy--such as rising social and environmental standards--but the threat of imminent shortages of conventional energy sources is not one of them.

EQUITY: THE DISTRIBUTION OF BENEFITS AND BURDENS

Overview

Equity involves issues of distributive justice: local public finance, relations between energy-producing and energy-consuming regions of the nation, occupational health and safety, and methods of apportioning the burdens and benefits of energy development (Rawls, 1972). For some issues the actors may be stratified according to income or class, while for other issues they may be stratified according to occupation, age, or region of residence. However fundamental the goal of assuring adequate energy supplies may be in the aggregate, the distribution of burdens and benefits must be perceived as fair in order for an energy system to work effectively.

[8] Oil shale reserves are also apparently plentiful, with estimates ranging from 80 billion barrels (U.S. Department of the Interior, 1973) to 129 billion barrels (National Petroleum Council, 1973). The lower figure is nearly seven times the entire 1970 U.S. energy input. Following the Arab oil embargo, oil companies paid almost half a billion dollars for lease tracts in Colorado and Utah in early 1974, but later withdrew. The reasons were high start-up costs, technological uncertainties, and environmental problems.

Urbanization and Public Finance

Faced with declining employment in agriculture and ranching, continuing loss of population to the cities, and apparently having few other prospects, many small towns in the West are approaching energy development as a means of rescue from further decline. The infusion of outside capital and labor is thought by many to provide the means of improving local opportunities. Such towns typically pass through three stages in their approach to development. The first stage is dominated by a land-based rural elite that wishes to maintain a traditional status quo. This is quite compatible with a "no-growth" position, hence the curious alliance of old guard and young environmentalist elements. In the second stage, a town-based merchant elite promotes a development philosophy of unabashed boosterism. This approach seeks to attract virtually any form of economic activity, provided it increases payrolls, population, retail sales, and other indicators of progress and prosperity. Towns in the third stage typically become more selective about the industries they wish to attract. Whether for environmental reasons, or because the first group of industries wants to exclude competitors, the terms of entry become more restrictive during this stage.

Since company towns have gone out of fashion, it has become a matter of public responsibility to provide the infrastructure for development--streets and roads, fire and police protection, water, sewage, electricity, education, public health and medical services, social services, and government planning. The problem of matching anticipated tax revenues with anticipated costs is highly visible nowadays, no less for Rosebud, Mont., than for New York City. Building the infrastructure to cope with energy development is apparently beyond the ordinary taxing capacity of many small towns located near the coal resource. A study of sample counties in Wyoming, Montana, and North Dakota found that per capita public expenditures increased at a faster rate than population (U.S. Department of the Interior, 1975). Both the long-time residents and the newcomers paid increasing tax rates. These conclusions were reached by estimating future populations associated with a probable combination of coal mines, synthetic fuel plants, and electrical generating plants, projecting future infrastructure needs associated with these populations, and estimating the costs of needed services. Comparison of these costs with anticipated revenues showed that the revenues would be inadequate during the construction period and adequate thereafter, except in one sampled county (Sheridan County, Wyo.) which would experience difficulties past the construction period.

Tax revenues based on completed plants or product flows do not of course materialize until well past the plant construction period when they are most needed. Municipalities may have more of a problem than higher levels of government because industrial plants can be located beyond town limits, exempting themselves from the town's property taxes. Increased taxes impose the greatest burdens on vulnerable groups such as the elderly, the unemployed, and other people outside the high-wage sector. Ranchers may be disadvantaged by higher property taxes because ranch operations depend on vast acreages, low land prices, and low taxes. Although sale or lease of the land under such conditions might yield a substantial capital gain, this may not be preferable to staying in business at the accustomed place (Smith and Martin, 1972). Plant employees and managers, developers, some merchants, and others with a stake in development would be insulated from the effects of local inflation and tax increases. This disassociation of costs from benefits is the essence of inequity and is likely to remain a serious obstacle until appropriate methods of compensation are devised.

Occupational Health and Safety

Coal mining has always been one of the most dangerous occupations in the United States. In 1971, the fatality rate in coal mining was 60 percent greater than the average for the minerals industry. The rate of nonfatal injuries in 1970 was about twice that of the average for all manufacturing (U.S. Department of Commerce, 1973). In recent years the rate of fatal injuries in underground coal mining has varied between 150 percent and 200 percent that of the rate in surface mining. Nonfatal injuries in underground mining have typically been double the number in surface mining per person-hours worked. In 1973, for example, there were 0.49 fatal injuries per million person-hours in underground coal mining, 0.28 in surface mining; nonfatal injuries occurred at the rate of 49 per million person-hours in underground coal mining, and at 19 in surface mining. These figures do not include the incidence of chronic lung disorder, pneumoconiosis, that comes from years of breathing coal dust.

Both underground and surface mining pose risks associated with operating heavy equipment. Modern coal-cutting and earth-moving machinery is so huge and noisy that equipment operators can neither hear nor see people who may be in their way. The major additional risk in underground mining comes from roof cave-ins. With the room-and-pillar technique of underground mining, a certain amount of coal is left in place to shore up the roof of the mine. Roof stability is further protected by bolting the overhead seam of coal to the overlying rock layer. Despite these precautions, subsidence resulting from undetected weaknesses in the roof can occur, with disastrous results. Working conditions in deep mines are generally more onerous, with the workday spent out of daylight, often in damp, cramped quarters and uncomfortable postures. Oil shale mining (except by *in situ* methods) would most resemble underground coal mining in technique of recovery, and could be expected to have a similar safety record once in operation.

Injuries, deaths, and chronic diseases have been treated as "externalities" by the coal industry, which has steadfastly resisted improvements in working conditions. Cheap energy from coal has been available in the past in part because the costs of mineworkers' deaths and injuries were not fully internalized. If safety conditions were to be made equivalent to those in other mineral industries, the cost of producing coal would probably rise, and this would probably be passed on to coal consumers, and so on throughout the economy. The total cost would probably be less, however, than the cost of the black lung payment program, currently in the hundreds of millions of dollars. It is also a sound principle of insurance to spread such risks as widely as possible among all the beneficiaries of a system. Whether future hazards are to be compensated through *post hoc* transfer payments or prevented by thorough improvement of health and safety conditions is a matter still to be decided.

Federal Investment in Energy Development

Mineral Leasing Regulations

Leases for mineral exploration and extraction represent the bargain struck between the owner of mineral rights and the mine operator. When the owner of mineral rights is the federal government, the public expects the leasing agency (the U.S. Department of Interior's Bureau of Land Management) to make the best possible deal in its behalf, as a matter of public policy. However, leasing regulations are governed by contract law, not by public law. This means that the federal government does not act in its capacity as sovereign, but has exactly the same status in court as any other owner of mineral rights. Mineral leasing regulations are thus a kind of private contract between the lessee and the federal government as proprietor. Virtually the only explicit principles of public policy governing such transactions are contained in 30 USC §187, which states that the Secretary of the Interior may include provisions in leases "to insure the sale of the production of such leased lands to the United States and to the public at reasonable prices, for the protection of the interests of the United States, for the prevention of monopoly, and for the safeguarding of the public welfare."

Early in the history of mining on public lands, the object of public policy was to transfer as quickly as possible the nation's natural resources from public to private hands. The first mineral leasing regulations were adapted to a belief in unlimited resources and were designed to further practically unlimited extraction. At the turn of the century, the federal government began to assume a caretaker role. President Taft, reacting to reports of profiteering on public oil lands in California, withdrew 3 million acres from disposal under the mining laws. The Supreme Court later ruled such actions constitutional (United States v. Midwest Oil Co., 236 U.S. 459 [1915]), and Congress granted formal authority under the Pickett Act to make such withdrawals. Although provisions tending to maximize exploitation of mineral resources were retained in the law, the federal government began to recognize an obligation to conserve resources and to manage them in an orderly way.

The environmental movement and the energy crisis focused greater public attention on the rate of extraction, the uses of land after mining, and the payment of a fair price for the right to extract the resource. While these concerns had existed for at least 50 years, they coexisted with regulations that posed no limit in practice to rates and methods of mineral extraction from public lands. The coal leasing moratorium, begun in 1971 by Interior Secretary Rogers Morton, came in recognition of the fact that reform of leasing regulations was in order.

Pre-moratorium weaknesses. The pre-moratorium coal leasing regulations were criticized for failing to protect the interests of the United States as proprietor (Council on Economic Priorities, 1974). The supposedly competitive bidding process, for example, often worked out to be noncompetitive, producing less revenue for the Treasury than the coal was worth. A mine operator obtained a license to explore for coal on public land; if coal was found, the operator could then obtain a prospecting permit to find out whether coal was present in commercially recoverable quantities. If such coal was found, the operator was then entitled as a matter of right to a preference right lease, the reward for undertaking exploration and prospecting. This process deprived the government of any bonus it might have received for entertaining competitive bids following discovery of commercial quantities of coal. Furthermore, it has been customary to accept nominations from the mining industry for the leasing of particular tracts, resulting in many lease sales that failed to attract more than one (well informed) bidder. In some cases, lease awards were apparently made without bids. All of this was within the legal discretion of the Secretary of the Interior.

Coal leases were awarded for indefinite lengths of time, reviewable at intervals of 20 years. Although the lessee was formally required to undertake "diligent development" and "continuous operation," in practice this was not enforced. Thus the rate of extraction was entirely at the discretion of the mine operator, enabling operators to hold certain lease tracts until price fluctuations and other market conditions made mining more profitable, thereby reserving any speculative gain to themselves rather than to the owner of the mineral estate (the federal government). Although the regulations contained limits on the amount of land that could be awarded by lease to one operator, there were also provisions for exceptions if part of a leaseholding were close to depletion or if assembly of a commercially useful tract required additional land.

Other provisions of the mineral leasing regulations favoring the interests of the mining industry as against those of the federal government have concerned rents and royalties. The statutory minimum for rental of coal land is 25 cents an acre for the first year, 50 cents an acre for second through fifth years, and $1 an acre thereafter. It has been customary to set these rents at the statutory minimum. Since the rents have been set for 20-year terms, they have provided a substantial benefit to the coal industry at public expense. Royalties, set at between 15 cents and 20 cents per ton of coal mined, have also proved to be a great bargain for the coal industry. In addition to sacrificing large amounts of revenue, the federal government has also given up a potent means of environmental regulation by failing to use the mineral leasing regulations as a management tool. It is to be expected that new legislation or regulations will change many of these features in the interest of securing a better bargain for the federal government.

Past mineral leasing regulations have been indifferent to the use of coal once it leaves the mine. Had there been a synthetic fuels industry derived from coal, it would have been affected in the same way as the conventional coal industry. The only circumstance under which future mineral leasing regulations would affect the two industries differently would be if royalties were tied to the market value of the coal extracted rather than being based on a flat amount per ton. If royalties were based on a proportion of market value, problems in determining that value could arise when a synthetic fuels producer sold coal to itself. The same problem can arise with any vertically integrated firm in which the value of an intermediate product is not determined by an arms-length transaction. Presumably a vertically integrated firm, capable of entering into production of synthetic fuels from coal, would benefit more from a proportional royalty (or would lose less from it) than a conventional coal producer.

Oil shale leasing regulations seem, on their face, to strike a better bargain for the federal government than other mineral leasing regulations. The most startling difference appears in the amount of the bonus bids: $210 million for one Colorado tract and $117 million for another. Two oil shale tracts in Utah were leased for $75 million and $45 million. Oil companies paid a total of $447 million for the privilege of taking oil shale from public lands. These prices may have reflected the belief, in January and February 1974, that the commercial possibilities of oil shale were greater than they turned out to be.

Less publicized than the enormous lease bids, however, were provisions in the leasing regulations for the costs of improvements and operations to be credited against bonus payments. If these costs eventually equalled or surpassed the fourth, fifth, and sixth (final) bonus installment payments, in effect the last three payments would be nullified. Operations costs can also be credited against royalty payments in succeeding years, over a $10,000 annual minimum royalty. Given the escalation in construction costs that has already taken place since the announcement of these bids, the bonus payments look much less impressive. An exact comparison of coal and oil shale leasing regulations in this respect is impossible without a detailed accounting statement.

Other major differences between oil shale and other mineral leases appear in the form of requirements in the oil shale leases to pursue development with "due diligence" in accordance with a detailed development plan; and bonds in various amounts to guarantee compliance with lease terms, reclamation, and mine operation regulations. Detailed "environmental stipulations" similar to those governing the Trans-Alaska Pipeline are incorporated by reference into the oil shale leases. However, since there is ample discretion to modify or suspend many of these regulations as necessary, actual differences between the two sets of regulations will show up, if at all, in enforcement practices.

Federal Subsidies

The uncertain economics of energy development have prompted numerous suggestions for federal aid or public financing of the capital costs of plant construction. For example, Hollis M. Dole, general manager of Colony Development Corp., an oil shale consortium, argued, "This is a high-risk venture, and the federal government should be involved. We have to have a guarantee." Walter Herget, president of another oil shale consortium, agreed: "We will pursue our work to the point . . . where we have to lay out big checks. Then it will take some kind of incentive from the government" (Business Week, 1975). Representatives of synthetic-fuel interests have similarly indicated that both construction grants and price guarantees might be necessary to establish production capability. The electric utility industry is in a somewhat more secure position as a regulated monopoly, being able to include plant construction costs as part of its basis for calculating rates. The regulatory system which has developed over the years in the utility industry has insulated the industry from market risk in return for reliable supplies of reasonably priced electricity. It is not clear, however, whether similar institutional arrangements could be developed to reduce the risk and the price of energy from synthetic fuels.

Some federal subsidies could come at the beginning of the fuel cycle, in the form of favorable lease terms; others apply specifically to plant construction; and still others apply to prices. Since plant construction is by far the most costly element of the fuel cycle, subsidies that occur throughout the fuel cycle will probably be examined by the energy industry in terms of their implications for the plant construction decision. Direct subsidies for plant construction would, however, be politically unpopular and, ironically, would probably not appeal to the energy industry either because they would require more precise cost estimates than have generally prevailed, with large penalties for error. The appearance of a direct subsidy could be avoided by various forms of tax incentives, such as a 10 percent investment tax credit. Its impact on profitability, except at politically excessive levels, would, however, be minimal. Despite repeal of the oil depletion allowance, other opportunities for savings in tax payments are so abundant that an additional tax incentive would probably not make much difference to oil shale or synthetic fuels. Finally, price supports could be used to maintain parity among the products of oil shale, synthetic fuels, and domestic natural crude oil. Their purpose would be to protect a new industry from sudden drops in world oil prices. However, deregulation of the price of natural gas and of "old" domestic oil would also have to occur to make synthetic fuels or oil shale competitive. This is an unlikely possibility. Another form of price support would be a contractual arrangement for government procurement at cost plus fixed fee, or at a fixed price. The cost-plus approach would remove incentives for efficiency, and the fixed-price approach would be subject to the same uncertainties that have so far prevented commercialization.

A serious potential exists for gross misallocation of resources in the above subsidy alternatives, with minimal return in energy production. At a cost of $1 billion for a 100,000-barrel-per-day capacity, an oil shale or synthetic fuels plant can deliver a daily barrel of oil for $10,000. A conventional coal mine, complete with draglines, can be established for a small fraction of that cost of a daily barrel of oil equivalent. Even with transportation costs included, coal can be delivered to the point of end use far more cheaply. Construction of electrical generating capacity, while expensive, is a known technology and hence not subject to the kinds of cost overruns to be expected in synthetic fuels or oil shale. Of the three energy systems considered here, the conventional coal system is least likely to require a large, potentially wasteful, and certainly controversial subsidy program.

Furthermore, the electric utilities are part of an existing and, for the most part, well-working regulatory system designed to accomplish the objective of energy development--reliable supplies of energy at fair and reasonable prices. As a matter of relative emphasis, then, the analysis shows that the conventional coal system is the most compatible with existing cost constraints, regulatory structures, and supply flexibility.

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REGIONAL ANALYSIS OF
ENERGY DEVELOPMENT IMPACTS AND RESPONSES:
SOME RESEARCH METHODS, RESULTS, AND NEEDS

by

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INTRODUCTION

Many decisions will be made in the near future regarding energy systems in the United States. The alternatives being considered are numerous and are dissimilar in many ways. Perhaps among the more noticeable of these differences at the micro-level are variations in local and regional impacts and responses among the alternatives. That is, choices made in the energy field may directly or indirectly shape patterns of employment (through industrial location and technology choices), land use, income distribution, population distribution, and much more.

Several of these linkages are examined in some detail elsewhere in this volume. There, however, the focus is more often local or project-oriented than it is regional or program-oriented. That is reasonable, considering the importance of site-specific factors which tend to shape the magnitude and distribution of impacts (e.g., degree of urbanization, local tax structure, local planning, etc.). Still, there exists the broader regional picture, which has been studied in much less detail.

Now that a large body of literature exists on local social and economic impacts of energy development, it may be possible to build on these more detailed studies to develop good regional analysis of energy development impacts. Specifically, it may be possible, by aggregating the results of many available local impact studies, to suggest regional impacts of importance. This paper puts forth a practical method of doing this.

Certain relevant findings from existing studies of socioeconomic and sociopolitical impacts of energy development are summarized, primarily through the identification of key empirical factors, variables, and useful analytic frameworks.[1] In addition, several reasonable propositions and reserach needs, which can be justified given the conclusions of the studies completed to date, are stated. Obviously, these propositions themselves could be foci of future research in this area.

Most of the following has been drawn from studies of the impacts of larger-scale nuclear and coal power plants for two very practical reasons. First, these are the areas with which the author is familiar. Second, few detailed studies of the socioeconomic and sociopolitical impacts of other options at the local and regional levels have been completed to date. Much of the information derived from the study of the nuclear and coal options, however, is generalizable to other technologies.

It should be noted that the following points basically reflect only one of several perspectives one may adopt in undertaking social or political impact assessment. From this perspective impacts and responses

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[1] Most of the methodology and findings summarized herein are drawn from and are considered at greater length in two recent research reports (Isard *et al.*, 1976; Isard, Reiner, and Van Zele, 1977a). One aspect of the research discussed in the 1976 study is a search of the literature on local and regional impacts of nuclear power development; the reader is referred to this report (especially to the annotated bibliography) for references and detailed discussions of these findings.

are shaped to a large extent by certain intermediate socioeconomic variables, themselves functions of the choice of energy systems. Responses at the community level typically relate to the impacts of technology "in the small," that is, to changes in employment opportunities, tax burdens or benefits, land use controls, opportunities for participation in local public decision making, access to social institutions, migration patterns, and so forth. Thus, while other perspectives may be useful and should be pursued, the social and political responses to such changes comprise a significant proportion of the issues one ought to consider at the local and regional levels.

THE SURROGATE-SITE CASE STUDY APPROACH

This approach to regional analysis of energy development impacts involves the further development of the surrogate-site concept used in Isard *et al.* (1976) to study the impacts of nuclear plants. Stated very briefly, the concept involves the selection of prototypical sites within the larger region that would illustrate the range of potential public policy and siting issues. Each of these sites would, in turn, be viewed as representative of a more numerous class of sites. Judicious extrapolation and aggregation could yield a regional analysis that would attend to issues at both the regional (e.g., the Northeast) and the state, county, and perhaps local levels. The primary justification for this approach derives from the economy of research effort: it permits maximum returns in terms of the breadth and validity of information generated, given tight time and resource constraints.[2]

As indicated above, this approach was developed to study regional impacts of the construction and operation of nuclear and coal-fired power plants, primarily in the Northeast. The method will be explained in the context of this empirical work, but is generalizable to a much wider range of energy projects and to a much broader geographic area.

The development of this approach involved three stages. In the first stage, the literature on socioeconomic impacts of large-scale facilities--e.g., coal, nuclear, water resources, defense--were reviewed to identify factors important for socioeconomic impact analysis. The next stage built on the results of this review to consider methods for classifying sites into surrogate categories. The final stage involved considering the problems of aggregating the case studies of surrogate sites to the regional level.

It should be noted that the primary spatial unit of analysis used throughout this work is the county, a unit selected because it is the least aggregated unit for which data typically are readily available given limited research resources. The choice of the spatial units of analysis should be considered carefully, however, early in any regional study. A more appropriate unit may be indicated for a specific study.

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[2] See Isard *et al.* (1975, 1976), Isard, Reiner, and Van Zele (1977a), and U.S. Nuclear Regulatory Commission (1976) for more detailed justification of this approach.

Factors Important to the Analysis

Impact analysis can be based on one of two approaches--one designated spatially confined, the other extensive. Using the spatially confined approach, the researcher selects an impact area at the outset based on an intuitive feeling for the area of expected significant impacts. Using the extensive approach, the researcher begins by pursuing certain causal chains with the intention of defining the impact area as a product of the research. In practice, of course, the two cannot be entirely separated; the question at hand, however, is the initial choice of an approach. On a spatially confined basis, for example, one may focus attention on a single county or community, a group of contiguous counties or smaller spatial units, or some other spatial entity such as a Standard Metropolitan Statistical Area (SMSA). On an extensive basis, encompassing a wide-ranging research outlook, one may be led to a much broader and perhaps discontinuous impact area. For example, turbines from Japan for a plant in New Jersey will result in socioeconomic impacts thousands of miles from the spatially confined impact area one might posit surrounding the plant site.

For two reasons, we chose the former approach, although it will perhaps be modified in the course of our research. First, our research on social-economic-political impacts of energy facilities development focused at the outset on a spatially confined area, the Northeastern U.S. Second, commencing research on the extensive basis is advisable only with significant research resources; our research resources are constrained.

The literature of social and economic impact assessment identifies three classes of factors which shape the eventual socioeconomic impacts of any large-scale development. The *local context* in which the facility is placed is described by various socioeconomic and demographic factors such as population, income, and so forth, for the more narrowly circumscribed spatial units such as community or a county. The *nonlocal context* is described by regional or national economic conditions or abilities to control local conditions. Finally, the *facility characteristics* are described by material and labor inputs, physical characteristics, ownership, etc. The following outline lists several important factors of each type identified in the literature.

I. Local context

  A. Socioeconomic

    1. Degree of urbanization (e.g., urban/rural ratio, density, population)

    2. Relative scale of capitalization

    3. Demographic characteristics (e.g., out-migration and in-migration)

    4. Economic base (size, composition, growth or decline)

- B. Political-institutional
  - 1. Tax structure
  - 2. Local public control (e.g., planning, environmental regulations, local land-use controls and other standards)
  - 3. Presence of interest groups (e.g., Sierra Club, Chamber of Commerce)
  - 4. Local values, attitudes
- C. Physical
  - 1. Resource endowment
  - 2. Water availability
  - 3. Land availability
  - 4. Microclimate
  - 5. Accessibility

II. Nonlocal context

- A. Economic
  - 1. Demand for power
  - 2. Economic climate (e.g., level of unemployment)
- B. Political-institutional
  - 1. Federal preemption
  - 2. Tax structure
  - 3. Subsidies and other economic development procedures
  - 4. Labor unions
  - 5. Accessibility, infrastructure
  - 6. Control (e.g., environmental, health, safety regulations, licensing)
  - 7. Proximity in time and space to other large developments

III. Facility characteristics

  A. Institutional

    1. Ownership (i.e., public or private)

    2. Degree to which development represents discontinuity (i.e., familiar vs. the unfamiliar)

  B. Physical

    1. Material inputs (quantity, type, sources, rates of flows)

    2. Labor inputs required

    3. Life cycle of facility

    4. Physical characteristics of plant (e.g., effluents, aesthetics)

    5. Colocation (i.e., economics of scale)

    6. Spatial pattern of all elements of development (e.g., off-site elements such as transportation or transmission links)

A prototype for impact analysis is depicted in Figure 1. While they are not included, there obviously are feedbacks. One type of feedback occurs between the classes of factors, as where the attribute of a facility is affected by the nonlocal context. Environmental standards, for example, determine characteristics of a power plant. Another type

FIGURE 1 A simple form of impact analysis.

of feedback--the meat of impact assessment--occurs as the facility shapes the local environment. For example, a malfunctioning facility sets in motion institutional development and consequent modification of pollution standards.

In Figure 1 one sees a predevelopment environment--comprised of the local and nonlocal contexts--which, together with the characteristics of the new facility, produce certain socioeconomic impacts and, in turn, certain sociopolitical impacts. There are, of course, other effects which may be the subjects of other studies, e.g., environmental impacts. These in turn may have direct and indirect socioeconomic impact as well.

Figure 1 possesses the structure of a linear regression model, called the implied causal model by Putman (1971). Conceptually, it is quite simple. A set of independent variables, call them X_1, X_2, X_3, and X_4, are viewed as the causes of some given dependent variable Y, as restated in Figure 2. Much impact analysis implicitly or explicitly reflects this approach. In this simple model, impact Y does not have a feedback effect on the X_i; further, the X_i are not dependent on each other within the context of the research.

A more sophisticated model would, of course, allow for such interactions. For the ultimate purposes of impact analysis, therefore, a significantly more complex conceptual model is necessary. Unfortunately, once stated, this model must be simplified considerably for operational application. Nonetheless, the statement of the more complex conceptualization is the appropriate starting point and the model itself the appropriate ideal. Like Figure 1, this model represents a linear regression, but it demonstrates the inherent interdependence among variables in the social, economic, and political systems being studied. Putman (1971) calls this the common (empirical) causal model; its structure is illustrated in Figure 3. Here one sees symmetrical relationships (i.e., two-ended arrows) as opposed to the asymmetrical linkages in the implied model. It suggests a very complex web of interdependence indeed, but one much more like reality than that of Figure 2.

A method for analyzing certain socioeconomic issues needs to be modest in scale and to produce meaningful results that preserve the spirit of

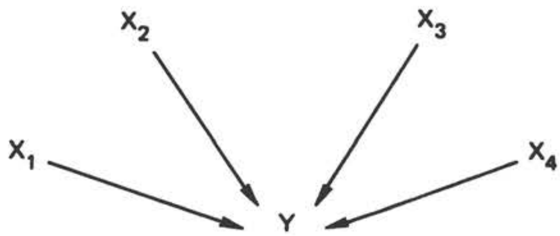

FIGURE 2 Abstract restatement of Figure 1: the implied causal model.

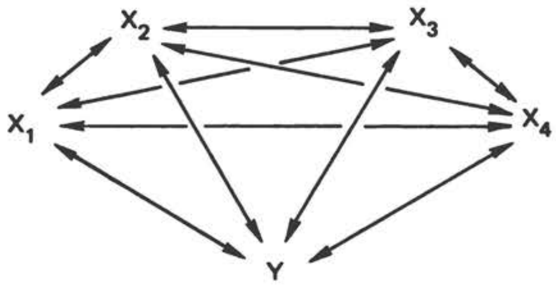

FIGURE 3 The common causal model.

the empirical causal model of Figure 3. For reasons explained earlier, the surrogate-site method has been judged appropriate for the aim. The questions addressed in the remainder of this section deal with the best methods for selecting the surrogate sites and for aggregating the results of prototype case studies to the regional level.

Classification of Sites and Generalization of Case Studies

Of the three possible bases for establishing a prototype approach--the facility characteristics, the nonlocal context, and the local context--the local context and, to a limited extent, the nonlocal context are best suited to our needs. A focus on facility characteristics, which is beyond the purview of this investigation, considers different *energy-production configurations* such as technology, site, mode of operation, ownership, and management of the power source. The second and third orientations, on the other hand, focus on the *environment* in which the facility is to be placed. Because the search for a prototype considers the *location* of the energy facility, local and nonlocal contexts will form the core of the present investigation and report.

The aim is to classify regions within which energy facilities are to be established and then to study the likely impacts of factors associated with the regions, so that a particular case or local impact study may provide quidelines for future facilities. This strategy is appropriate because of the many possible regions in which energy facilities are now located and may be located in the future. Facilities in similar regions would, it is believed, have similar impacts.

Variables used in prototype analysis must be considered in the selection process. Variables that define areas--which help distinguish one spatial unit from another in terms of some presumed significant attribute --constitute only one set of variable. A second set consists of variables that measure impact. Assessments done to date suggest that these two sets are neither equivalent nor completely disjoint. For example, distance from metropolitan area would appear only in the first list, but growth in population would appear in both. Fast-growing counties are indeed different from those with slow growth, *and* population growth might be an important consequence of the construction of a power plant. The level of environmental pollution might appropriately be included as an impact of the construction of a power plant, even though it would not likely be included in the information base for designating prototype counties.

There are two styles of establishing prototype environments. One is statistical, while the other relies on informed knowledge of the economic and social geography of the study regions. Statistical techniques have been developed and employed in the last two decades for grouping geographic areas into regions. Patterns are based on similarity of attributes in the units of analysis (e.g., income and demographic composition as the variables, county as the unit). One such technique, developed by B. J. L. Berry and his associates, applies one or another variant of factor analysis or principal-component analysis to the task.[4] A series of (*ex ante* reasonable) candidate variables are subjected to statistical manipulation that generates in turn a series of explanatory composite variables accounting for a major share of the variance. This method requires not only that some basic unit of analysis be adopted (e.g., census tract, county) but that a full set of data on the unit exists for each of the variables. Since many of the variable-by-variable pairwise correlations may be quite high, it is important to note the result is a sparing (e.g., three or four) variable statement of minimally redundant information.

In order to conduct such a factor analysis, rich data sources as well as the capacity to run the calculations must be available. When the scores on each of the counties are generated, there remains the task of selecting thresholds. Categories must be identified (e.g., the prototype is identified as one that is high on composite variable *a*, high on variable *b*, and high on variable *c*, compared with one that is low on all three composite variables). While this approach is useful, it requires a sizable research effort. Thus, the statistical method has not been included here, other than to cite several examples of such studies in the attached bibliography and to suggest that should sufficient research resources be available, this method may be preferred and should be considered further.

Instead, a cheaper and far simpler procedure for designation of prototype areas is described here.[5] The variables selected represent a careful evaluation of the many impact assessment studies, and are significantly related to impacts associated with facility construction and operation. The initial survey led to the selection of variables that allow one to distinguish some seven basic types of counties in the Northeast United States. Although certain of the categories may not apply to some regions, this list is generalizable to other regions for the most part. With

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[4] For example, see Berry (1972b) regarding the search for latent dimensions to be used in the classification of urban places.

[5] As resources are made available, it may prove to be useful to reconcile it with the statistical approach.

relatively little effort, each county in this large region can be classified or assigned to one or another of the seven groups, though there conceivably might be a few counties that, so to speak, fall between the cracks.

These seven types of counties--prototypes for the study of impacts of energy facilities--differ in terms of some half-dozen variables. Depending, of course, on the metric for each of these variables, there could be many hundreds of possible region types. No attempt has been made to standardize region types in terms of specific measures on the variables. Rather, after having designated the region types intuitively (though with a considerable familiarity with the structure of the Northeast on the part of the author and colleagues) the nature of the variable is noted.[6]

The following is a specification of the region types:

1. Core of large SMSA's
2. Suburbs of large SMSA's
3. Rim counties of large SMSA's (i.e., exurban counties)
4. Small urban counties with declining population
5. Small urban counties with growing population
6. Nonurban counties with extensive economic activity (e.g., agriculture and tourism)
7. Nonurban counties with poor economic prospects.

It is envisaged that these seven classifications will be mutually exclusive and collectively exhaustive over the counties of the Northeast region. The specific criteria by which each will be defined have yet to be developed, but generally these will involve population size and magnitude and structure of economic activity. An initial qualitative description of each category is presented in Table 1.

The 268 counties (including the District of Columbia as one county) of the Northeast will be classified according to the scheme depicted in Figure 4. Each county ultimately will be assigned to one category. Examples of counties in each category are:

Category	*County, State*
1	Erie, N.Y.
2	Bucks, Penn.
3	Salem, N.J.
4	Jefferson, N.Y.
5	Tompkins, N.Y.
6	Franklin, Vt.
7	Indiana, Penn.

[6] If each variable could take only one of two alternate states, there would be 2^n types of regions; clearly this is far in excess of the instances of plant location and would completely vitiate the intent of this exercise.

TABLE 1 Characteristics of Prototype Counties

	Prototype						
Attributes	1	2	3	4	5	6	7
Population							
Size	Large	Large	Small	Moderate	Moderate	Small	Small
Density	High	Moderate	Low	Moderate	Moderate	Low	Low
Dynamics	Declining	Stable	Growing	Declining	Growing	Growing	Declining
Access to national markets	Excellent but with localized congestion	Good to excellent	Limited	Poor to limited	Limited to good	Limited to good	Poor to limited
Tax problems	Many	Few but growing	Few	Many	Few	Few	Many
Economic base	Broad industry; declining	Light industry and services; stable	Minimal; growing	Manufacturing and raw material extracting; declining	Light industry and services; growing	Agriculture; tourism; growing	Minimal; declining
Availability of land	Generally high	Scarce	High	High	High	High but politically sensitive	High
Energy demand	Heavy	Heavy	Light; possible heavy point demand	Light; possible heavy point demand	Light	Light	Light

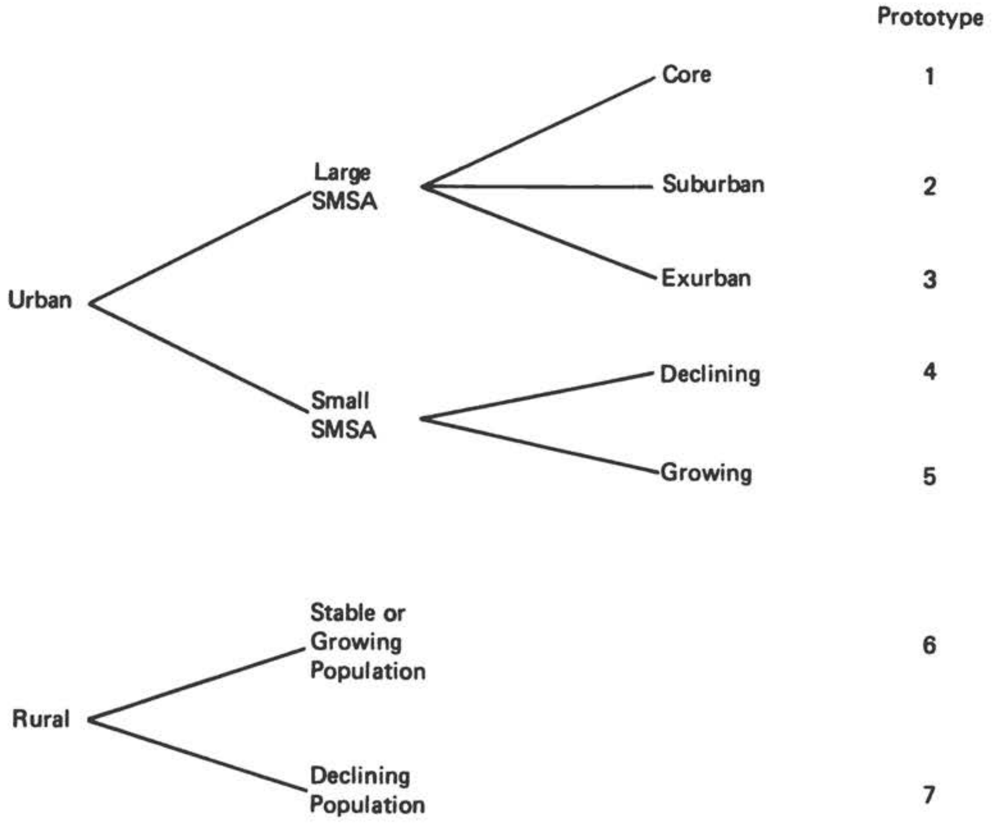

FIGURE 4 Classification of prototype counties.

One or more case studies for each category could be drawn upon to represent all sites in that category. Basically, this should be done in the manner of the study of the socioeconomic impacts of nuclear plants done by Isard *et al.* (1976). That is, the direct, indirect, and induced efforts of both material and labor inputs to the plant from within the region must be considered. Individual input-output studies as employed in this earlier study would be inappropriate due to the scale of this task, but the multiplier analysis described there and in Isard *et al.* (1975) and in Stenehjem and Metzger (1976) would be sufficient. Additionally, the method of the latter study for lagging the secondary impacts over time is suggested as a worthwhile refinement of earlier efforts. Where scenarios include several different types of energy facilities, it would be useful to include a separate case study for each.

Obviously, where good case studies already have been completed for locations corresponding to any of the prototype sites, new case studies need not be undertaken. For example, the study by Isard *et al.* (1976) is representative of a nuclear plant for sites in Category 3, the exurban counties of large SMSA's.

Such analysis yields, among other information, expected aggregate levels of economic activity (year by year), their breakdown by sector designation, overall and sector employment levels, and regional population. For each of these, a breakdown of direct, indirect, and induced impacts can be obtained. Information output specifies a) the bill of goods for the facility, b) anticipated in-migration and temporary labor force to work on its construction, and c) existing industrial structure to allow estimates of the local supply as distinct from imports.

Of what use are such projections? The following applciations are noted in brief:

- to aid in the assessment not only of the project's viability but also of the social benefits and costs
- to estimate increases in households and housing
- to estimate the base for social infrastructure and public services (e.g., schooling) needed as a result of increased population
- to estimate public revenues as a result of increased economic activity
- to tentatively indicate existing sectors capable of expanding to supply larger economic activity, and to identify sectors where new capacity could appropriately obviate the need for imports.

Aggregation to the Regional Level

Once the case studies for each of the prototype sites and for each type of energy facility are in hand, the individual results must be aggregated to reflect a best estimate of region-wide impacts. The first step in such an aggregation procedure might be to accumulate the set of time profiles of socioeconomic impacts on the prototype sites. An example of how this might be done is indicated in Isard *et al.* (1976), in which three prototype sites were used to assess the income and employment effects of six nuclear plants (i.e., 20 units) built within the Mid-Atlantic Area Council (MAAC)[3] region through the end of the century. Employing prototype analyses and the scenario of plant construction starts, an overall time profile of the impacts was constructed for each plant. These, in turn, were added on a year-by-year basis for all activity within the region to yield a region-wide impact profile. While this was adequate for that study of lesser scope, additional refinements are required here. Such a simple aggregation procedure ignores all externalities, those within a region as well as those between regions.

[3] One of nine Electric Reliability Council regions within the U.S. This area includes parts of Maryland and Pennsylvania and all of New Jersey and Delaware.

where only a few plants within a smaller region were considered, it was not unreasonable to omit consideration of such externalities. For the assessment of broader scenarios, however, externalities must be considered.

Following the completion of the simple aggregation procedure described above, some thought must be given to adjusting the results for cross-effects. For example, the number of new jobs within a region may not, in fact, be the sum of the new jobs indicated in the prototype studies, because of agglomeration effects; the relative positions in time and space of facility construction and operation should suggest where such effects are likely to obtain. For example, one plant relatively isolated in time and space may not attract other industry; a number of plants in close proximity, however, may serve as a type of growth pole.[7] Conversely, one plant in isolation may not create an environmental problem, whereas 12 plants in proximity may imply significant environmental deterioration, each of the 12 experiencing increased costs when standards are exceeded. When such sites are identified, judicious adjustment of multipliers should follow.

Another effect can be designated the domino-growth pole. The agglomeration of economic activities around a community's power plant complex may positively affect other relatively nearby growth poles. For example, a power plant complex in one community in upper New York State may in time lead to substantial economic growth in other upstate New York communities which previously experienced a shrinking economic base due to declining agriculture. It should be noted that it can be the psychological impact as well as the economic influence of a growth pole which can have a domino effect. If attitudes change from pessimism to optimism in the first community, similar changes in all communities may occur.

Likewise, cumulative migration effects may not necessarily equal the sum of the anticipated effects for individual prototype sites. For example, a single plant built in isolation might draw upon the unemployed in the given region, causing no significant in-migration. On the other hand, 12 plants in temporal and spatial proximity might lead to significant out-migration and in-migration. The converse is true for negative effects such as environmental deterioration and its impact on out-migration, where local populations and even firms might be sensitive to environmental quality.

A third area in which regional impacts may not equal the sum of impacts anticipated for individual isolated plants is that of local and state fiscal policy. That is, a single plant within a taxing jurisdiction in a state where local taxes go directly to the host community may provide a windfall to that community. A cluster of plants within such a community, on the other hand, may create an embarrassment of riches.

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[7] One conclusion from earlier studies (e.g., Isard *et al.* [1976]) was that nuclear power plants do not serve as growth poles to any appreciable extent. Such may not be the case for coal-fired plants, however, where centralization of transportation facilities, waste-processing facilities, and the like may be desirable.

The uneven distribution of fiscal benefits from development on such a scale may be so obvious as to cause a movement for tax reform.

Such adjustments of multipliers and coefficients should be made in light of intraregional and interregional externalities. Hypothetically, the six major regions within the United States are related in one way or another when one considers socioeconomic impacts of energy development; it often will be sufficient, however, to consider only those areas bordering the study region in any detail when making adjustments.

It has been stated above that input-output studies are not appropriate for individual case studies, given the aims of inexpensive and simple analysis, and further that the prototype site mentioned is preferred to a regional input-output study because of the potentially significant differences between sites within the region. It may be desirable, however, to aggregate individual cases for study using input-output should a number of plants be located in close spatial and temporal proximity and fall into the same classification. If this is done, it would be necessary to take out of the structural matrix households and all other sectors, particularly export and import sectors, that are sensitive to agglomeration. For example, shoe-repair service would not be sensitive, whereas research and development activities or high-quality, skilled, specialized, small firms might be very sensitive.

If a number of energy facilities are all constructed at about the same time within a state, it may be desirable to examine statewide impacts with the use of a state input-output study, especially when an input-output model for the state exists. Similarly, of an econometric model exists for a state, as it does for New York, that model may be used to estimate certain statewide impacts.

SOME PRELIMINARY RESEARCH FINDINGS

Of the factors important to regional impact analysis identified through the literature review, several merit slightly more detailed discussion here. Specifically, a few comments on the importance to impact analysis of site specificity, colocation of industry, centralization, and adequate treatment of the temporal dimension are offered here. These results have been derived primarily from study of the nuclear option.

Site Specificity

Perhaps the most useful general conclusion to be drawn from recent local and regional impact studies of nuclear power plants is that the nature and magnitude of these impacts are determined almost entirely by site-specific factors. On the local level, the magnitudes and distribution of impacts of any energy development will very much depend on three important variables--degree of urbanization, tax structure, and extent and type of land-use controls and other planning efforts. For certain nonnuclear technologies (e.g., coal), a fourth variable, the extent and type of environmental regulations such as air and water quality standards might be added to this list. To a lesser, but still not insignificant extent, other variables will shape local and, to some extent, regional impacts. These variables include the influence and character of the relevant labor unions, local geographic features, and ease of access to metropolitan labor pools.

These variables shape, and are shaped by, impacts at the local level both directly and indirectly. For example, the construction of a nuclear power plant in Plymouth, Mass., had the direct effect of lowering the tax rate substantially. This and other factors increased the pace at which the processes of suburbanization occurred. In-migration from nearby Boston increased significantly over a relatively short period of time. The accompanying increased demand for public services in turn created new needs for additional revenues. The tax rate now is increasing rather rapidly and the suggestion of some causal links might be made. A second nuclear plant has been proposed and the people of Plymouth have voted in favor of the plant by a four-to-one margin, driven primarily, some argue, by the need for revenues. A third and even a fourth plant are being discussed as realistic possibilities. Thus, the town is becoming heavily dependent on nuclear installations for revenues. If tax laws were revised, nuclear development stopped, or the existing plants closed due, say, to large-scale nuclear disaster, the town would face economic and social disruption from the heavy loss of revenues; therein lies one risk at the local level for the nuclear option.

These variables have broad ranges and thus impacts may differ substantially from one locality to another. Some communities anticipating unplanned growth have engaged in early planning efforts to mitigate the effects they view as undesirable, e.g., adopting zoning laws and sanitation codes to preclude large population growth. In some states, tax laws are such that local communities do not reap windfall taxes. In others, localities now do enjoy these revenues but the obvious regional inequities involved are spurring efforts for tax reforms. Even where tax laws or planning controls are formally similar, differences may result, such as when plants are taxed at the same rate but are appraised at widely varying values.

Where the local tax structure is such that these windfalls are permitted, contemporary urban problems may be exacerbated by the choice of nuclear and other centralized energy systems. The flight of energy facilities to the suburbs and beyond for technical, safety, economic, and other reasons have reduced urban tax bases already depleted by the demographic shifts of recent years.

At the broader metropolitan area or county level (e.g., the Philadelphia SMSA), these same variables shape impacts, although from a regional perspective they are less severe. In our study of regional socioeconomic impacts of nuclear power plants (Isard *et al.*, 1976), two counterpulls were noted. The logic of constructing nuclear power plants suggests some remoteness from population centers. However, both site considerations (especially the need for vast amounts of cooling water) and the desirability of being close to load centers tend to cause the planner to select sites at the edge of metropolitan labor markets. While the immediate vicinity of a power plant may experience, for example, little reduction in unemployment, the large metropolitan area experiences some benefits. However, when the regional economic impact of the construction of even a large project was compared to the level of economic activity of a metropolitan area, the resulting effect was found to be relatively small. On the other hand, were power plants to be built in a relatively remote area, the economic impact would be large in comparison with the level of economic activity in the region. But in such a case there is likely to be a fairly heavy infusion of outside workers and entrepreneurs, who are likely to be the primary beneficiaries.

At the level of the still broader region (e.g., the Northeast or the Rocky Mountain states), little work has been completed, although one approach has been suggested in this paper. Clearly the distributions of impact are quite different across this set of regions. A high-coal-usage scenario involves problems of supply and air quality for the Northeast while it implies problems of boomtowns and land mangement for coal-producing regions with low population densities. It follows that site-specific studies are required, in that impacts at this level must involve the cumulative totals of impacts at the lower levels of this geographical hierarchy. A basic research question here, of course, involves the further consideration of how to do appropriate regional analysis.

Colocation

Often the major local and regional impacts associated with industrial development are not those directly related to the initial perturbation of an area's economic and social structure. Instead, the direct impacts can be magnified many times by attracting to the location of the original development many other firms or industries hoping to take advantage of the new activity. Thus, as one studies impacts of development, one must consider the aggregate response of the system as well as the set of first-round impacts and responses.

In a study of nuclear power plant operations and construction and in a brief look at other elements of the nuclear fuel cycle, the author and colleagues found two conclusions of interest (Isard *et al.*, 1976; University of Pennsylvania, 1975). First, little colocation of industry occurs. There are no direct economic incentives for locating near a power generating plant, i.e., no incentives of the type one might find, in an industry drawn to the vicinity of a steel mill, where spatial proximity would mean substantial savings for a heavy user of steel. What incentives exist are related to the local tax structure, as mentioned above, and to characteristics of the site which would be attractive to other industries whether or not a power plant is located nearby. In addition, the spawning of service activities as reflected through the derivation of economic multipliers by the use of an interindustry (input-output) model is not noticeably different than that for other capital-intensive heavy industries. This seems to suggest that sociopolitical responses to socioeconomic change would not be dissimilar to those accompanying other comparably sized industrial developments. Initially, the reasons for these conclusions seem generalizable to other technologies, but additional study is required to make any stronger statements.

Centralization

The degree of centralization is one measure by which alternative energy systems may be described. The previous studies referred to herein have been concerned for the most part with energy systems toward one end of this continuum, i.e., the highly centralized nuclear option. A special case of the nuclear option which exhibits an even higher degree of centralization than that of existing facilities is the Nuclear Energy Center containing many reactors, a concept studied extensively by the Nuclear Regulatory Commission. In addition to the local and regional impacts of the typical nuclear plant discussed above, two additional points are relevant if one wishes to consider this extreme of the centralization-decentralization continuum.

The first of these is an extension of the points mentioned above regarding taxes. Unlike the case for smaller single- or double-unit plants, the existing tax laws permitting windfall revenues for small communities with power plants would not be allowed to stand should energy centers be built. One very practical reason for this is that such centers might encompass entire taxing jurisdictions within their exclusionary zone. Thus, these legal and political entities would disappear. Further, the inequities in the distribution of the tax revenues would be so apparent and so great that a rewriting of the tax laws would be forced.

A second point concerns federal preemption. The feasibility of acquiring a site for an energy center via this approach has not yet been tested. The Nuclear Regulatory Commission's study of energy centers concluded that there are neither significant advantages or disadvantages to the nuclear power park concept at this time (U.S. Nuclear Regulatory Commission, 1976). Thus the issue of preemption has not been examined closely. This does not mean that the issue is dead. When a national energy policy has been formulated, the concept of energy centers (both nuclear and nonnuclear) may again emerge for consideration. If this happens, and given the local opposition to energy park siting, the ability of the federal government to preempt the use of federal lands for power generation may then be tested. Obviously, the implications of this issue for local and regional impact assessment are significant.

The Temporal Dimension of Impact Assessment

Even using the shortest of the short-run scenarios for the many serious studies of alternative energy futures, it is clear that simple static analyses of comparative impacts are grossly insufficient. Energy problems, like problems of environmental management, will never be "solved" for a certain point in time. Rather, one should conceive of these problems in their dynamic context; that they are ongoing problems or issues to be managed recursively. Learning processes and demonstration effects are key elements to be considered in the study of local and regional impacts and responses.

It is clear that the general conclusion regarding spatial specificity has a temporal analog. That is, the social, economic, and political impacts and responses one may anticipate for a particular energy facility may vary considerably over its life cycle from the early planning stages to its final decommissioning. Accordingly, impacts should be studied as time profiles.

As an example of how impacts vary with time, consider the case of nuclear generating plants. Planning activities within the energy sector have had significant sociopolitical impacts on society at large, impacts qualitatively different from those following from the socioeconomic impacts of facility construction and operation discussed above. To wit, consider the role of local and regional planning in nuclear plant siting. The Nuclear Regulatory Commission historically has ignored impacts that occur beyond plant boundaries. Communities have been very unsophisticated in their attempts to confront proposed projects. The planning vacuum, therefore, has been filled by developers and others in the private sector. This situation now is changing. One of the major impacts of nuclear plant construction has been the generation of public planning and other such activities. The negative aspects of allowing the planning role to fall to developers have forced more public involvement. This in turn has had two opposite effects. Local planning pulls together many diverse factions while at the same time exacerbating long-standing differences. Nuclear plant siting thus has had the effect of creating local conflicts. The scale of nuclear facilities and certain siting requirements seems to make such conflict more likely here than in the cases of less centralized energy technologies. Indeed this is a proposition one could test.

An auxiliary issue which might be addressed questions the desirability of such conflicts. Confrontation may be undesirable in some cases, but in others may indicate a process of creative conflict. For example, existing inequities in a system of property taxation may be magnified through the siting of substantial taxable properties in a small taxing jurisdiction, prompting the amelioration of these previously unattended inequities.

A closely related issue is that of dissociation of cost and benefit streams, which exists in both spatial and temporal contexts. It involves the problems of multiple publics as well as that of intertemporal comparability for the same public. Studies by the author and colleagues suggest that the more disaggregated one's level of analysis becomes, the more clearly one sees an imbalance between costs and benefits in the broader social-utility calculus, particularly as centralization of energy facilities increases (Isard, Reiner, and Van Zele, 1977a,b). Of course, this is yet one more area where detailed study is required.

Finally, it seems reasonable to suggest that as differences between time profiles of alternative energy system impacts increase, the greater will be the emphasis on value differences. The choices to be made will evoke moral rather than technical arguments. While the specific sociopolitical implications of this change are difficult to predict, it seems reasonable to suggest that they may be important. It has been well established that tradeoffs and compromise solutions to conflicts are very difficult to effect when the dispute is of a moral nature.

CONCLUSIONS

Several propositions and observations are offered regarding regional energy development impacts and risks, and some research needs and directions are suggested.

Propositions and Observations

1. Regionalization of impact assessment is an absolute necessity. Current impact assessment efforts, while increasingly more sophisticated methodologically, typically are project-oriented and consider only local impacts of individual facilities. Little research at the regional or program level has been conducted. This paper offers one approach to regionalization, that of surrogate site analysis.

2. Regional impacts of energy development are to a large extent site-specific. Several important region- and locality-specific variables tend to shape the magnitudes and distribution of impacts: degree of urbanization, tax structure, extent of planning efforts, and institutional constraints (e.g., environmental regulations).

3. Regional economic impacts (e.g., employment and income) of even large-scale energy projects are relatively small when compared to the overall level of economic activity in a large metropolitan region. In remote, less densely settled areas, the economic impacts are relatively large and newcomers to the area typically are the primary beneficiaries.

4. The scale of the individual projects comprising any energy development scenario will do much to shape both impact and response at the regional level. Sufficiently large capital investments concentrated within a small geographical area (taking a Nuclear Energy Center of many reactors as one extreme case) may necessitate regional and national institutional changes of several types.

    a. Tax revenue-sharing between subregional units (e.g., municipalities) may become imperative in the face of large windfalls to small subregional jurisdictions.

    b. Intraregional imbalances in the spatial and temporal distributions of energy development costs and benefits and the higher level of externalities and social costs may stimulate the creation or expansion of effective regional institutions, such as regional planning bodies.

    c. Large capital demands for projects may result in interregional transfers of some important financial benefits of plant investment, e.g., interest payments may flow out of a region to the national money markets.

d. The larger the scale of energy development projects, the greater the need for federal, regional, and state involvement. Though these more active roles will present opportunities as well as problems, federal preemption will see the federal role in conflict with those of state and regional units.

5. The power-generation elements of the nuclear fuel cycle (and perhaps those of the nonnuclear as well) provide few incentives for industry to locate near nuclear facilities, and thus provide few stimuli for regional growth through direct agglomeration economies. Increased economic activity near a power plant typically is a function of the comparative advantages (e.g., tax rates) of the subregional jurisdiction but is not relative to other regions. That is, growth is redistributed within the region, not increased.

6. The higher the level of skills demanded for facility construction and the more centralized the spatial patterns of energy facilities (particularly in rural areas), the more likely it is, given the present institutional arrangements, that a well-paid itinerant labor force of highly skilled workers will develop. Evidence from the nuclear case suggests certain social problems at the local and regional level would be associated with such migration patterns.

7. The need for severe quality control regulations for materials in nuclear facilities reduces the number of potential suppliers, thus concentrating the benefits in certain regions; i.e., an oligopolistic or monopolistic situation involving interregional transfers is created.

Some Research Needs and Directions

The research needs of regional analysis of energy systems greatly outnumber the field's substantive results. First, the comparability of economic and noneconomic attributes of alternative systems must be considered in some depth, not only in the mission-oriented context of specific policy studies but also at a basic research level. Tradeoffs between market and nonmarket commodities ought to be made explicit insofar as possible, but there is a dearth of scientific research into the means for such tradeoff analysis; such analysis would be possible only after the dimensionality of noneconomic commodities is established. To increase the extent to which research results can be transferred from one context to another, both causal phenomena and impacts and responses ought to be classified. The site-specific nature of impacts and responses does not mean that meaningful classes of sites and impacts cannot be developed.

Related to this need for synthesis is the need for methodological integration. Each social science discipline now possesses some expertise in impact assessment. Too often, however, the truly multidisciplinary analysis required for the effective survey of impacts of and responses to technological change is foregone in favor of the narrower perspectives of individual disciplines. When one discusses the impacts of alternative energy systems, one sees many broad social implications which cannot be compartmentalized conveniently as social, economic, political, or environmental but which, nonetheless, are significant.

Finally, it should be noted that the study of impacts and responses tends to take on a negative tone almost from the outset; impact assessment typically identifies only undesirable effects. Though this is a very important task, particularly where these effects can be avoided or mitigated as a result, it is not the total task. Local and regional benefits as well as liabilities can be associated with energy development. The identification of opportunities as well as pitfalls for communities and regions, therefore, is an important research task.

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II.

INSTITUTIONAL AND POLITICAL IMPACTS

ENERGY RESTRICTION, CONSUMPTION, AND SOCIAL STRATIFICATION

by

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PREFACE

This essay was originally published in slightly different form under the title Restrizioni energetiche, consumi e stratificazione sociale, in La Ricerca Sociale (Autumn 1975).

INTRODUCTION

One cannot talk about the impact of the energy crisis on social stratification without understanding its impact on the whole of society in which the stratification system is embedded. If we did not heretofore believe it, the contemporary energy crisis certainly teaches us that society is a system of interrelated parts. The crisis does not affect these parts in isolation; it touches all of them and sets off the most complicated series of ramifications throughout society. So, in light of the complexity of the subject, I am going to touch on different aspects of energy restriction, returning from time to time to issues of stratification and consumption.

It would be a mistake to focus attention too narrowly on energy. Energy is a particularly vivid symbol, and, partly because it is so visible, it has in recent years become the most discussed aspect of humanity's relation to nature. But the issue before us is larger. It concerns the limitations of the physical substructure of human existence and involves our relation to resources other than energy--resources such as mercury, copper, steel, and other materials which themselves promise to become focuses of crises in a matter of time. It also concerns humanity's relation to food, which is already a matter of crisis which promises to intensify in the future. So while we may use the word "energy" for shorthand, it is important to realize that we are, in fact, considering a broader range of problems.

Myths of The Energy Crisis

I shall attempt to avoid three oversimplified, perhaps even magical, diagnoses of the problem of energy constriction:

(1) *The diagnosis that converts a short-term trend into a long-term prophecy of gloom.* Certainly, it is important to distinguish between the short-term and the long-term features of energy constriction. What in the short run may be higher prices and shortages of oil may in the long run turn into the search to replace petroleum as a source of energy altogether. What are inconveniences in the short run may become disasters in the long run. It is important, however, to avoid simple-minded predictions on the basis of a few current trends. Robert Heilbroner, for example, has noted that the energy needs of the world are expected to double every 10 years into the indefinite future. If that is the case, the earth's atmosphere in 200 years will be 50° Centigrade, which of course would make conditions impossible for human existence as we know it. But such a prediction holds only if everything else is equal. As we know, everything is not equal in the long run, and different adaptations and courses of action must also be envisioned.

(2) *The diagnosis that resolves the energy crisis by assuming it will be overcome by technology*, particularly by the discovery or application of new sources of energy or by the discovery of new means to synthesize resources. Technology is not irrelevant to the severity of the crisis

in energy supply; indeed, it is one of the major variables to be taken into account. But the current crisis of energy and other resources cannot be regarded simply as a short-term hardship that will disappear when the right technological formulae become available.

(3) *The diagnosis that regards the energy crisis as the result of conspiratorial manipulations by powerful economic and political interests.* The policies of large multinational corporations and national governments no doubt contribute to the severity of supply constrictions. In addition, once a crisis in supply is at hand, various economic and political groups attempt to capitalize on it and maximize their self-interest. Yet it is a gross oversimplification to regard the present crisis as a by-product of international rigging and to ignore the fact that a long-term crisis in man's relation to his natural resources is at hand.

THE CULTURAL ASPECT

Perhaps the most fundamental impact of the specter of the exhaustion of energy and resources is a cultural one. Such a specter, more than any other feature of modern civilization, causes us to question a wide range of cultural values which have become almost second nature to us in the past several centuries. These values, deriving originally from what has come to be known as the "Protestant Ethic" but now having spread worldwide, include the following:

-- *Freedom* to exploit the natural environment.
-- *Hard work* for its own sake.
-- *Mastery*, *achievement*, and *personal ambition* as desirable human qualities.
-- The use of *rationality*, especially scientific rationality, in the organization of economic and social life.

It seems that the headlong and mindless worship of these principles constitutes a large part of the reason we now face some of our environmental imbalances and crises. Adherence to these concepts has contributed directly to the exploitation and, ultimately, to the exhaustion of the environment. It is one of the ironies of modern history that after centuries of struggle and precisely at the moment of their apparent victory, these values have proved to be archaic and outmoded, even burdensome and dysfunctional.

The immediate impact of a dramatic event such as a widespread energy crisis is to create a sort of cultural confusion, a cultural vacuum. We become haunted by many questions: What have we been living for? What is of worth if these values are not? Where are we to turn if we cannot turn to these guideposts? At the same time, we are such victims of the goal of rationalistic mastery of the universe that we find it difficult to think of solutions in other terms. Yet these values, we are made increasingly aware, are not the appropriate ones in our current situation; to apply them blindly would be simply to worsen the situation we have created for ourselves.

I am not saying that there is not a technological aspect to meeting the crises of energy and resource restriction; I shall turn to this momentarily. But I would suggest that the worship of the system of values that gives technology such a central role is inappropriate for the future, and that greater emphasis will be given to more humanistic values that have fallen by the wayside as science and technology have conquered the world. And is it not natural for values to drift or even to race in the humanistic direction? I mean here "natural" in the sense that a shift in values is evidently the adaptive thing to do when the ideals that have helped humanity survive reach their limits of usefulness.

Impact on Stratification

This cultural aspect immediately touches the issue of stratification. Students of stratification have long noted that systems of social ranking depend in the first instance on the *differential valuation* of certain types of activities over others. The possession of magical powers, the possession of knowledge, the ability to wage war, and so on--each of these may be ranked in different ways by different societies. It is also a rough axiom of these students that societies tend to reward the activities they value most highly, and that the result is a differential distribution of rewards--a stratification system. Now, in the modern history of the West, those agents who best manifest the cultural values of the rationalistic mastery of the world have been permitted to reap the greatest rewards; I refer, of course, to the commercial, industrial, and professional classes. By the same token, there has been a relative downgrading of traditional military, religious, and aesthetic activities, and the roles associated with them. The question now posed to us in sharp form is this: do we wish to esteem those kinds of activities--the rationalistic mastery and exploitation of the material world--as those most to be rewarded when, in fact, they appear to be becoming less valuable for mankind?

The value changes implied in that question are usually slow in developing and cannot be legislated into effect. At the same time, governments can influence the rewards that fall to different classes of people and can thereby influence stratification and cultural systems. But before entertaining any grand predictions of a system of centrally administered rewards different from that which now exists, perhaps we should observe what is likely to happen to material goods--especially wealth--as the energy crisis makes itself more severely felt in the long run. Of course, this leads immediately to the economic aspect of energy and resource constriction.

THE ECONOMIC ASPECT

One of the economic principles that we have come to assume as more or less universally true is that unemployment and inflation are negatively related to one another; this principle is the heritage of Keynesian economics. If a society experiences a high unemployment rate, the tendency will be for prices to be depressed; but in a state of full employment, demand will be high, with pressure on exsiting resources and a tendency towards inflation of prices and wages. Furthermore, in the period after World War II, most governments of the industrialized countries committed themselves to policies of economic growth, high employment, and moderate inflation--policies which have generally satisfied the major economic classes, with most of the struggles occurring over what share of the expanding pie each class is going to receive.

The energy crisis--and here I again include food and natural resources as well--has exploded the Keynesian principle relating unemployment and inflation; it promises to create in the short and long term both high unemployment *and* serious inflation, based on the higher costs and shortages of the basic materials necessary for production. What is the impact of this new situation?

Regressive Impact

First, it is instructive to review which groups tend to suffer under these circumstances: *inflation* typically hurts those groups whose income is based on fixed rates of pay, changes in which are usually difficult to achieve, and which lag behind the general wage and price structure. These groups include retired persons, welfare recipients, students on scholarships, those living off savings yielding fixed rates of interest, and so on. These are the groups--along with salaried groups generally--that are usually the most visible victims of inflation. Those groups that have strong bargaining power, such as some trade unions, also suffer, because in general wages tend to lag behind prices in the current situation; but insofar as they have bargaining power they can make up the loss more quickly than other wage sectors. Under conditions of energy shortage, *unemployment* strikes a different pattern of blows. It tends to hit industries that are especially dependent upon energy, such as automobiles, perhaps steel, and business and recreation travel.

Whatever the precise pattern of unemployment and inflation, however, we may generally expect that the effect of both on the structure of income is likely to be regressive, with unemployment and inflation taking a greater toll on the lower economic groups in the society. We have seen some evidence of this already, and there is reason to believe that this regressive effect will continue unless public policy is directed toward correcting it.

Shift in Allocation

Another kind of serious dislocation should be mentioned. Worsening cost conditions for basic industries that are dependent upon energy signal, in effect, a decrease in productivity--that is, an increase in cost relative to output--in these industries and a decreasing amount of economic surplus that can be devoted to other kinds of industry and activity not "economically productive" in that immediate sense. Under conditions of energy and resource constriction, therefore, we should expect a relative squeeze on the latter kind of industry and activity. If we were optimistic, we would predict that societies would begin to dedicate less of their surplus to the fantastically wasteful and unproductive military sector. I think this will not be the case, however, and that the pressure will be to cut back on education, medicine, welfare, and other social services we have come to value as integral parts of social-democratic systems. The productivity of modern nations has permitted them to devote their surpluses to gigantic military arsenals and massive welfare establishments. The crisis of energy and resources calls into question the ability of industrial nations to continue these economic "luxuries."

In the longer run, of course, we must expect a certain amount of adaptiveness and inventiveness in the economic sphere. We already see the beginnings of efforts to step up the exploitation of new reserves of oil; we see an increased interest in rejuvenating the coal industry in the United States--whose reserves, it is said, could supply the country's energy needs for three centuries; we see an interest in the exploitation of shale oil, more difficult to extract but plentiful in supply; we see an interest in Europe in accelerating the construction of nuclear power installations; we see efforts to render economically feasible systems of exploiting the internal heat of the earth and of the sun's rays; and we shall no doubt see the acceleration of scientists' efforts to unleash fantastic amounts of energy through processes such as the fusion of hydrogen.

The economic effects of such adaptations are familiar. New industries arise, old ones are outmoded; unemployment of workers with obsolete skills, new training, labor mobility, and new occupational specializations result. We have seen the pattern as oil displaced coal as the most economical source of energy; we shall see it again as other resources displace oil. It is the pattern of industrial advance. Yet, while not forgetting the potential for economic adaptiveness, we should always remember that in the forseeable future humanity will always be pressing against *one limit or another*--if it is not oil, it may be some metal in short supply and difficult to substitute for or synthesize; or it may be certain classes of foodstuffs. It is very difficult not to envision the future as a constant series of crises and diversions of resources to overcome these crises.

SOME SOCIOLOGICAL RAMIFICATIONS

International Effects

One of the most vivid consequences of the constraints on energy and resources is seen in the pattern of international stratification. Earlier I observed that the likely economic impact of the energy crisis on the industrial nations would be regressive in terms of the distribution of income. Is a similar pattern to be observed on the international scene?

We must note first that, with respect to international stratification, the world has inherited from its colonial past a system of international specialization in which the less developed countries of the world supply the industrialized countries with various kinds of raw materials; the industrialized countries consume these materials directly or channel them into the industrial process, and often export the end products to the less developed countries. The less developed countries have been struggling to break this pattern and industrialize themselves, but with few exceptions the patterns of international specialization and stratification have remained very stable.

On the face of it, shortages of material resources--energy and otherwise--should initially favor the producers of primary products. The great advantage reaped by the Middle Eastern oil-producing countries from the increases in oil prices, and the boom to the Argentine meat industry from the worldwide increase in meat and grain prices, are examples of this. There is some evidence, however, that the advantage may be the other way around. The less developed countries depend on primary products as well, and are less able to sustain shortages and severe price increases; the economies of India and the African countries are cases in point. As for the industrialized countries, their increased costs for materials and sources of energy are passed on not only in higher prices for domestically produced goods but also in higher prices for exports to the less developed countries. In general, the economies of the less developed countries are more fragile than those of the industrialized countries and it is likely that, despite some exceptions like the thinly populated oil-producing nations, the pattern of economic dependency of the less developed on the more developed nations will become more pronounced than it already is. Nor are analogs to the oil embargo (totally withholding a product badly needed by the industrialized countries) likely to be generalizable as weapons by which the less developed countries can improve their positions. Most of them are too dependent economically on the export of such primary products to be able to afford this strategy for long. Even the wealthy oil-producing countries could not hope to rely on the embargo as a political weapon for a very long period of time.

Let us return now to the domestic scene, and consider some of the sociological implications of the changed pattern of consumption resulting from a crisis in energy and resources.

Devaluation of Symbols

One characteristic feature of stratification systems in societies is that various kinds of visible signs come to *symbolize* a person's position in the stratification system--styles of dress, evidence of education or cultivation, location of residence, possession of art objects, location of summer residence, and so on. It is also clear that in modern history much of the symbolization of class position is closely tied to material items linked to energy: to own a car; to own two cars; to own two sports cars; to own a boat; to own a plane; to maintain two residences between which one travels frequently for weekends or vacations.

Such status symbolization is threatened both by outright shortages and by the increasing costs of these items in relation to others. Automobiles and other forms of travel are going to demand a greater proportion of the family income than before, and a certain proportion of families will be forced to cut back. Once again history is playing tricks on those who made it. Having taught our citizens that the signs of status are luxury and mobility, we now learn that these signs of our worth are increasingly unavailable to us. Under such circumstances people begin not only to feel the pressure to modify their life-styles, but also to question the value of symbols that were once taken for granted. The press reported that the Sundays without automobiles in many European countries during the depths of the 1974 fuel crisis constituted less of a hardship than was initially anticipated. Part of this may be due to the kind of collective pleasure that people experience when they face a crisis together. But in addition, people discovered that they were engaging in activities that were intrinsically enjoyable to them--visiting, talking, walking with the family, and so on. Such experiences sooner or later raise the question in people's minds whether the best thing to do on Sunday or any other day is to race about the countryside in an automobile. In this way the *standards* of symbolization of life-style also begin to be brought into question.

Restraint on Social Mobility

The changing patterns of consumption under conditions of resource constriction also have implications for social justice. First, as we noted earlier, in periods of unemployment the unskilled, marginal laboring groups experience the highest rates of unemployment--witness the examples of the American minorities, especially blacks, and the migrant workers in various European countries. Moreover, with the diminution of growth and productivity rates, previously disadvantaged groups find it increasingly difficult to gain parity. It is easier to realize equality of opportunity when a system is growing and new positions are being created. In their research on patterns of social mobility in recent American history, sociologists Otis Dudley Duncan and Peter Blau found that much upward mobility is accounted for by the creation of new occupational positions in the process of relatively steady economic advance. It follows that should the growth rate of the economy slow, the effect on rates of social mobility would be adverse.

An example from the recent history of higher education in America will suffice. Late in the 1960's, as part of the political turmoil in American society, various minority groups (blacks and Mexican-Americans, for example) and women became more politically conscious of the long pattern of exclusion from faculty positions in institutions of higher education. Out of this increased consciousness developed increased political pressure on institutions of higher learning to recruit from among these groups. But precisely at the moment when the promise of access was increasing, the growth rate of institutions of higher education slowed and in some instances stopped, leaving few positions open for candidates of any sort, and, of course, leaving the pattern of disadvantage intact.

One discovers once again the *regressive* effects associated with a slowing of the rate of economic growth. Unless active efforts--usually by national governments--are made to counter such effects, these changes in patterns of consumption--particularly the relative decline in consumption by different groups--are likely to generate serious social discontent and conflict. Citizens will endure hardships in the name of a crisis for a certain time, but this adaptation cannot be counted on in the long run. People eventually come to feel threatened, deprived, and cheated; they begin to demand things of the society; every social group begins to feel that it is carrying too much of the sacrifice. Furthermore, the *pattern* of social conflict under conditions of restriction is different from that under conditions of growth. With growth, the pattern of conflict typically found is associated with rising expectations; it is a kind of manic, aggressive struggle to reap a larger section of the social and economic pie, combined with a sense of expansiveness and limitlessness that gives conflict a somewhat uncontrolled character. Under conditions of static or falling expectations, however, the style of conflict typically differs. People become defensive and security-minded; groups grasp what they have and resist the intrusions of others, and this gives conflict a bitter, closed character.

SOME SOCIAL-PSYCHOLOGICAL ASPECTS

We cannot discuss the problem of shortages, particularly of energy and food, without commenting on some of the psychological consequences that invariably appear. Energy is, above all else, power; and the symbolism of many energy-consuming devices that make up the pattern of modern consumption is that of power, or potency, often with sexual overtones. The automobile is certainly laden with that sort of symbolism. Moreover, when a shortage of energy or power threatens, the initial psychological impact is to create a feeling of powerlessness, of helplessness, of anxiety, of death--as though that which has been sustaining us is being exhausted. I need not press the point that the prospect of everything running out can excite the strongest and most primitive psychological fantasies of desertion and destruction. Insofar as the same sense of the withering away of the world's food supply develops, similar primitive fantasies of starvation and death are excited. It would be difficult to imagine a stronger combination than a threat to both food and power to arouse infantile anxieties and fantasies.

The Conditions of Panic

Add to this the observation that the prospect of increasing shortages of things we value replicates the classic sociological conditions that are conducive to a panic response. Those conditions include a threat, to be sure; but even more, they include a condition in which escape or access is neither completely open nor closed, *but closing and threatening* *to close entirely.* Panics do not occur when the impact of threat is certain and escape impossible; they occur when the impact of the threat is uncertain and escape may be possible. The latter are precisely the set of conditions generated by the prospect of world shortages of energy and food. And, of course, the fact that access is closing but not closed triggers the panic--the rush forward toward access before others get there or before the supply is exhausted.

Some behavior of individuals and nations in the energy crisis is understandable as a manifestation of the classic panic response to such a situation. Consider the behavior of American car drivers when shortages of deliveries to gas stations began to develop. Part of the congestion and long lines was created by what was called "topping off," or buying only a few gallons of gasoline while the tank was still three-quarters full--to get a little gas so that one would be able to survive a little while longer as a motorist. There was some evidence of a possible panic response on the part of some national governments as well. The rush on the part of some individual nations to guarantee for themselves a supply of oil for a long period had an ingredient of this. The behavior of the American government had an element of panic as well--immediately opening offshore drilling; immediately beginning the Alaska pipeline, which had long been delayed by conservation groups; immediately letting preliminary contracts for the development of shale oil; and the President's call for self-sufficiency in energy by 1980. All these responses had an element of rationality, to be sure, but they also had the component of getting your share before it runs out. The panic mentality, moreover, placed a greater premium on *getting* rather than *conserving*. It is true that rationing is a politically unpopular thing to do and is feared by most politicians. But it is also not the sort of thing that occurs to people in a panic-stricken frame of mind. In that frame of mind it is not to guard and save what one has, but to get what one can of what is left.

Intensified Environmental and Social Pressure

These particular responses, which I have identified at least in part as panic responses, have a number of consequences that deserve mentioning. One is that they actually aggravate the initial situation that gave rise to the panic response. The drive to exploit Alaskan oil, the search for new reserves, the plunge into the North Sea, the effort to bring Middle Eastern production back to a higher level--all these responses were, in fact, moves to utilize the available reserves faster, thus aggravating the threatened shortage even more. This is a typical consequence of the hoarding phenomenon, whether it be hoarding of gold, food, or fuel.

In addition, the emphasis on *getting* rather than *conserving*--at least a balance in favor of the former--has the effect of setting back a number of serious efforts to protect the environment. American offshore drilling was halted because of environmental considerations; so was the Alaska pipeline; one of the known drawbacks of shale-oil mining is pollution from waste materials. All these considerations were set aside in the interest of exploiting reserves during the energy crisis. In addition, the decision to postpone the "clean air" requirements for automobile manufacturers was prompted by the consideration that automobiles equipped with clean-air devices are less efficient and consume more fuel.

Finally, the emphasis on getting rather than rationing has its costs, in terms of social justice. In effect many nations made the judgment that they would, at least in part, ration by price rather than by administered quotas of fuel for consumers. To ration by price, however, discriminates against the poor. Even a 200 percent or 300 percent increase in gas prices does not make a significant difference for the very wealthy consumer, whereas for lower income groups it is a decisive increase that threatens to alter consumption habits drastically. Rationing is a more egalitarian device, even though it, too, can be subverted by the development of black markets, which signify the re-introduction of rationing by price and a corresponding advantage for the wealthy.

THE POLITICAL ASPECT

I noted earlier that governments are reluctant to impose full-scale rationing of fuels because of the political unpopularity of such a decision, particularly in democracies where this unpopularity can make itself felt in the form of voting politicians out of office. I might speculate further and suggest that the economic and social changes I see arising from resource constrictions pose a severe test for individualistic democracy as a political and legal system. This test, moreover, promises to have two facets.

Testing Political Rights

The first concerns the volume of conflict that societies are going to be called upon to accommodate. If what I have said about the impact of declining expectations is correct, there will be few groups and classes who will not be discontented and who will not express that discontent in the form of demands on the political channels. And if what I have said about the regressive effects of an energy crisis is correct, we should expect the accumulation of an overload of relative deprivation, experienced especially by those at the lower end of the stratification system.

Now, two conditions of stable democracy are that its internal conflicts take place within a framework of general consensus about the legitimacy of the system of government, and that the level of conflict not rise above that which the mediating political processes can sustain. If either of these conditions fails to be met, the political system itself is endangered, and there arises an increased temptation on the part of political authorities to rely on methods more repressive than the arts of mediation and compromise to deal with internal conflict. To say this is by no means to predict that heretofore democratic societies will move in a totalitarian direction; democratic institutions have their own kind of resiliency. But they will be tempted to move in that direction, mainly because they will be confronted with conflict of a magnitude and bitterness that will contrast with the relative political quiescence of various social groups during the past quarter-century.

Testing Property Rights

The second facet concerns a probable threat to institutions associated with the system of private property--institutions that permit individuals great freedom in acquiring, using, and disposing of economically valuable resources and commodities. These institutions do not require plenty; they operate, like all of human life, in the realm of scarcity, since most resources have never been free. But when scarcity turns to shortage --that is to say, when the unavailability of a resource becomes a matter that affects the functioning of society as a *whole*, then the society's interest in that resource necessarily becomes a *collective* interest. Certainly that has been the case with various fuels; they have invariably become the subject of national regulation. Indeed, logic would dictate the need for the collective interest in such resources to extend to the international level. Once again, in observing this, I venture no predictions as to the exact form that the collectivization of interest in resources will take. Many options are available--nationalization, international coordination, regulation of various sorts, and reliance on market mechanisms. But I am suggesting that the increasing role of government that accompanied the expansion and increasing complexity of the industrial democracies will continue in the same direction as these democracies suffer from shortages of resources and slowing rates of growth.

A CONCLUDING REMARK--POPULATION

I have refrained from mentioning population as a part of the crisis of energy and other resources, but it must be at least mentioned in closing, because it is one of the three great variables that must be taken into account in discussing humanity's relation to the physical and biological environment. The first variable is the *supply of resources* themselves, including energy. The second is the *kind of technology* available to increase efficiency of use of these resources. And the third is population, which constitutes a large part of the *effective demand* for resources. Change in any of these variables changes the other two, and the relations among all three. I have focused more on technology and the supply of resources here but we must be reminded that the crisis in the supply of resources can be attacked, and to some degree alleviated, on the demand side as well as the supply side.

ON THINKING ABOUT
FUTURE ENERGY REQUIREMENTS

by

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PREFACE

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OUR ENERGY FUTURE: PLANNING VERSUS PREDICTING

We *plan* events subject to our control and *predict* events that are beyond our control. Thus we predict a lunar eclipse, but plan the trajectory of a rocket to Mars. We predict the Russian response to our foreign policy, but we plan our own policy. Although planning and prediction are easily distinguishable in most cases, there is one area where they often are confused. In the area of collective behavior some events are beyond the control of individuals (subject to prediction) but are controllable by society as a whole (subject to planning).

Energy use is one such difficult area. We can make a collective social decision regarding energy use and attempt to plan or *shape* the future under the guidance of moral will; or we can treat it as a problem in predicting other peoples' aggregate behavior and seek to *outguess* a mechanistically predetermined future. Future energy requirements are usually estimated in the second way, by prediction. As the art of foretelling the future has shifted from the prophet to the statistician, the visionary goal-oriented element and the accompanying moral exhortation have atrophied, while analytical number crunching has hypertrophied. Statisticians and econometricians frown on moral exhortation as unprofessional. Prediction sounds scientific and value free, while planning sounds value loaded and downright socialistic. So we feel better about predicting than about planning. Just as in an earlier age knowledge arrived at by dissecting cadavers was "forbidden knowledge," so in our times any knowledge arrived at outside the framework of mechanistic quantitative models carries a similar taint of illegitimacy.

But, alas, prediction has in practice become implicit planning. We project the trend of recent energy growth up to some arbitrary round-numbered date. We discover that energy will be "required" in enormous amounts that cannot be reached without full development of nuclear power, western coal, offshore oil, enormous imports, etc. We treat the prediction as a mechanistically determined condition or a constant of nature to which we must adapt. We adapt by developing all energy sources as fast as we can, thus fulfilling our own prediction. Outguessing a predetermined future and then treating the prediction as if it were determined by natural laws to which we must conform is what Robert K. Merton called "self-fulfilling prophecy"--or the elevation of trend to destiny, in René Dubos' phrase. It is an unsuccessful retreat from the responsibility of choosing goals, and is unworthy of any organism with a central nervous system, much less a cerebral cortex. To those of us who think we are also spiritual beings of some kind or another, this approach is almost incomprehensible in its total inversion of ends and means.

Four Questions of Purpose

The more sensible approach is *first* to give at least a vague description of goals, and then to work backward to determine the energy required to achieve those goals. This implies a movement away from pseudo-prediction and implicit planning toward explicit planning. The first question to face in discussing future energy requirements is obviously, "required *for what?*"

It seems to me that there are four elements of purpose that must be specified before it makes any sense at all to speak of energy requirements. In our eagerness to get a number and out of embarrassment of making value judgments we usually ride roughshod over this obvious demand of elementary logic. Energy is required:

(1) To maintain what size population? (Or what rate of growth?)
(2) For what level of per capita energy use? (And how distributed?)
(3) For how long a time period? (Indefinitely or for 20 years?)
(4) Using what kinds of technology? (Centralized nuclear electric? Small-scale solar?)

Any notion of future energy requirements must give some general answer, either explicit or implicit, to each of these questions. The usual approach gives implicit answers. Again, recent growth rates of population and per capita energy use are projected forward to some round-numbered date. Whatever technologies are required to produce the projected amount are automatically accepted, along with their usually unspecified social implications. Usually, nothing at all is said about how long the system can continue beyond the target year. History either stops or starts afresh on the bimillenial year, or the year 2050, or whatever.

Other answers to the four questions are at least conceivable. However, the four questions are quite interrelated, and cannot be answered independently. It would be unrealistic, for example, to choose larger population and higher per capita energy consumption, while at the same time opting for only soft technologies and for sustainability over an indefinitely long time period. Likewise, if we choose soft technologies and a long life for the system, we must accept stabilized or lowered levels of population and per capita use. There is a further trade-off between population size and per capita use--many people at lower per capita use versus fewer people at higher per capita use. There is a further constraint on the compatibility of goals if we require that the combination we choose be generalizable to the world as a whole.

Hard Versus Soft Approaches

In choosing a compatible set of answers to these four questions, two kinds of information are necessary. First, technical information about the trade-offs among the four elements of purpose; and second, value information about what is good. The first kind of information allows us to determine which combinations of the four goals are in fact possible, and the second allows us to say which of the possible combinations is best. Clearly we need more research on *both* of these questions. But I think we know enough to make a broad decision between two general directions. Basically there are two self-consistent package answers to the four questions: (1) the high-demand, hard-technology answer, and (2) the low-demand, soft-technology answer.[1]

The hard energy package says that there is no such thing as enough, that growth in both population and per capita energy use are either desirable or inevitable; that it is useless to be concerned about the future more than 20 years ahead, since all reasonably discounted costs and benefits become nil over that period, and that the increasing scale, complexity, and centralization of technology is simply time's arrow of progress, and refusal to follow it represents a failure of nerve, or doomsday pessimism.

The soft energy package gives far more weight to permanence and ecological stability, and opts for technologies that use renewable sources of energy. These technologies, in addition to being environmentally benign, are also less centralizing and less vulnerable to accident and sabotage, and can be controlled by the ordinary local people who depend on the technology rather than by a remote priesthood of technical experts. The *rate* at which energy is available from such sources, however, is limited, and may require the reduction of per capita use to European levels, or about one-half of current U.S. levels (about equal to 1960 U.S. levels). Furthermore, population must be stabilized or reduced.

The contrast between the hard and soft energy futures can be made more dramatically explicit by considering the choice between the archetypal hard technology, nuclear fission, and the archetypal soft technology, small-scale solar energy.

The question can be put in two parts as follows:

(1) Do we want a small-to-medium-scale, decentralized energy system subject to local control by the same people who use the energy; with minimal depletion or pollution, and minimal disruption of ecological services; which arrives already distributed and is useless to saboteurs, terrorists, and psychopaths; which can be equally available to all future generations independently of our usage; which will be highly beneficial to poor tropical countries; and which, since the whole biosphere is pre-adapted to the fixed solar flux by millions of years of evolution, imposes upon us an automatic and healthy ecological discipline?

(2) Or, do we want a plutonium-based economy, centrally administered by a technical elite; which is sure to promote the international and subnational proliferation of nuclear weapons; to increase our vulnerability to terrorists, and to the inherent instabilities of large complex systems; which increases the dependence of poor countries on rich countries; which requires garrison-like security measures at many points in the fuel cycle; which wastefully generates and distributes energy at too high a quality which must be uselessly degraded to fit the majority of end uses; which is based on highly uncertain assumptions about uranium

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[1] For demonstrating that there are alternatives to the hard energy path we are indebted to the Ford Foundation's Energy Policy Project report (Ford Foundation, 1974). For elaboration of the soft path and for the most cogent analysis of the issue we are indebted to Amory Lovins's *Soft Energy Paths* (Lovins, 1977).

supplies, and so far nonexistent reprocessing plants and permanent waste storage; and which imposes permanent absolute obligations on all future generations?

Choice and Bias Not Equivalent

The above contrast will leave no one in doubt as to where I stand on the issue of fission versus solar energy, and will lead some to dismiss my views as biased. But let us at least admit that the fact of having arrived at a definite conclusion is not by itself evidence of bias, any more than not having arrived at a conclusion is evidence of lack of bias --the latter may reflect only lack of thought. However, in advocating the soft energy path generally, we must guard against making absolutes of the relative virtues of smallness, decentralization, simplicity, and permanence. Some enterprises, such as insurance companies, cannot work on a neighborhood scale; the economies of factory organization cannot be taken advantage of below some minimal scale of demand. We cannot avoid *all* reliance on experts short of limiting ourselves to those technologies understandable by the dumbest member of society. If we are to strive for infinite permanence then we must never use any nonrenewable resource, and even that would not allow us to attain such an extreme goal. Complete decentralization of all decisions to the individual or village level is made impossible by the existence of public goods.

Clearly both the hard and soft energy paths can be reduced to absurdity by exaggeration. The difference is that while the reduction to absurdity of the soft path is an imaginative exercise, the reduction to absurdity of the hard path is being carried out in concrete, steel, copper, zirconium, and plutonium right before our eyes.

It seems to me that the values we profess, on ceremonial occasions at least, are much better served by redirecting our efforts to the soft energy path. Yet present policy has been, and to a slightly lesser extent continues to be, to devote vast sums to breeder reactors and comparatively little to solar energy and conservation. We continue to follow the hard energy path by default of enough imagination to recognize the alternative.

CHOOSING THE GAME: THE IRRELEVANCE OF ECONOMICS

The choice between a hard and a soft energy future is probably the major social and moral decision facing our generation. We have treated it as an economic decision, and this has obscured the issue greatly. Economics, "the sordid lore of nicely calculated less or more," is appropriate at the level of tactics, but not at the higher level of strategy. For example, the choice between, say, oil and natural gas for some particular use is an economic choice. Likewise the choice between photovoltaic and biomass conversion. In the first case the alternatives are both fossil fuels, and we are comparing one form of geocapital consumption with another. In the second case both alternatives are solar income sources. But the choice between solar income sources and geocapital sources, say biomass versus natural gas, is more a question of evolutionary strategy than of economic tactics. It is a different order of decision. Expenditure of depleting and polluting geocapital (and the evolution of technical change in that direction) is so different from the capture of nondepleting, nonpolluting solar income that a forced comparison in discounted abstract pecuniary units is misleading. Obviously, it is always easier or "cheaper" to live off capital than off income--for as long as the capital lasts. It is not surprising that for most uses fossil fuels are cheaper than solar energy (during an era of mineralogical bonanza).

We hardly need have recourse to the arcane numerology of benefit-cost analysis to conclude that living on capital requires less conscious short-run sacrifice than living on income. The economics of living on permanent solar income, as all other forms of life do, differs from living mainly off terrestrial capital as chess differs from checkers. The difference is deeper than the previous distinction between strategy and tactics would suggest. The very rules of the game are different, though the board on which the two games are played looks the same. One game recognizes permanence and ecological discipline as rules restricting legitimate moves. The other game has no such rules. What is a good move in the checkers of geocapital consumption economics is usually not a good move in the chess of permanent solar income economics. In checkers, all pieces are comparable; in chess, qualitative differences among pieces are essential. We simply must decide which game we want to play before we evaluate alternative tactics, so that moves based on pecuniary calculation can serve our basic purposes rather than obscure them. Some questions require sound judgment rather than accurate calculation.

The sophisticated tools of tactical decision making become entirely sophistical if we try to use them to help us decide which game to play. To illustrate: solar energy would surely become cheaper than fossil fuel energy for most purposes if we decided to deplete the remaining fossil fuels at one half the current annual rate. And what is to prevent us from gradually cutting the rate of depletion if we wish to live more off income and less off capital, to interfere less with the natural services of the biosphere, and to induce resource-saving technical change? Many would argue that such a substitution of solar for fossil fuels is uneconomic, and indeed, it would be if the calculation were made on the basis of prices valid under the old high rate of depletion. But we could just as well argue, on the basis of the new prices (i.e., those prices that would result if present depletion rates were cut by one half), that going back to the old reliance on fossil fuels would be uneconomic. Both arguments are completely circular. The point is that the decision of whether to play permanent solar income economics or temporary geocapital consumption economics is *price determining*, not *price determined*. Should it turn out, as some argue, that the soft technologies are cheaper even in terms of the prices prevailing in the bonanza period of high geocapital consumption, we could then add an impressive *a fortiori* punch to the argument. But we should not obscure the basic issue by admitting the opponents' grounds--even though that tactic might allow a short-cut to winning the argument--when those grounds are themselves misspecified.

The Game Determines the Price

But are resource prices really so arbitrary? What about competition and optimal intertemporal allocation, and all that? The value we assign to resources *in the ground*, before they enter the productive process, is largely arbitrary. Resources enter the market at their value in the ground plus cost of extraction. Their value in the ground is arbitrarily set at zero in both capitalist and socialist economies. Thus, resources are valued mainly according to their cost of extraction. In a bonanza period, when extraction is easy and natural resistances are minimal, the short-run supply is great and the price is low. The price may temporarily be driven even below the cost of extraction. Cheap energy from the petroleum bonanza has subsidized all other forms of mineral extraction. That the relative prices of many resources have shown a falling trend means that we have been enjoying the bonanza or waxing phase of the extraction cycle of many minerals. Such a trend does not mean that resources are becoming in any real sense less scarce--it just means that for a while we were able to extract them faster than we used them.

The essentially arbitrary nature of the price of resources *in situ* can be seen from the following reasoning. The price of resources in the ground is determined by supply and demand; no one denies that. But underlying the supply curve are cost curves, which require a definition of cost. Cost of production may be defined as actual historical costs paid, which in the case of resources *in situ* is zero; or as current or even future replacement costs, which for many resources would be very high, perhaps infinite. Further, cost can be defined as private or social. The temporal and ecological horizons over which we try to account for the consequences of our decisions must be arbitrarily cut off at some point. But cutting the chain just after the first link is too soon.

On the demand side we face a similar problem. The market demand curve is the sum of the individual demand curves for the population. But what is the population whose demands are counted? Who is allowed to bid in the market? Obviously, future generations cannot bid in present markets. Suppose we arbitrarily expand demand to include our estimate of the needs of the next ten generations instead of arbitrarily limiting it to one? Again, resource prices would be very high. Of course poor people in the present are also excluded from the market, and arbitrary decisions about income redistribution will also affect resource prices, as will the arbitrary geographical distribution of mineral deposits. The point is that resource prices, faithfully determined by supply and demand, could range from zero to infinity, depending on essentially *arbitrary* conventional definitions of cost (historical versus replacement; private versus social) and on an arbitrary definition of the demanding population (present only or some number of future generations).

The Bias of Short-Run Competition

In practice, short-run competition selects for the lowest price conventions--that is, for historical and private cost rather than replacement and social cost, and for consideration of the present generation only. Therefore the price of resources *in situ* is zero, at least until the generation in which exhaustion is imminent. The existence of market-determined rent (either differential rent or scarcity rent) does not really alter the picture. Differential rent depends on differential extraction costs, not on any concept of long-run replacement cost, or on any consideration of future generations. It is a premium paid for greater accessibility and easier extraction, not a value imputed to resources in the ground. Scarcity rent in the sense of "user cost" (value of future use foregone) provides no escape from fundamental arbitrariness, since its magnitude depends on when in time the foregone future use is assumed to be felt. The shorter a community's time horizon, the lower will be user cost.

The claim that discounting future values to equivalent present value by means of the interest rate automatically counts the demands of the future and thereby achieves optimal intergenerational allocation is simply wrong. Present value calculations achieve optimal allocation as judged by the present generation. There is no reason to suppose that a future generation would consider such an allocation as acceptable, let alone optimal. In any case, "allocation" is not the proper word since different generations are different people, and division of resources among different people is distribution, not allocation. Distribution can be fair or unfair, but not "efficient." At most, the interest rate can aid the allocation of resources within the time span of a single generation. The fact that single generations form an overlapping chain into the distant future does not extend the interest rate's proper domain into the distant future. If overlapping of decision time periods were the significant thing rather than the time horizon of the decision maker, we could reduce the time horizon to one year, or even one week, and then argue that no one need think more than a week ahead as long as the one-week periods formed an overlapping chain into the distant future. The absurdity is evident.

Suppose we were to change the rules of the game in favor of sustainability and calculate cost as nearly as possible on a replacement basis. Let renewable resources be exploited on a sustainable yield basis and let nonrenewables be exploited at a rate such that the resulting price is at least as high as that of the nearest renewable substitute. For example, forests would be managed on a sustainable yield basis with alcohol being made from trees. The extraction of petroleum would be limited to an amount such that the resulting price per Btu equivalent would be at least as high as that of wood alcohol. Resources in the ground would then have a positive value, probably a very high value, which could be captured by the government via a severance tax or sale of depletion quota rights. This would certainly be no more arbitrary than current practice. If one prefers the soft energy future then it would be a desirable policy.

If prices are to be good servants instead of bad masters, we must realize that the zero price of resources *in situ* is not a measure of relative scarcity objectively calculated by an omniscient market. Rather it is a conventional assumption on the basis of which the market determines all other prices and the resulting allocation and rate of use of resources. The price system should be viewed as a useful instrument to help us achieve efficiently whichever of the two energy futures we choose. It cannot make the choice for us. Market prices should not be the criteria for deciding the rates of flow of matter-energy across the economy-ecosystem boundary (in either direction, i.e., depletion or pollution), nor for deciding the distribution of resources across generational boundaries. The first must be an ecological decision, the second an ethical decision. These decisions will, of course, influence market prices, but the point is that the ecological and ethical decisions are *price determining*, not *price determined*. Many economists fail to grasp this point, and appeal to prices as the criteria for making the ecological and ethical decisions.

THE CHOICE IS OPEN

The low-demand energy future is feasible. "Whatever exists is possible" (Boulding's First Law) is about as axiomatic as one can get. The low-demand scenario (half the current U.S. per capita energy usage) *exists* today in Western Europe, and existed in the U.S. as recently as around 1960. Whether this lower total amount could eventually be supplied by soft technologies is less certain, but growing evidence suggests that it could be. Lovins's soft energy path envisions only a slight eventual reduction below current energy consumption, achieved very gradually.

The common notion that the low-demand, soft technology scenario is "far out" or merely a hypothetical polar case is due to inability to recognize the obvious. It is the high-demand, hard-technology future that has never before existed and is completely hypothetical. Yet our crackpot realists all treat the hypothetical high energy scenario as if it were empirically verified, and treat the empirically verified, already experienced low energy case as if it were the flimsiest conjecture!

Certainly the transition to a soft energy future must be gradual, and of course there is room for compromise. But the basic question must be put in a clear-cut way, and a definite either/or decision must be made on the *direction*, even though the *rate* at which we move in that direction is subject to compromise and economic constraint. Many people do not like to face up to this basic choice because it is not a question of rationality of means, but sanity of ends. Taking a position requires more than counting--it imposes moral self-definition and responsibility.

Dickinson (1907) describes the condition very well, as seen from the viewpoint of an Oriental spectator looking at England early in this century:

> Your outer as well as your inner man is dead; you are blind and deaf. Ratiocination has taken the place of perception; and

> your whole life is an infinite syllogism from premises you have not examined to conclusions you have not anticipated or willed. Everywhere means; nowhere an end. Society is a huge engine, and that engine itself out of gear. Such is the picture your civilization presents to my imagination.

We are still in the same fix: everywhere means, nowhere an end; everywhere market prices, nowhere moral values. Unless we face up to the four questions of purpose, then reason our way toward some minimal moral consensus, it does not really matter what our energy policy is.

Objective Value: The Basis for Consensus

Where is this moral consensus to come from? Ultimately it must come from a dogmatic belief in objective value. If values are subjective, or thought to be merely cultural artifacts, then there is nothing objective to which appeal can be made, or around which a consensus might be formed. Subjective consensus, or consensus based upon what everyone recognizes to be a convenient cultural myth, simply would not work, even if it were thought a worthy goal. Only real objective values can command consensus in a sophisticated self-analytical society. We have no guarantee that objective value can be clarified, nor that once clarified it would command the consensus that it merits. But without faith in the existence of objective value and in our ability to know it, we must resign ourselves to being driven by the force of technological determinism into an unchosen and perhaps unbearable future.

In C. S. Lewis's words, "A dogmatic belief in objective value is necessary to the very idea of a rule which is not tyranny or an obedience which is not slavery" (Lewis, 1962). The same insight underlies Edmund Burke's famous dictum that, "Society cannot exist unless a controlling power upon will and appetite be placed somewhere, and the less of it there is within, the more there must be without" (Burke, 1899). Control from within, if it is not to be from brainwashing or from drugs, can only result from obedience to objective value. If interior restraints on will and appetite diminish, then exterior restraints, coercive police powers, or, ultimately, Malthusian positive checks, must increase. In Burke's words, "Men of intemperate minds cannot be free. Their passions forge their fetters" (Burke, 1899).

The greatest of all causes for pessimism about the course of human affairs is that the very phrase "dogmatic belief in objective value" automatically shuts the minds of most modern intellectuals. Scientific and technical progress--with its mechanistic, arithmetic mode of thinking--has led to the debunking of all knowledge that does not have a mechanistic or arithmetic structure. Knowledge about value and right purpose derives from an "illicit" source, and is considered "forbidden knowledge" by the priests of scientism. The reductionist world view has simultaneously increased knowledge that yields power, and diminished or undercut the kind of knowledge that yields purpose. Everywhere means, nowhere an end.

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AMERICA'S MODULAR INTEGRATED UTILITY SYSTEM PROJECT: A CASE STUDY IN THE PROBLEMS OF PIONEERING NEW ENERGY SYSTEMS

by

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INTRODUCTION

In the effort to meet the energy needs of this nation, much attention has recently been devoted to the dramatic possibilities for exotic and controversial new energy sources, as typified by this press item:

> Vast arrays of solar power cells floating in orbit around the Earth could beam back 25 percent of U.S. electricity needs by 2025, according to a scientist who proposed the notion 10 years ago [Dr. Peter E. Glaser].
>
> The microwave beam of energy would be safe for birds, planes, and people and would be a cheap, nonpolluting energy source for the next 5 billion years . . . It would cost $10 billion to put the first solar power generator in orbit 20,000 miles up, and it could be done by 1995 with existing technology (New York Times, 1978).

Since the media tend to emphasize novel material likely to attract and hold the public's interest, a distorted and skewed picture of energy development efforts may result. Potentially important but comparatively prosaic possibilities often elude warranted attention and assessment.

One such little-noticed possibility is the Modular Integrated Utility System (MIUS), proposed in 1972. Its ambitious and strategic objectives are to:

> Conserve fuel and other natural resources, reduce environmental degradation, reduce total public costs, match the reliability of service of separate utility systems, be capable of installation in phase with community development, and permit greater flexibility in intensive land development (Jacobs, 1976, p. 3).[1]

These objectives, although still awaiting a full-scale field test, amply qualify MIUS for academic, commercial, and public scrutiny.

MIUS is basically a combined energy, utility, and waste-disposal plant. Located directly on the site of its host community, it can provide some or all of five critical support services--electricity, space and water heating, air conditioning, solid waste processing, and waste water treatment. While custom-designed in a site-specific way, the prototypical MIUS is compact, highly integrated, and deliberately nonintrusive;[2] if successfully implemented, few residents would know their community were being serviced by a MIUS save for its exceptional

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[1] See also Schaefgen (1976).

[2] "A MIUS may be sized to accommodate from several hundred to a few thousand multifamily dwelling units, nearby single-family housing, and associated commercial facilities" (Oak Ridge National Laboratory, 1976, p. 1-9).

reliability and lower than average costs. In a pioneering way, then, MIUS brings together subsystems left isolated in America's conventional energy systems and utility grids, building them into one synthesized master system. MIUS promises to save more money and energy for its users than any conventional system currently available or readily foreseen.

The better to scan MIUS prospects, this essay will be organized around four questions: What is the MIUS program? What does the MIUS research experience teach about the new art of technology assessment? What are the major lessons for other energy innovation projects? And finally, what are the prospects for the MIUS effort?

The Origins of the MIUS Project

In the background of the entire MIUS saga is the effort of the U.S. Department of Housing and Urban Development (HUD) to help the private sector keep up with the nation's demand for a larger and better supply of housing. New home starts and urban rehabilitation efforts confront growing problems of energy availability, clean water availability, and solid and liquid waste treatment and disposal. For the housing supply to keep up with average rates of urban, suburban, and exurban growth would be difficult enough, but the upgrading of relevant standards by the U.S. Environmental Protection Agency (EPA), along with new citizen activism on environmental policy issues, add further pressure. Rounding out the picture, of course, are the rapidly increasing costs of providing energy and utility services.

MIUS was begun in 1972 as part of HUD's effort to meet the related problems of housing supply and energy costs. HUD joined with several other organizations--the National Aeronautics and Space Administration, the National Bureau of Standards, the Oak Ridge National Laboratory, the Federal Power Commission, the Department of Defense, the National Research Council, EPA, and the Department of Health, Education, and Welfare--to explore ways of expanding utility service options while using fewer resources and reducing the hazard to the natural environment.

Linked to this unique public consortium was private sector representation from the International District Heating Association, the Edison Electric Institute, and the American Public Power Assocation. Through its early involvement with the Committee on the Challenges of Modern Society, created by NATO, the MIUS project has also exchanged information with nearly 200 MIUS-like projects in 15 other countries (U.S. Department of Commerce, 1978).

The MIUS project has operated since 1972 with five guiding objectives: to assess the technical and economic feasibility of MIUS; to mount at least one full-scale, real-life test (an initial version of MIUS may soon evolve from a HUD cogeneration project at Jersey City, N.J.); to assist the private sector in implementing its own MIUS; to identify relevant institutional constraints, such as laws or public attitudes that discourage the commercialization of MIUS; and finally, to monitor impacts after private industry uses the MIUS concept (Oak Ridge National Laboratory, 1976, p. 1-9).[3]

MIUS ATTRIBUTES

If we are to understand the initial enthusiasm of proponents, the unexpected faltering of developmental progress ever since, and the larger institutional context within which the MIUS scenario unfolds, attention must be paid to the following critical aspects of the MIUS model.

Conventionality of Hardware

To begin with, MIUS has practical and realistic hardware requirements. While every MIUS installation must be custom fit to its own site, the equipment *per se* is either now available or can be very readily produced. The deliberate preference for proven, off-the-shelf hardware stands in sharp contrast to proposals for exotic, untried, "blue sky" technologies.

MIUS proponents line up with a major faction in the dispute over how to alleviate energy and ecological pressures *now*. This faction insists we need not wait for development of the exotic inventions, such as floating solar power cells, provided we begin immediately to make better-than-ever use of existing technology. MIUS proponents advise that if there is actually to be a short-term mitigation of energy/ecology problems, it will require governmental creativity and innovation in synthesizing what we actually have on hand--off-the-shelf hardware and on-line field-proven techniques--into fresh solutions like MIUS.

Centralized Services, Decentralized Siting

At present, the utility services of many American communities originate at several different, distant, and usually mammoth central plants. The utility services--electricity, clean water, and waste disposal (solid and liquid)--are wired or piped or trucked to and from the target community, with a host of attendant problems in energy transmission loss, adverse cost structure, public nuisance issues, and so on. With a MIUS installation, however, these services can origiante at the site itself--thereby eliminating many costly losses associated with long-distance transportation or transmission. The on-site self-sufficiency of a MIUS results in considerably reduced vulnerability to breakdowns ("brownouts," "blackouts") that originate elsewhere. Conventional energy plants have ties with large grid systems that leave them highly vulnerable. MIUS, in contrast, can be designed to be largely independent of distant energy producers. To be sure, MIUS installations may be required by economics and by local safety and health regulations to

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[3] See also Rothenberg (1976).

develop a connection to the local electricity grid, but a site-specific MIUS design could provide for continued (reduced) operation long after the surrounding energy grid has gone down.

Synergy

The principle of linking elements in a system to secure a desired result different from the sum of the individual parts--synergy--is a major advantage of MIUS. Operationally, this means that MIUS can use waste products of certain components as fuel for other components, and in this way earn a total reward greater than the sum of its five distinct parts. Thrown-off heat is commonly disregarded in conventional utility systems as too costly to transmit and distribute to residential customers. Given the MIUS on-site location, however, waste heat from electrical generation or solid waste incineration can be turned to the task of residential space or water heating. Similarly, newly cleansed waste water from the MIUS site can be used to fight fires, to water lawns, to cool plant operations, and to irrigate land.

Expandability

MIUS is designed to be replicated elsewhere in a community as the area's growth makes this necessary (e.g., in the boomtowns near newly opened energy sources or the steadily growing cities of developing nations). This sort of engineered flexibility is especially vital if HUD is to help aid private sector dynamism on behalf of the nation's land development. With its unique capacity for incremental growth rather than large-scale, one-time growth, MIUS can facilitate rapid community development; by contrast the rigidities and great costs of a conventional utility system buildup can actually impede the pace of fast-breaking or unevenly paced development. By providing for economical replication, and also by requiring a sharply lower initial capital investment for energy and utility service, MIUS can be put in place fast and cheaply, and thus should earn considerable support from private sector land developers.

Cost Savings

Looming more significant than all other attributes is the bottom line cost savings available from MIUS. Typical of various claims made is the notion that as an on-site generator and processor of utility services a MIUS plant can achieve immediate savings. Contrasted with the promise of MIUS is the present problem: "Today's average consumer receives only one-third of the fuel energy used to produce electricity, but pays for the other two-thirds lost in its generation" (U.S. Department of HUD, 1974, p. 8). MIUS is also represented as offering considerable savings in environmental quality maintenance:

> MIUS promotional literature claims that MIUS can reduce pollutants over conventional systems by 50% where thermal pollution is concerned; 35%, combustion products pollution; 80%, liquid waste pollution; and 65%, solid waste pollution (U.S. Department of HUD, 1974, p. 6).[4]

While it will take more than one field test of various MIUS constellations to validate these cost-saving potentialities, certain computer simulations run by MIUS developers encourage guarded confidence that it may prove cost-effective and competitive under specifiable conditions and institutional arrangements. All the parties to the attendant controversy agree that only field tests will resolve the matter.

Technology Transfer

Assuming that MIUS is potentially profitable, a sixth and final attribute is noteworthy. Commercialization has always been the goal of the project, and a clear-cut gauge of project success or failure will be the ultimate achievement of technology transfer from public to private hands. A leading piece of HUD public relations literature on MIUS makes this quite clear:

> The objective of the HUD-MIUS program is to demonstrate the feasibility of the MIUS concept as a potential alternative means of supplying utility services to communities, and to assist in the implementation *by the private sector* of such an alternate utility service concept (U.S. Department of HUD, 1974, p. 19). (Emphasis added.)[5]

In short, MIUS is not to be another TVA, or NASA, type of operation; while paid for and developed in the public sector, MIUS has always aimed at being transferred wholly to the private sector as soon as possible, the better to prove its basic worth.

INSTITUTIONAL INSIGHTS

Much to the project's credit, it has commissioned considerable study of its prospective impact in nonengineering matters--including a major 1974 report by an industry-led *ad hoc* review board, a formal 1974 interim and 1976 final technology assessment (TA), a formal 1975 assessment, by George Washington University specialists, of the interim 1974 TA, a 1975 Environmental Impact Statement, and numerous other explorations of the

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[4] See also Mixon (1975).

[5] Cf. Ridgeway and Conner (1975).

potential MIUS impact on government, organized labor, the environmental movement, the public, and so forth.[6]

This material generally remains far too little known, though all of it, including the TA and its evaluation (the George Washington University report) are in the public domain. From these and related documents, it is clear that MIUS project managers have long recognized an impressive sweep of relevant institutional factors:

> The term "institutional factors" refers to the diverse behavioral changes that must accompany a MIUS, and to the various barriers that manifest resistance to those changes. . . . The term also connotes political, regulatory, social, or psychological adjustments and changes (National Research Council, 1974, p. 12).

The above-cited report, prepared early in the MIUS program by the Integrated Utility Systems Board (IUSB) (organized by the National Research Council), goes on to explain that the term is broadly taken to mean "the many non-technological things that if left unrecognized and unresolved, could impede the implementation and dissemination of the MIUS concept" (National Research Council, 1974).

More specifically, the MIUS institutional analysis has included earnest, if uneven, pioneering research on the likely relationship of MIUS to technological incentives and risks; reliability, safety, and performance; housing markets, development, and financing; tax structures; regulatory factors; labor practices and availability; and public acceptance. Indeed, when the IUSB was asked for guidance by the MIUS project, the IUSB's response in its 1974 final report identified over 50 potential institutional factors for evaluation and monitoring.

Another major input, the formal TA prepared by a MIUS collaborator, the Oak Ridge National Laboratory (1976), defined the following institutional issues:

> What would be the likely primary consequences of the application of MIUS, such as the reliability of service, cost, and environmental impact?
>
> What are likely highest order impacts--economic, psychological, and social?
>
> What community or interest groups are most likely to be affected by the anticipated impacts of MIUS, and are most likely to take action to influence those impacts?

Elsewhere in the TA report, the writers boldly assure readers they "have examined the *total* social cost of MIUS and conventional system . . . (Oak Ridge National Laboratory, 1976, p. 82). (Emphasis added.)[7]

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[6] The resulting publications include National Research Council (1974); Oak Ridge National Laboratory (1976); and Mayo (1975).

[7] See also Orlando and Limaye (1974).

Thanks in large part to this well-advised sensitivity to the social as well as engineering aspects of the MIUS developmental effort, many valuable social impact response plans are now stockpiled in the HUD-MIUS file, awaiting use in impact studies of MIUS and comparable projects.

In 1973, industry representatives urged the MIUS project to "investigate and develop mechanisms for handling liability" (Integrated Utility Systems Board, 1973). The IUSB developed and urged a far-sighted and revealing approach to the liability challenge in its 1974 report:

1. The liability for damages (real or pretended) due to improper operation of MIUS from a health standpoint (as from a bioactive windfall) and for damages to apparatus (such as appliance damage due to low voltage) is an institutional worry.
2. A realistic appraisal of risks must be made as early as possible if MIUS is not to be penalized by high insurance rates or excessive redundancy of facilities.
3. The costs of MIUS liability insurance coverage must be included in overall cost estimates.
4. Early MIUS demonstration projects must be designed with the greatest possible reliability: failures could be devastating to the system's entire future (National Research Council, 1974).

Noteworthy is their additional suggestion that "a possible solution to this problem would be to have a utility own and operate the MIUS" (Integrated Utility Systems Board, 1973).[8]

Another intriguing social issue is illuminated by the following comments on a very sensitive labor aspect of the demonstration:

> The questions of which unions and trades would be involved in the fabrication, installation, and operation of MIUS' system has not been addressed. There will be difficulties in establishing jurisdiction of various unions both on-site and off-site.
>
> . . . with MIUS reliability a prime concern, should automation of MIUS be encouraged as a buffer against possible labor disruption? Or, should MIUS operating and service employees be subject to no-strike laws? (Integrated Utility Systems Board, 1973).

Elsewhere in the same report, the writers puzzle about how a MIUS developer might handle the fact that the first installations could be at public housing projects and thus be stigmatized by the same prejudices suffered by the housing projects. IUSB also urges attention to the possibility that MIUS neighbors may perceive the system as a cause (real or imaginary) of illnesses, noise, odor, pollution, or other nuisances. In this connection, note is often made of the likely resistance of local public health officers and the EPA to the MIUS on-site recycling of wastewater, a matter so contentious as to have caused many

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[8] See also U.S. Department of HUD (1975, pp. 6-16, 6-17); cf. Ridgeway and Conner (1975).

MIUS project leaders in 1978 to recommend dropping this option from contemporary MIUS feature lists.

Evaluation Guidelines

Especially fascinating is the existence of a rare review of a review--the 1975 evaluation, prepared by a leading TA research center at George Washington University (GW),[9] of the interim 1974 draft of a TA prepared by MIUS specialists on the staff of Oak Ridge National Laboratory (ORNL). Unable in 1973 to locate any actual TA's to use as a model, the ORNL team relied on a pioneering Mitre Corp. prototype, an early effort long since expanded and revised. GW reviewers of the 1974 interim ORNL report offered telling, constructive criticisms that led to substantial improvements in the final ORNL report (Oak Ridge National Laboratory, 1976).

Looking directly at the sociological issues raised, ORNL's interim TA coverage of institutional subjects earned special praise from GW for its recognition of the equity or social justice implications of MIUS systems: the question of how the costs and rewards might alternatively be distributed--a "highly relevant criterion which is often ignored in technology assessment efforts" (Mayo, 1975, p. III-7).[10] On the other hand, however, the interim ORNL TA was criticized for seeking more to "sell" than to assess, by including an elaborate treatment of "ways to overcome resistance" to MIUS. Said the GW review:

> . . . "public acceptance" is of critical importance to MIUS implementation, but to what extent should an assessment effort be devoted to conditioning the public to this favorable disposition? (Mayo, 1975, p. III-9).

The interim report was faulted for confusing a strategy for MIUS implementation with a strategy for impact assessment--although the GW critics conceded that the ORNL assessors had confronted a very difficult task: "In general, the technical analysis is not organized or executed in a fashion conducive to identifying or assessing higher order impacts" (Mayo, 1975, p. III-35).

The interim TA was also criticized for having failed to expand on its own list of social effects, given very short shrift in one and one-half pages (Mayo, 1975, p. III-57). A list of missing study items cited by GW included:

social stratification
social structure
social norms, values, mores
social institutions
sociopolitical factors
life-styles

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[9] Mayo (1975).

[10] See also Schnaiberg (1977).

ethnicity and racial relations
patterns of land use, growth, and development policy
patterns and capacity of "life support" systems (schools, hospitals, etc.)

The GW specialists especially regretted ORNL's deemphasis of existing community patterns, social expectations, and the full range of human behaviors (e.g., significant adverse psychological or social effects). And they were troubled by the interim TA's optimistic tilt which intimated that negative social effects of a MIUS could be readily corrected. GW critics recommended a more cautious and skeptical approach lest the advance warning function of the TA--its ability to "red-flag" hazards far ahead of their occurrence--not be unduly diluted by unrealistic assurances.

Not surprisingly, the GW critics closed by urging, among other things, that the project soon undertake a carefully designed real-world demonstration that would permit going beyond the ORNL hypothetical model to a TA of "the actual social environment into which the MIUS is introduced" (Mayo, 1975, p. IV-11).[11] This, and all the other constructive GW suggestions, were acknowledged with appreciation and variously accommodated by ORNL staffers in the final TA report, the published version now available to the public.

LESSONS

Drawing now on all that has gone before, what are some major insights applicable to the trial of any new energy alternative that confronts, as does MIUS, a well-entrenched, conventional system?

To begin with, the MIUS experience recommends careful attention to the pros and cons of the early build-up of a constituency. MIUS project leaders chose to sharply curtail their own 1972-1978 public relations activities; in consequence, MIUS strikes project critics as having been one of HUD's best-kept secrets, though no one ever intended it this way. Now, when the MIUS project is taking a new direction and might profit from the rallying of relevant outside support, there are hardly any pro-MIUS constituents to draw on.

Second, there is a real question of whether the MIUS project gained or lost from the effort entailed in drawing simultaneously on many different public-sector and private-sector contributors. Considerable hours and strain were required to coordinate work assignments and personnel schedules (travel plans, work deadlines, etc.). In addition, there were the inevitable personality conflicts inherent in any such large-scale undertaking. Its members, the six governmental agencies and three private companies most directly involved, had seldom, if ever, collaborated in this way before. Accordingly, it required demanding management techniques to create new protocol systems, a common communication system, an avenue for redress of grievances, and the like. Even

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[11] See also Ryan and Reznek (1977).

with such inventiveness, however, seemingly unavoidable costs accompanied differences of opinion among the collaborators over the project's appropriate degree of documentation, the necessity for outside review of project reports, the priority ranking of project goals, and so on.

Third, the MIUS project, by electing to put all its eggs in one (demonstration) basket took a calculated risk that in hindsight looks somewhat ill-advised. Planned as a 1978 $6 million addition to the HUD-assisted "new town" of St. Charles, Md., the demonstration of the nation's first actual MIUS was expected to serve as the proud forerunner of a nationwide series of exemplary MIUS installations. True, with sparse funding and an inadequate number of full-time MIUS personnel, the circumstances appeared to compel a single-site concentration of effort. Nevertheless, as evidenced by the internal turmoil accompanying the fall 1977 cancellation of the St. Charles project, the risk of tying the entire program's fortunes to *one* test situation was considerable. It would seem wiser to have spread the risk to at least two dissimilar sites, rather than to have concentrated it, although this would have necessitated distinct risks in stretching the project's resources and attenuating its development timetable.

Fourth, the MIUS experience attests to the importance of technology assessments *per se* and to the value of having the TA's critically evaluated. The MIUS project invested heavily in securing as thoroughgoing a TA as ORNL could prepare, along with the unique GW review. These analyses of anticipated institutional impacts of probable MIUS constellations, complete with recommended mitigations of negative impacts, actually aided in boosting morale among the six agency partners in the project. The analyses also spotlighted institutional resistance sufficiently in advance to facilitate at least some anticipatory planning by various MIUS proponents.

Finally, the MIUS experience calls attention to fundamental questions of technology sponsorship. Like many other energy developments, MIUS was initiated and financed by the public sector, but it was aimed from the start for adoption by the private sector. MIUS *could* have been managed instead for retention in a public, or government ownership, system. That is, MIUS could have been kept open to the possibility of long-term ownership and management by the public sector, much as TVA was. Once demonstrably successful, various MIUS plants could have then been leased or sold to private parties (such as utility companies)--at terms advantageous to the taxpayer sponsor and to the local MIUS users alike. Or the local users could have decided in a referendum whether to municipalize a federally owned MIUS, with the city thereafter leasing the MIUS or running it as its own energy and utility system. The energy crisis should be understood to generate *new* political responses, and thereby new political opportunities.

Summary

In sum, five major lessons are apparent from the ongoing MIUS project. Drawing on MIUS as a case study, the development of a new energy system should probably include (1) the earliest possible building of a support constituency of both interested citizens and legislators; (2) the tightest possible administration of any multiagency effort; (3) the simultaneous implementation of more than one demonstration; (4) the most sensitive possible use of new institutional tools like technology assessment; and (5) the most open-minded approach to the question of private or public sector domination. Naturally, the applicability of each of the five guidelines to other development projects will vary widely, but all warrant consideration.

MIUS PROSPECTS

The MIUS program was initiated in 1972 for still timely and still unobtained objectives:

> . . . to develop and demonstrate the advantages of integrating community systems for providing utility services . . . to provide the desired utility services consistent with reduced use of critical natural resources, protection of the environment, and minimization of cost (Mayo, 1975, p. iii).

Adopted widely--nearly 200 proto-MIUS projects under development--in a score of Western European nations, the project has only one incipient prototype (Jersey City, N.J.) in this country.[12]

Given the attractive list of MIUS attributes--conventionality in hardware, centralization of on-site services, synergy, expandability, potential economic competitiveness, private sector transferability, and a modicum of institutional sensitivity--the uncertainty of its future in this country is perplexing in the extreme.

On the bright side of the forecast is the steadily growing interest shown by private utility companies in using a local, small-scale MIUS as a peaking plant. Under this novel arrangement a MIUS would sell electricity on demand to the utility's grid, and the utility, during its off-peak hours, would sell power back to the MIUS at lower rates. The utilities admire the MIUS cogeneration feature (its reuse of waste heat), especially as this may enable the MIUS to sell power at lower rates itself.

New recognition of a profitable use for a MIUS has appreciably reduced the indifference or muted hostility of the utility industry--although the threat of a new MIUS "stealing" local customers from an existing giant utility remains to be an issue. Should utility companies build or buy local MIUS plants, however, the competition problem will of course disappear, though along with it will also go any chance the public might have ever had of using MIUS rates as a yardstick with which to assess conventional utility rates.

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[12] See U.S. Department of Commerce (1978). The Jersey City site, while initially only a total energy system demonstration, is now being altered to serve as a MIUS demonstration.

Deemphasis by HUD

On the darker side of the forecast is the disinclination of the present administration to assign a high priority to any HUD project that cannot clearly, economically, and immediately help the older cities and the inner city areas of all cities. MIUS was initiated under a Republican administration with an avowed eagerness to help suburban and new construction ventures. All federal projects begun under one political party's guidance must stand review in terms of fresh priorities when the opposition party comes to power. The attempt to use MIUS in built-up areas of older cities, rather than in unbuilt areas of new communities, would necessitate tearing up the streets to retrofit the existing utility infrastructure. MIUS has understandably been downgraded by HUD relative to other claims on the same scarce HUD development dollars.

To make things worse, HUD has also decided to end its support of the satellite "new town" program in favor of expanding its older city reform effort. The satellite community effort facilitated the conversion of large landholdings into carefully planned, economy-conscious, fast-growing small cities--very appropriate sitings for MIUS. Cessation of HUD's federal loan guarantees for new town projects ensures a moratorium on their initiation, and thereby further reduces the number of likely customers for a MIUS.

As of fall 1978, the HUD MIUS project was moving into Phase III. Aimed at developers, designers, and municipal officers, the two-year Phase III effort may lead to a new set of site-specific plans for an actual MIUS. In addition, the National Bureau of Standards is scheduled to conduct seminars on MIUS at several university engineering schools. This level of activity is a far cry, however, from the dramatic momentum of the now-defunct St. Charles project, and still leaves the near-term prospects for MIUS in considerable doubt.

Two additional sources of uncertainty warrant mention in any effort to predict the near future of the MIUS development projects.

First, HUD has joined the U.S. Department of Energy (DOE) in an Oak Ridge-MIUS effort to develop a fluidized-bed, coal-fired energy package capable, among other things, of powering a MIUS. The technological difficulties here remain formidable, and prominently include the likely creation of a local air pollution problem (due to the on-site nature of the MIUS) and a wastewater disposal problem (due to the nature of slurry systems under consideration). Nevertheless, the use of coal rather than gas or petroleum could help make MIUS economics all the more attractive to utilities and developers.

Second, DOE is working hard to develop its own MIUS-like Integrated Community Energy System (ICES). It differs from MIUS in its special stress on energy savings, its openness to unavailable "blue sky" technology, and its focus on institutional and commercial, rather than residential, usage. Its success could bolster interest in MIUS. If, on the other hand, ICES is misperceived as a substitute for MIUS, rather than a distinct, noninterchangeable counterpart, its success could deflate any support still left for MIUS.

The final disposition of the six-year-old MIUS project thus remains very uncertain, as the struggle persists to bring it from the drawing boards to operational success, and then on to private-sector acclaim and use.[13] Yet, as it is already a rich source of insight into the art of energy-system innovation, the MIUS saga promises to further reward future study--regardless of the ultimate disposition of the project itself.[14]

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[13] Revealing in this connection is Jobes (1977) and Tichy (1975.)

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PUBLIC OPPOSITION TO NUCLEAR ENERGY: RETROSPECT AND PROSPECT

by

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PREFACE

The Project on Risk Assessment of Rare Events (RARE) research reported herein was supported by the Ford Foundation. Principal investigators for the project are Roger Kasperson (project coordinator), Ian Burton, Christoph Hohenemser, Robert Kates, and Anne Whyte. The authors are indebted to our colleagues but are solely responsible for the views expressed.

INTRODUCTION

Until very recently the place of nuclear energy as a source of electrical power in the United States seemed assured. The conventional wisdom held that the rapid development of nuclear power, at first light water reactors and eventually the breeder, would compensate for the decline in national reliance upon fossil fuels. Even in the face of growing difficulties, the Ford Administration recognized a goal of 200 nuclear plants by 1985 and 600 by the year 2000. While President Carter ostensibly demoted nuclear energy to a secondary status and has opposed the deployment of the breeder reactor, the energy conservation program and the envisioned acceleration of coal production may well fail to fill the void. It is entirely possible that nuclear energy will, after a hiatus, regain its favored status.

The prospect for nuclear energy depends upon a variety of factors: the success of energy conservation, the long-term economic competitiveness of nuclear energy, the growth of coal production, the future availability of uranium resources, and the changing regulatory environment. Prominent among these factors will be a societal consensus that the benefits of nuclear energy outweigh the risks, that the Faustian bargain is worth the price. Currently, signs abound that this consensus is not yet at hand: proposed plants are the target of determined intervenors; Nobel laureates openly disagree on the risks of nuclear energy; middle-level managers resign from a major manufacturer to protest current policy; regulators testify to the inadequacy of current safety measures; local communities ban the shipment of radioactive wastes over their streets; a series of television "specials" air the nuclear debate; and 15,000-20,000 protestors demonstrate at a proposed reactor site in Seabrook, N.H. It is not surprising that one of the most astute nuclear proponents, surveying the situation of nuclear energy in 1977, felt rather like Horatio at the bridge (Weinberg, 1977).

To assess the implications of current trends in public acceptance, we first review the emergence, at both local and national levels, of public opposition to nuclear energy. Second, based upon our recent comparative studies of public attitudes and organized elite opposition, we inquire into the validity of the assumptions underlying alternative explanations of the sources and future of this public discontent.

THE EMERGENCE OF PUBLIC CONCERN

Postwar History

One measure of public concern over a particular issue is its success in competing for space in the mass media; while there is, of course, no necessary correlation between the two, surely media attention is an important factor in shaping public opinion. To evaluate concern in terms of this surrogate, the authors surveyed and categorized all articles appearing in the New York Times between 1945 and 1975 (Figure 1).

Prior to 1955 there was little concern over the risks posed by the various experimental reactors in operation at that time. With the first commercial reactor still to be built at Shippingport, Penn. (1957), the dominant concern was with the effects of atomic bomb and weapons development.

The period between 1955 and 1961, however, was a time of substantial press concern over nuclear safety. A number of accidents were reported: nine persons were injured at Sylvania Electrical Products in New York; there were control problems at the Argonne National Laboratory reactor; a steam explosion shattered the core of an experimental military reactor in Idaho; and the serious Windscale accident in Britain was widely reported. The U.S. Atomic Energy Commission (AEC) issued the first major safety report (WASH-740) citing the possible catastrophic consequences of a major reactor accident (U.S. Atomic Energy Commission, 1957) and Congress debated insurance for nuclear plants. This was also the period in which the first opposition to the siting of nuclear plants by citizen groups occurred. Significantly, concern over nuclear safety at this time correlates closely with a period of intense debate over atomic fallout from weapons testing, suggesting the hypothesis that media attention to nuclear plant safety was largely a product of the widespread protest against fallout (Mazur, 1975). The AEC responded to these developments by setting new safety standards, conducting extensive experiments and tests, and sponsoring a conference on nuclear plant safety.

Between 1961 and 1968, the nuclear energy industry grew rapidly. While there was only 1 plant in operation prior to 1961, by 1968 there were 14 with another 39 under construction. Moreover, the size of reactors had increased from the 90 megawatts-electric (MWe) of the Shippingport reactor to reactors 8 to 10 times its size. This was also a time within the AEC of soul-searching over the possible effects of a major loss-of-coolant accident (1965-66), the adequacy of siting practices, and the commissioning and subsequent suppression of an update of the 1957 safety report (Mulvihill *et al.*, 1965). Yet, despite the seeming context for a growth of public concern in the 1961-68 period, it instead appears from Figure 1 to have declined precipitously.

Two factors may explain this discrepancy. In 1963, the signing of the Partial Test Ban Treaty eased public fears over fallout from nuclear testing and likely contributed to a decline of concern over nuclear reactor development. Secondly, by the middle of the decade, Vietnam and the outbreak of ghetto riots diverted the attention of the press, and the nuclear issue faded from public attention.

Beginning in 1968, the burgeoning environmental movement revived dormant public concern. At first the focus was largely on possible adverse environmental impacts, particularly thermal pollution. In 1970, the Calvert Cliffs decision forced the AEC to include environmental impacts in its licensing decisions, and this institutionalization of environmental protection contributed to a shift of public attention from environmental to safety issues during the 1970's. Concern over nuclear safety, as Figure 1 indicates, escalated dramatically. During 1971-72, the rule-making hearings on emergency core cooling systems

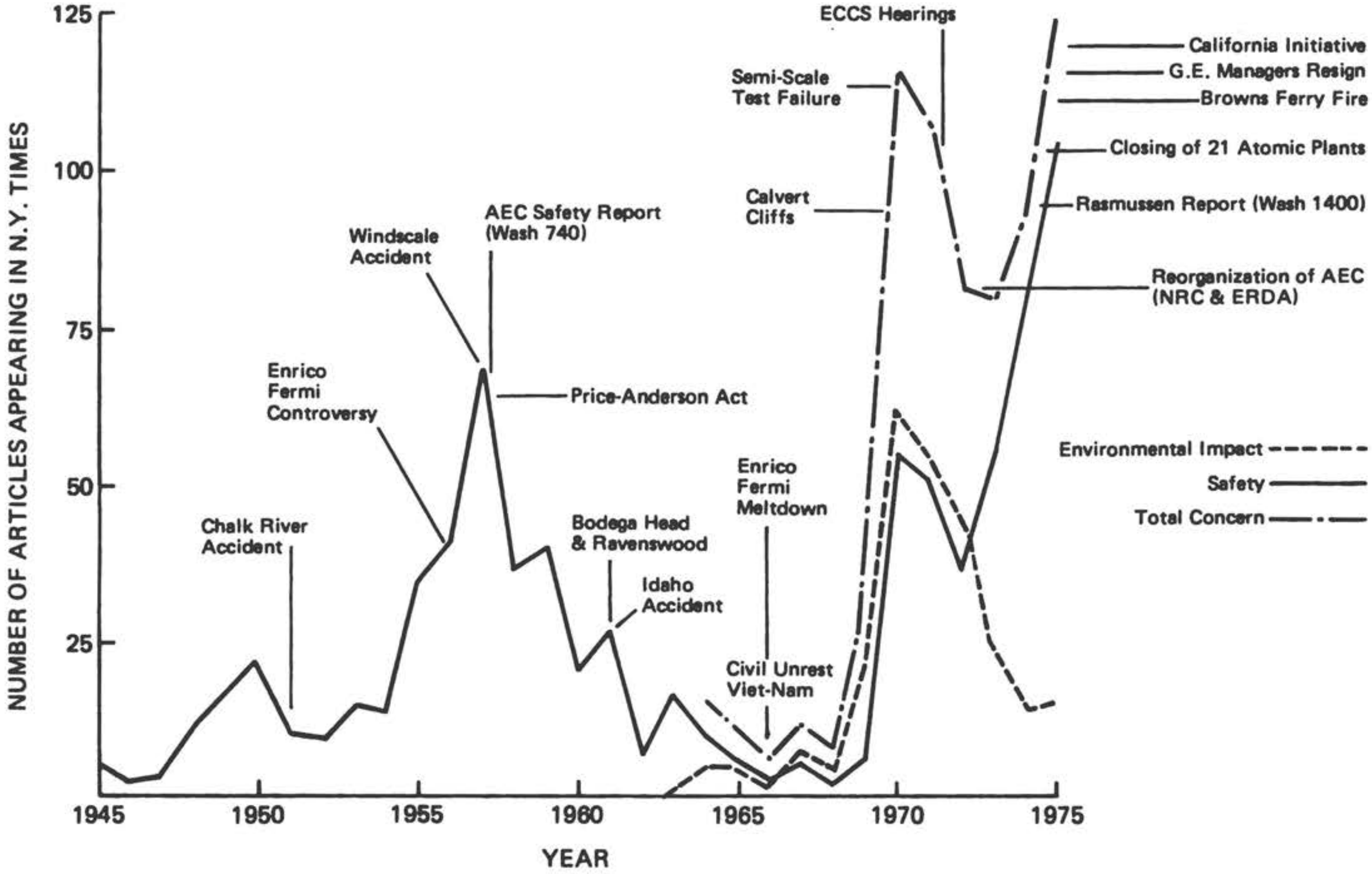

FIGURE 1 Concern over nuclear safety and environmental impacts, 1945-1975.

publicly revealed widespread disagreement among AEC safety experts over the adequacy of safety systems (Cottrell, 1974; Ford and Kendall, 1972; Primack and Von Hippel, 1974, pp. 208-235). The following year Ralph Nader and the Sierra Club took up the cudgels against nuclear energy and the national antinuclear movement was under way.

Local Initial Focus

The emergence of the antinuclear movement, as indicated by the widespread concern in the press since 1968, had its roots in the local areas where nuclear plants were proposed or actually built. The 1954 Atomic Energy Act provided for interested citizens to participate in construction permit hearings, and 1957 amendments made public hearings mandatory before the issuance of any license or permit. Yet the obstacles to citizen participation have been formidable. The prehearing conference among the Nuclear Regulatory Commission (NRC), the Advisory Committee on Reactor Safeguards (ACRS), and the applicant excludes the public; citizens lack the extensive funds needed for attorneys and expert witnesses; the stringent time schedule works against the intervenor; and, finally, some types of data (privileged information) are unavailable to the intervenor whereas other types are manipulated to substantiate decisions already taken (Green, 1974; Ebbin and Kasper, 1974; Keating, 1975).

Despite the obstacles, the licensing hearings have been the only available arena for public participation. Accordingly, opponents are compelled to articulate general concerns into allegations of specific inadequacies in plant features, topics on which they have little competence and few resources. Locked into a no-win situation, they use delay, with the potential of costing the utility up to $1 million per month, as a bargaining tactic for winning concessions (Green, 1974). As a result, the licensing process ends up frustrating all parties involved.

The first grass-roots opposition to a nuclear plant occurred in 1956 over the construction of the Enrico Fermi Experimental Fast Breeder Reactor at Lagoona Beach, Mich. In 1961 a proposed plant at Bodega Head, 50 miles north of San Francisco, sparked local opposition centered on damage to a unique natural coastal environment and on possible safety hazards arising from the proximity of the site to the San Andreas fault line. The plant was cancelled in 1964. In 1962, a proposal by Consolidated Edison to construct a 1,000-MWe plant at Ravenswood, in the Queens area of New York City, elicited widespread local opposition as well as grave concern in the ACRS and in the AEC regulatory staff (Advisory Committee, 1962-63). This plant was also cancelled. Despite the decline of overall public concern (at least as indicated by media attention) during the 1960's, local controversy not only did not diminish but increased with the expansion of nuclear energy in the United States through 1976.

Perhaps the best documented case of intervention is Dorothy Nelkin's study of the successful local opposition to a nuclear plant at Lake Cayuga in upstate New York (Nelkin, 1971). The controversy illustrates well the dominant concerns of the late 1960's. In this case the response of local scientists based at Cornell University provided the scientific and technical resources for a citizen group (The Citizens' Committee to Save Cayuga Lake) concerned with possible thermal and radioactive contamination of the lake. To force more adequate environmental safeguards, the group used a strategy of airing issues, educating the public, and creating costly delays. Under skillful leadership, the organization burgeoned from 60 to 854 paid members within a year. Eventually, the inability of the utility to resolve the technical issues and its unwillingness to bear the high cost involved in design modification forced postponement of the application.

Categorizing Local Opponents

To provide comparative data on current local conflict, we undertook a study of local antinuclear organizations at four proposed nuclear plants in the Northeast (Jamesport, N.Y.; Greene County, N.Y.; Charlestown, R.I.; Seabrook, N.H.). We identified some 42 organization leaders for interviews according to the "snowball" technique: an initial set of leaders was identified from hearings transcripts, newspaper accounts, EPA files, or by nomination by town officials. Each initial interviewee was then asked to nominate other prominent local opponents and organizations. When no new names appeared, the list was assumed to be complete.

We next categorized the local antinuclear leaders into four major types--private, parochial, environmental, and ideological. *Private* opponents are those motivated by self-interest, particularly material well-being. *Parochial* opponents are community activists who object to community impacts but not the nature of the facility. *Environmental* opponents have a history of involvement on environmental issues predating their antinuclear opposition. *Ideological* opponents are those with a history of opposition to nuclear power as a technology predating the present site conflict. Although classification cannot eliminate some overlap between ideological and environmental opposition, it is useful in highlighting some characteristics of local organized opposition.

It is apparent that while all leaders expressed their opposition in similar terms, a diversified set of concerns underlies the opposition. The 20 private and parochial opponents were largely concerned with impacts that were not specific to nuclear plants but would be found associated with a coal-fired plant or, often, with other large construction projects. The 8 environmental opponents have been drawn into nuclear opposition recently, whereas the 14 ideological opponents have a long history of disenchantment with nuclear energy due to fallout, disarmament, or medical-health reasons. It is clear that diverse local organizations exist to take up the battle with nuclear energy, and the potential scope of community mobilization is broad.

The leaders reveal a number of common demographic and socioeconomic characteristics. While one-half of the male leaders could be categorized as opposing nuclear energy for private reasons, only 5 percent of the female leaders were similarly inclined. Instead, all but 2 of the 19 women involved were ideological or environmental. Further, in the interviews almost half of the women but only one-fourth of the men expressed concern over the moral issues of nuclear power--the genetic effects of radiation, the burdening of future generations with radioactive wastes.

There appears to be no shortage of talented and effective leadership resources available to localized opposition. Most leaders had rather extensive prior political experience, and nearly all came from professional backgrounds or were spouses of professionals. All the environmental and ideological opponents, but only two out of three of the privates and parochials, had previously been active in a variety of local organizations. While a strong environmental concern is nearly universal, the leaders also share, or at least state, a strong interest in energy conservation, alternative energy sources, the decentralization of political and energy systems, nuclear safety, and waste disposal.

Finally, it is clear that whereas the rather specific environmental concerns that characterized local controversies during the 1960's continue, the fire in the opposition has shifted to the more generic safety and ideological issues connected with nuclear energy. Local concerns closely mirror the issues raised by national antinuclear forces. And more and more, the intent of the protest is not to force a change in design to upgrade safety or alleviate some environmental impact, but rather to put an end to any nuclear (or perhaps any other) plant at all.

Local linkages with national antinuclear outlets are close--local leaders talk comfortably of the Rasmussen Report, critiques by the Union of Concerned Scientists, and recent articles in Science magazine and the Bulletin of the Atomic Scientists treating fuel-cycle risks. This apparently high level of information is consistent with the findings of a recent study of public values toward nuclear waste disposal which revealed that of 20 groups studied, members of the environmental organizations (national and local) rated themselves higher in knowledge than all other groups save environmental scientists and public officials, corporation engineers, public interest lobbyists, and members of an undergraduate physics class (Maynard *et al.*, 1976). There is, in short, a conventional wisdom in nuclear opposition, and the extent to which it is shared by even the smaller of local antinuclear organizations is quite remarkable. But while grass-roots opponents are, by any measure, highly informed, they often are not knowledgeable in the larger sense. The information contains systematic biases, originates from sources committed to a particular stance, fails to apply similar exacting standards to the risks of other energy sources, and tends to see alternative energy sources, especially solar energy, as a panacea. As with the committed proponent, the antinuclear activist uses data and events to support a preconceived position, with the result that new pieces of information have little impact on existing attitudes. This is perhaps nowhere more apparent than in the differing assessments of the Brown's Ferry fire (Nuclear Regulatory Commission, 1976; Lanovette, 1975).

Thus, while local opposition continues to be quite variegated, it is increasingly a creature of the national crusade against nuclear power.

THE ESCALATION OF CONFLICT

From the isolated clashes over individual reactors, a coordinated national campaign of nuclear opposition emerged that finally succeeded in inserting the nuclear issue into the 1976 Presidential campaign. It was probably only a matter of time until the overlapping concerns among intervenors at various sites produced some cooperation. Daniel Ford's successful local intervention at Indian Point, N.Y., coupled with a series of unsuccessful tests on the emergency core cooling system of the light water reactor at the major safety consulting laboratory, prompted the AEC to call for rule-making hearings in Washington, D.C., in 1971 and 1972. These hearings were a benchmark in the history of the antinuclear movement because they sparked a national coalition of environmental groups and local intervenors and revealed widespread disagreement within the AEC regulatory staff and in the national laboratories over the adequacy of safety programs (Cottrell, 1974).

On the heels of a remarkable series of Science magazine articles on the disarray of the nuclear safety program (Gillette, 1972) and the inadequacies uncovered in the emergency core cooling system hearings, Ralph Nader and the Sierra Club decided to take up nuclear opposition. By 1976, Ralph Nader stood as the titular head of opposition to nuclear energy. Critical Mass, a Nader-led antinuclear organization, sponsored and coordinated a national meeting in 1974 which attracted more than 100 antinuclear groups from throughout the United States (Bronfman and Mattingly, 1976). While the major topics of the meeting were reactor safety and a moratorium on any further construction of nuclear power reactors in the United States, the overriding ideological issue was no less, in Nader's phrase, than "the democratic control of technology" (New York Times, 1976). Nader forces decided to begin initiative campaigns in several selected Western states.

Between 1974 and 1975, nuclear opposition made impressive strides. "Critical Mass '75" drew representatives from still more groups, and the early success in the initiative signature drives led to a change of strategy--the launching of a massive effort to shift the nuclear debate from the area of industry strength in Washington, D.C., to the states, where environmental and consumer groups are more effective. The so-called "Western Bloc," composed of some 22 state coalitions, coordinated the initiative campaigns.

The first major test of this political strategy, and of the muscle of the Nader-led antinuclear movement, occurred in the 1976 California referendum. Spearheaded by the People's Lobby, a Los Angeles-based group, the initiative forces managed to enlist the support of a number of established environmental organizations such as the Sierra Club, Friends of the Earth, and the Planning and Conservation League. These veteran groups, however, were having difficulty collecting the required signatures before Project Survival, a new activist citizens' group utilizing innovative tactics, intervened and completed the task in four weeks. Western Bloc was then established as the umbrella organization for the initiative and staffed with a Nader organizer from Washington.

The initiative (Proposition 15) was dazzling in its complexity, requiring a two-thirds decision by the state legislature on the adequacy of reactor safety and technology for storing or disposing of nuclear wastes, and a provision for unlimited liability for a nuclear accident. If these stipulations were not met, existing plants would have to reduce output to 60 percent of licensed capacity by 1981 and shut down by 1987 unless the safety verdict changed. In the end, the initiative was rejected by a greater than two-to-one margin, and subsequent initiatives in six other states in the fall of 1976 produced very similar results (Table 1).

Surveys of the grass-roots strength of antinuclear organizations also testify to the growth of the nuclear controversy. Sen. Mike Gravel (D.-Alaska), in his 1975 survey of the antinuclear movement, identified some 140 antinuclear groups (Gravel, 1975). Similarly, The Directory of Nuclear Activists (Environmental Action of Colorado, 1975) identifies some 139 antinuclear organizations, many with local branches or chapters, as well as an impressive inventory of audio and visual aids, library and graphics resources, periodicals, and individuals to act as speakers, to lobby, or to provide testimony. Perhaps the surest sign of the success of a social movement in acquiring legitimacy is a demonstrated capacity to elicit the support of a sizable portion (even if a minority) of the electorate. The state initiatives, as well as the national polls, have demonstrated this measure of success for the antinuclear movement. The entrance of the nuclear issue into the 1976 Presidential election and its role in the Carter energy plan clearly indicate that the escalation of controversy has not only placed the nuclear issue on the national agenda but has jeopardized the future of nuclear energy.

TABLE 1 Summary of Initiative Referenda

Initiative Referenda to Restrict Nuclear Power	For (%)	Against (%)
California (1976)	33	67
Arizona (1976)	30	70
Colorado (1976)	29	71
Montana (1976)	42	58
Oregon (1976)	42	58
Ohio (1976)	32	68
Washington (1976)	33	67

Linkage to the Environmental Movement

The growing opposition to nuclear energy cannot be explained as simply the tip of an iceberg of public discontent. Public opinion polls continue to show consistently strong public support for nuclear power, and the seven state initiative results add credence to the polls. Nuclear energy would probably not be in trouble today were it not for the opposition's roots in a broad-based social movement, namely, the environmental movement.

There is substantial evidence that environmental activists are spearheading the opposition to the development of nuclear energy. Our comparative study of local antinuclear organizations described above revealed a central role for environmentalists. The 1975 and 1976 Harris polls on attitudes to nuclear energy found that, of the various groups sampled--political leaders, business leaders, regulators, people living near nuclear plants, environmentalists--all supported the building of more nuclear plants by a better than two-to-one margin except for environmentalists, who were opposed by four to one in 1975 and two to one in 1976 (Louis Harris, 1975, 1976). Two-thirds of 30 leaders belonging to an umbrella group of activists called the National Intervenors were active in the environmental movement prior to their involvement in the nuclear energy controversy (Mazur, 1975, p. 68). More than one in three nuclear-activist organizations listed by Environmental Action of Colorado (1975) can be categorized by name as environmental, and the figure is probably closer to one in two. Environmental groups and issues have played a prominent role in nuclear opposition in both France and Sweden (Bupp and Derian, 1975).

Over the past decade, the environmental movement has not, as some predicted, dissipated in the face of the energy crisis, the recession, or other pressing social concerns. In fact, there is growing evidence that it is deeply rooted in the American public and will not fade quickly from the public scene (McEvoy, 1972; Buttel and Flinn, 1974; Opinion Research, 1975). While the passion of the Earth Day drama and guerrilla attacks on polluters may today be gone, the movement has reached downward in social class to embrace the lower middle (but not the lower) class. Support for the environmental movement, in fact, now reveals a remarkable consistency across age-groups, regions of the country, sex, and (with the notable exception of the lower class) income and education groupings (Opinion Research, 1975).

As the environmental movement has matured in organization and in the sociology of its support, so, too, has its theory acquired increased sophistication. Earlier concern with special segments of unique or irreplaceable environments has given way to a more comprehensive approach to the environment involving a new concern for urban environments; a rethinking of the long-accepted norm of growth and technological progress; and a preference for low- or appropriate-technology solutions, Buddhist economics, and decentralized participatory decision making.

Nuclear energy collides head-on with these concerns. Thus, it is not concerned with specific adverse environmental impacts of nuclear plants which today form the backbone of opposition from environmental groups. Rather, it is the more generic issues--safety, waste disposal, and a set of interrelated questions about high technology, growth, and centralization--which are primary concerns. The Sierra Club, for example, in its 1974 resolution based its opposition to nuclear energy development on three counts: "The Sierra Club opposes the licensing, construction and operation of *new* nuclear reactors pending . . . resolution of the significant safety problems inherent in reactor operation, disposal of spent fuel, and possible diversion of nuclear material capable of use in weapons manufacture . . ." (Sierra Club, 1975).

Environmentalists as a group are substantially more critical than the public in their assessment of the safety of nuclear energy. Not only do they see accidents, nuclear explosions, and escape of radioactivity as major problems, but they also indicate grave concern over sabotage and plutonium theft (Louis Harris, 1976). Further, they have taken the lead in bringing these issues to the attention of the public.

The entrance of nuclear wastes into the biosphere constitutes a second major source of nuclear opposition. For the environmentalists, plutonium, a man-made pollutant of extreme toxicity and longevity, seems to symbolize uniquely the central concern of the environmental movement--the fear that technological growth will destroy earth as a home for humanity. Their concern, therefore, appears to extend well beyond the current problems accruing from a decade of inaction on the waste disposal problem or the actual risks of waste disposal. "In exchange for relatively short-term gains, to what extent may one generation jeopardize the safety and well-being of future generations and the environment?" the Sierra Club (1975) queries.

The severity of environmentalist worry over waste disposal into the biosphere is quite impressive. A handful of leading environmentalists were instrumental in drafting the highly critical National Council of Churches' report on the "Plutonium Economy" (National Council of Churches, 1976); a provision demanding an acceptable solution to the waste disposal problem appeared on the seven state initiatives; the environmentalist media consistently register deep concern over this issue; and waste disposal has played a major role in nuclear energy controversies in Canada and a number of European countries (Mackintosh, 1975). In short, nuclear waste is rapidly becoming one of the prime *bêtes noires* of environmentalists, and it is unlikely that even the dramatically expanded federal research and demonstration effort will allay these fears.

High technology, centralization, and growth form a nexus of concern among environmental activists. Nuclear energy, perhaps more than any other energy source, symbolizes a commitment to growth and consumption. The voluminous environmental impact statements and safety analysis reports issued by the NRC also indicate just how remote the individual citizen is from decisions on this complex technology. As a highly centralized industry regulated largely in Washington, D.C., nuclear power runs directly counter to the citizen-action base of the environmental movement and raises fears of the "technological state." Decentralization of energy systems would, in the antinuclear view, not only save energy and capital outlay, reduce pollution, and enhance self-reliance but also "encourage essentially grass-roots efforts involving individual and community action and small businesses, thus giving many people the opportunity to do something effective to help solve the world energy problem" (Friends of the Earth, 1976, p. 2).

The strong linkage apparent between the environmental movement and the organized local and national opposition to nuclear energy is less apparent when one turns to the general public. There the patterns of attitudes are only now beginning to become clear.

WHITHER THE PUBLIC?

The study of public attitudes toward nuclear power is still in its infancy, but a handful of national probability surveys, several localized in-depth studies, and a number of less systematic polls have now been conducted throughout the industrialized world (Table 2). There is now at least fragmentary evidence for an initial comparative assessment of public attitudes toward nuclear power and the bases of public opposition to nuclear power in North America and abroad, with the caveat that the state of the art in this area is still painfully rudimentary.

The surveys conducted in the United States are remarkably consistent in their conclusion that a large majority of Americans favor the development of nuclear power. Approval usually ranges from 55 to 70 percent (approximately the same range indicated in the seven initiative results). This support tends to dissipate, however, as the issue moves from general policy at the national level to the actual building of plants in the respondent's community. For example, the Canadian national survey found that while 68 percent of the public favored the building of nuclear plants in Canada, support dropped to 63 percent for new plants in the respondent's province, and down to 40 percent for a prospective plant in the respondent's community (Greer-Wooten and Mitson, 1976, p. 103). Similarly, the 1976 Gallup Poll in the United States found that more respondents were opposed than not opposed to the building of a nuclear plant within five miles of their home (Gallup, 1976, p. 5). Nevertheless, the findings of the U.S. surveys to date suggest that most Americans support the national development of nuclear power.

While public support in the United States is noteworthy for its consistency, the international picture is sharply divergent. Strong public support is apparent in Canada, Great Britain, France, and Finland, while broad-based public opposition exists in Sweden, Norway, Japan, and West Germany. In Canada, where the nuclear program has been largely confined to the province of Ontario, public support for nuclear power continues to be high. The British public has, despite the mixed record to date, endorsed the nation's nuclear energy program (Bonnell and Dale, 1973), although the fact that no new plants have been ordered since significant opposition began in other countries undoubtedly contributes to the lack of opposition (Surrey and Huggett, 1976, p. 291). In France there was an intense 18-month national debate (1974-75) culminating in an antinuclear march by 20,000 persons in Paris and large-scale protests in 1977 against the Super Phenix breeder reactor; nonetheless, the public has, on the whole and at least in the recent past, supported the government's rapid development of nuclear energy (L'Express, 1975). In Finland,

TABLE 2 Comparative Summary of Public Opinion Surveys

				Attitude to Nuclear Power (%)		
Survey	Location	Scope	Sample Size	Favor	Oppose	No Opinion
Public Service Co. of New Hampshire (1972)	U.S.	2 N.H. counties	350	52	10	38
Becker Research Corp. (1973)	U.S.	National	1,431	61	13	26
Becker Research Corp. (1974)	U.S.	National	1,252	64	17	19
Harris Poll (1975)	U.S.	National	1,536	63	19	18
Harris Poll, Nuclear Site Survey (1975)	U.S.	3 Sites	301	63	23	14
Oak Ridge Lab. (1975)[a]	Tennessee	1 City & county	350[b]	62	27	11
			288[c]	68	22	--
Eagleton Institute of Rutgers University (1975)	New Jersey	State	?	74	16	10
Project RARE (1975)						
Boston	U.S.	1 City	100	69	24	7
London	England	1 City	100	62	25	13
Toronto	Canada	1 City	100	83	9	8
Project RARE (1976)						
Boston (data normalized)	U.S.	1 City	243	58	42	--
Indian Point, N.Y.	U.S.	1 City region	100	47	49	4
Waterford, Conn.	U.S.	1 City region	100	65	28	7
Seabrook, N.H.	U.S.	1 City region	100	63	32	5
Gallup Poll (1976)[d]	U.S.	National	1,524	Not against, 42; against, 45; NR, 13		
Harris Poll (1976)	U.S.	National	1,497	61	22	17
Harris Poll, Nuclear Site Survey (1976)	U.S.	3 Sites	309	70	21	9
Ontario Hydro (1974)	Canada	Local region	700	67	4	29
York University (1976)	Canada	National	2,100	68	21	11
L'Express (France) (1975)	France	National	--	51	--	--
SOFRES (France) (1976)	France	National	?	55.5	33.5	11.0
SIFO (Sweden) (1974)	Sweden	National	600	?	59	?
SIFO (Sweden) (1975)	Sweden	National	600	31	63	24
Netherlands	Netherlands	National	--	20	33	45
Gallup Institute of Norway	Norway	National	1,600	Prefer hydro, 44; nuclear, 17; existing, 31; DK, 8		
NZIE (1975) (data normalized)	New Zealand	National	?	Prefer nuclear, 24.6; oil, 27.8; coal, 47.6		

[a] The question asked whether the respondent would permit construction of the proposed TVA plant.

[b] January.

[c] August.

[d] The question asks attitude toward a plant within 5 miles of the respondent's home.

the lack of alternative energy sources has doubtlessly reduced the appeal of nuclear opponents (Miettinen, 1976).

Sweden presents perhaps the most striking case of the emergence of strong national sentiment against nuclear energy. In the early 1970's Sweden had embarked on an ambitious nuclear energy program with the unanimous endorsement of Parliament, and apparently strong public support. In 1974, a privately commissioned national survey by the Center Party revealed, surprisingly, that almost half the respondents were "strongly committed" against nuclear power and only one in four favored the building of any additional nuclear plants. In the ensuing national debate, political parties launched some 7,600 study groups throughout Sweden, each composed of 10 to 20 persons, to debate the nuclear power issue. By 1975, the Swedish Institute of Public Opinion Research found that while a large majority accepted the existing nuclear program, Swedes opposed any expansion beyond the envisioned 11 reactors by 63 to 31 percent (Surrey and Huggett, 1976, p. 302). The defeat of the Social Democrats in 1976 has been widely attributed to the intrusion of the nuclear issue, although the actual impact must await more authoritative study.

In Norway, a poll conducted by the Gallup Institute of Norway (1974) showed a strong preference for the expansion of hydroelectricity and more efficient use of existing sources over the building of nuclear power plants. In Japan, a country where the energy situation makes nuclear energy highly attractive, the legacy of public fears from Hiroshima, concern over marine pollution, and a lack of available sites constitute formidable obstacles to Japan's ambitious program of nuclear expansion (Langner, 1974; Surrey and Huggett, 1976). In West Germany, well-coordinated national opposition has emerged since the announcement of the Fourth Nuclear Power Program in 1973. In the Netherlands there is considerable ambivalence in public attitudes though substantial opposition is apparent (Smith and Spanhoff, 1976). The debate in the Soviet Union has been largely confined to the scientific community (Grunbaum, 1976), despite national plans to mass-produce nuclear reactors.

Socioeconomic Correlates

Perhaps the single most noteworthy characteristic of public response to nuclear energy is the difference between men and women. The two Harris polls found that 70-73 percent of men, but only 52-54 percent of women, favored nuclear power (Louis Harris, 1976, p. 95). In research conducted by the authors as part of the Project on Risk Assessment of Rare Events (RARE) in 1976, 243 person-in-the-street interviews in Boston and 300 residential interviews selected by random cluster sampling at three nuclear reactor sites (Indian Point, N.Y.; Waterford, Conn.; and Seabrook, N.H.) revealed that 2 of every 3 men in both surveys supported nuclear energy but only 1 of every 2 women was similarly inclined. The Canadian National survey (Greer-Wooten and Mitson, 1976), the Oak Ridge study (Sundstrom *et al.*, 1977), and Groth and Schutz (1976), also confirm a substantial sex difference in attitude. In addition, our study of local antinuclear leaders reported above (pp. 266-267) indicates a prominent role for women among activist opponents. While men outnumbered women by six to one among civic and private interest (primarily farming and fishing) leaders, women predominated by better than two to one among environmental and antinuclear leaders.

This difference in response between men and women, and the size of that difference, is the more remarkable since recent polls have shown few differences between the sexes in attitudes to environmental issues. One of the ingredients of this differential response is undoubtedly the safety issue. All the studies to date which have examined this question reveal that women are more concerned and uncertain than men over this issue. Based on his analyses of sex differences in the Louis Harris (1975) poll, Otis Dudley Duncan suggests that the woman "not sure" may actually be registering dissent from the majority of men (Duncan, 1976). The linkage that many people make between nuclear plants and nuclear weapons (there is widespread, and ill-founded, concern that a plant will explode) may play a significant role in these sex differences for it is known that women across a variety of cultures are less prone to violence and more concerned about loss of life than men (Setlow and Steinem, 1973; Steinem, 1972).

There is further direct empirical evidence of significant sex differences in concern from our Project RARE interviews at the three nuclear reactor sites of Indian Point, Waterford, and Seabrook (see Table 2). In response to a sentence completion item with the stem: "When I think of the nuclear power plant, I feel ______________," twice as many women as men (37 to 16 percent) answered with anxiety, while twice as many men as women (42 to 21 percent) cited progress and benefits. In response to a stem: "When I hear the word radiation, I __________," 23 percent of the men, but 41 percent of the women, responded with anxiety. Finally, of those who responded to the radiation stem by showing concern over disease (and especially cancer), two out of three were women.

Outside of this striking sex difference, other possible socioeconomic correlates reveal more ambivalent results. The Louis Harris polls (1975, 1976) and the 1971-72 surveys reported by Mazur (1975) found a tendency for better-educated persons to be more supportive of nuclear energy, but the Greer-Wooten and Mitson (1976) and Sundstrom *et al.* (1977) surveys found no clear relationship. Our Project RARE surveys in Boston and the three reactor sites and the California initiative voting study, on the other hand, found an *inverse* relationship between education and support for nuclear energy. While the Harris Poll and the California initiative study found greater support among the more affluent, other surveys have found no such relationship. Finally, there appear to be some significant regional differences in attitudes--the Louis Harris polls (1975, 1976) found opposition greatest in the East and support greatest in the West; the Canadian survey (Greer-Wooten and Mitson, 1976) found the Province of Ontario (where existing reactors are located) most supportive and British Columbia (with ample alternative energy sources) the most opposed.

Geographical Hypocrisy

Opposition to nuclear energy could well be a function of the degree to which an individual benefits or experiences costs from the technology. One of the problems of a high technology with huge capital investments is that the installations provide highly concentrated tax benefits to the host community while distributing only diffuse benefits (ample energy at reasonable cost) but concentrated risk to the surrounding region. Opposition could well be expected to arise, then, in a doughnut-shaped pattern around a nuclear plant's host community, where residents of neighboring communities find a nearby nuclear plant provides them with no tax incentives but exposes them to possible consequences of accidents or sabotage. Carey and Greenberg (1974, p. 249) have described this behavior as follows: "One anticipates hypocritical behavior on the part of small communities; costs--ecological and otherwise--are likely to be overlooked with respect to their own benefit-concentrating projects, but their neighbors' projects will elicit outraged opposition."

To test this hypothesis for nuclear power plants, we examined both overt behavior and survey data results. We first analyzed the distribution of local opposition leaders by place of residence. The resulting pattern is inconclusive; opposition leaders came from both the host community and surrounding towns. Turning to our surveys of the public at the 3 reactor sites, we compared attitudes of respondents within the host community with those just outside the corporate limits (or taxing jurisdiction) but within 15 (and usually 5) miles of the plant. The results reveal a remarkable *lack of difference* between the two populations. Both showed the same level (within one percentage point) of aggregate support, and although both were generally aware of the tax benefits accruing from a plant location to the host community residents, our results showed no significant difference in risk assessment or perceived safety of the plant. Nor were there any differences in our open-ended sentence completion items dealing with nuclear safety. All of these consistencies stood up when the relationships were controlled for site.

Several interpretations of these results are possible. Since environmental and ideological concerns motivate most opposition leaders, they are probably relatively unmoved by the benefit/cost calculus. The lack of significant geographical variation in public assessment of risk is more puzzling. This may be explained in part, however, by the possibility that utilities may locate plants strategically in areas with high unemployment or low environmental awareness and where surveying suggests that only minimal opposition is likely to arise. If that is the case their information is frequently faulty. Alternatively, residents in the host community may be skeptical of the potential benefits likely to occur. Although our surveys confirm a fair amount of such wariness, there is still substantial expectation of tax rewards. We do know, from the Louis Harris and Gallup polls, that attitudes tend to become more negative as the policy of nuclear development moves from the national to local level. It may well be that the perceived benefits involved, particularly if there is some skepticism that they will actually come true, may be insufficient to overcome heightened safety and community-impact concerns.

Risk Assessment

While Americans cite a number of advantages of nuclear power development (energy independence, lower fuel costs, less pollution), they clearly harbor some deep concern about this technology. Opinion polls taken across the United States consistently report qualms about the release of radioactivity, potential catastrophic accidents, waste disposal, and thermal water pollution. Our detailed evaluation of risks by Boston respondents shows that 9 of 10 respondents could, in free response, cite some hazards in response to the question: "What do you see as the dangers or risks of nuclear power?" These results taken together with the Louis Harris and Canadian polls (Greer-Wooten and Mitson, 1976), indicate that the public sees safety rather than adverse environmental impact as the major risk of nuclear plants and that a diversified set of concerns underlies the safety fears. Reactor operation risks (including routine risks), fear of explosions, and waste disposal questions dominate public concern over nuclear fuel-cycle hazards. Interestingly, those surveyed apparently do not yet fully share the current concern of antinuclear activists over sabotage, theft, and transportation accidents or the preoccupation of many scientists and policymakers with nuclear proliferation, though this may represent in part a lag in the trickle-down of issues.

Among the various fuel-cycle risks, waste disposal could well prove to be the one most difficult to resolve for the public. Harvey Brooks notes that from the start this issue has been the primary obstacle to the social acceptability of nuclear power (Brooks, 1976, p. 1). The second Louis Harris survey (1976) revealed that 67 percent of the respondents believe that radioactive waste disposal is a major problem. Several other studies provide credence to these survey results. A study of voter attitudes in Sacramento County toward the 1976 California initiative concluded that "the principal drawback of nuclear energy plants in the perception of our respondents was specifically the difficulty of safe waste disposal" (Groth and Schutz, 1976, p. 15). A careful study of a well-educated, high socioeconomic status group of subjects who were professionally experienced in energy research revealed that the creation of noxious wastes outscored all other determinants of attitudes toward nuclear energy (Otway and Fishbein, 1976, pp. 11-12). Interestingly, the waste disposal problem is the issue on which there appears to be greatest divergence in expert and public risk assessment. As revealed most recently in the MITRE (1977) report, experts tend to see high-level waste management as a relatively solvable problem, while for the public it may well be seen as a relatively intractable public policy issue. This assessment gap has been established experimentally by research at Battelle laboratories (Maynard *et al.*, 1976). A series of very difficult value issues, involving the dislocation of benefits and risks over time and regions, the public valuation of life today compared to life hundreds of years from now, the trade-off between safety for the public and safety for the worker, and the likelihood of future social disruption, exacerbate the concern over the risks of waste management (Kasperson, 1977).

Central to public risk assessment is suspicion about industry and regulator efforts to reduce or minimize these risks. Whereas tne Louis Harris (1975) poll found that only 20 percent of the public judged nuclear power as either "not so safe" or "dangerous," the Gallup (1976) poll revealed that only 34 percent of respondents felt that nuclear plants were safe enough, while 40 percent were sufficiently concerned to advocate cutting back plant operations. Respondents to our survey in Boston and in the three reactor sites bear out this concern over the residual risks. In Boston, a city likely to be more skeptical than the nation as a whole, 44 percent of the public viewed nuclear energy as "not so safe" or "dangerous," while at the three reactor sites the comparable figure was 30 percent. Boston and nuclear site respondents disagreed over the adequacy of safety precuations taken to deal with these risks, however; Bostonians by 45 to 36 percent found the precautions inadequate, whereas nuclear site residents by 55 to 34 percent judged them as adequate. What is significant about these figures is not the majority view but the existence of even a substantial minority of concern for a technology once viewed as possessing unlimited benefits for society.

Elsewhere the senior author and colleagues describe the public assessment of nuclear power as hypercritical (Hohenemser, Kasperson, and Kates, 1977). While the risks of nuclear power appear to be no greater than, and perhaps substantially less than, other generally accepted technologies, the public distrust of nuclear energy not only is not dissipating but in fact appears to be growing daily. The reasons for this are not well understood but several issues are involved. A recent psychometric study of nine risk considerations--voluntariness, immediacy, newness, chronic nature, known to the exposed, known to science, controllability, commonness, and severity of consequences--revealed that nuclear energy, when compared with 29 other technologies, elicited the greatest concern (Fischhoff *et al.*, 1976). The origins of nuclear energy as a means of destruction and increased societal concern over the quality of the environment are important sources of the present public distrust. To this Weinberg would add the newness and persistence of radioactive hazards, the diversion problem, and the meticulous attention to detail that nuclear technology requires (Weinberg, 1976).

While it is important to note that the concept of risk does not embrace all the relevant terms of the public assessment of nuclear power, it is also clear that resolution of the safety question will play a central role in the acceptance or rejection of nuclear energy.

TWO CONVENTIONAL WISDOMS

Within the nuclear controversy, opponents and proponents alike have fashioned interpretations of the attitudes and behavior of the public. Since all sides agree that citizens are entering more fully into nuclear policy making, conventional wisdoms have emerged as to how the public can be led to the "right" decision. These wisdoms, more properly myths, include a diagnosis of what is wrong as well as a prescribed remedy.

Stamping Out Ignorance

For the nuclear proponent, the 1970's have been a difficult decade. Until recently, nuclear decisions were considered to be primarily technical in nature; problems were amenable to "technological fix" solutions (as with engineered safeguards), and the major concern was to deploy the technology rapidly enough to exploit its "boundless potential." Only the expert, in this view, is in a position to exercise informed and intelligent judgments in policy or regulatory decisions on such a technically complex issue as nuclear energy. The entrance of first the intervenor and more recently the public--with their potential for decisions by the "uninformed"--threatens the integrity of the traditional policy process. Worse still, the proponent is concerned that the nuclear critic, by exaggerating dangers and playing on fear, may succeed in bilking the people and producing "irrational" decisions.

The entrance of outside parties into the once-exclusive policy making domain was initially greatly disturbing to industry, the utilities, and the regulators; there is now, however, an emerging recognition that what the public can undo it can also put right. A strong public endorsement of nuclear energy could, in this view, return power to those most able to make "good" decisions--the official caretakers of nuclear energy.

This view begins with a definition of the problem: ". . . the possibility of catastrophic failure is one that gives rise to the most lurid horror stories, which have been used by opponents of nuclear power to generate fear in the general public" (Cooper and Langer, 1975, p. 18). Exploiting the "wave of distrust in institutions which has been heightened by the Vietnam and Watergate tragedies, Congress failing to deal with problems, leaders who do not lead, public scandals, and the 'little men's' disillusionment with big government, big business, big anything," the antinuclear forces have made nuclear power a scapegoat (Hosmer, 1976, pp. 2-3). The antidote is also straightforward: ". . . the best answer to the problem of public perception, public attitudes, is information . . . the more people understand about nuclear power, the more they tend to favor it" (Roberts, 1975). In this view, information and education breed public confidence. Stamping out public ignorance, in turn, will stamp out the enemies of nuclear energy and this energy source will again "be positioned rightly and safely in the mix of energy that is essential for maintaining America first among nations and Americans first among the peoples of the world" (Hosmer, 1976, p. 5).

The nuclear community has acted on this view. Industry waged an aggressive campaign in the various initiative states. The Atomic Industrial Forum (a pro-industry group) has expanded substantially its public information program. Hosmer, formerly an influential member of the Joint Committee on Atomic Energy, formed the American Nuclear Energy Council to combat the public activity of nuclear critics. A very skillful set of strategies was formulated for the successful public relations campaign against the antinuclear initiatives. The Canadian Nuclear

Association, looking at events across the border, launched an expensive, ambitious program of public ecucation (Johnson, 1976). In short, the nuclear community has gone public.

The conception of reality underlying this action rests upon two assumptions: (1) public attitudes are primarily cognitive in basis, and (2) increased knowledge creates a more supportive attitude to nuclear energy. Both are in doubt.

Emotional Roots of Opposition

In a provocative analysis, Philip Pahner argues that a substantial part of the public concern over nuclear energy represents anxiety "displaced" from the fear of nuclear war and mobilized by the energy crisis of 1973-74 (Pahner, 1975, 1976). Response to nuclear risks, in Pahner's view, involves (a) preexisting images of the horror of nuclear war, (b) conscious or unconscious fears related to the invisibility of radiation and the uncertainty of exposure, and (c) conscious and unconscious fears of the immediate and long-term effects of radiation on genetic processes. Similarly, Robert Lifton argues that the public unease over nuclear weapons and power reflects the "wisdom of the body," the fundamental fears about the integrity of the human body as threatened by irradiation (Lifton, 1976). These fears are not susceptible to resolution by rational-probabilistic assessments of risk, such as the Rasmussen Report, because it may be the mode rather than the number of deaths which is critical. In Lifton's terms, the "most important human feelings are precisely those least susceptible to mathematical equations" (Lifton, 1976).

There is empirical evidence to support the foregoing interpretation. The concern of environmental opponents, and especially activist women, over nuclear weapons and possible genetic damage and cancer has already been noted. The Project RARE sentence completion item: "When I think of the nuclear power plant, I feel ______________," found that one out of four interviewees responded with anxiety. On the item: "When I hear the word radiation, I __________________," more than half of the respondents cited anxiety (30 percent), war (19 percent), or disease (7 percent). In addition, all the surveys to date which have examined the risks of nuclear plants perceived by the populace have found a widespread fear that a nuclear plant may explode despite the fact that, except for steam explosion, this is impossible in a light water reactor.

The Role of Knowledge

Turning to the role of knowledge in forming attitudes there is some weak evidence to support this conventional wisdom. As noted above, several surveys have found a tendency for better educated persons to support nuclear energy. It was also apparent in our survey results that women, the group most opposed to nuclear energy, scored lower in the knowledge test about nuclear energy than men. So there might appear to be reason to believe that with more information and knowledge support might grow.

But education may be a better measure of social class than of cognition. While our research has found some relationship between education and levels of knowledge on the nuclear issue, the linkage is tenuous (contingency coefficient of 0.34). Moreover, it is clear, as Angus Campbell and associates argue in their "funnel of causality," that social class variables are more distant from behavior than such intervening variables as individual knowledge and psychological characteristics (Campbell *et al.*, 1960). For this reason, it is more appropriate to examine the latter directly.

To assess the role of knowledge in attitudes toward nuclear energy, a scale of five questions requiring varying sophistication was formulated.[1] Our survey results in Boston and the three nuclear reactor sites suggest, contrary to the findings of some early surveys, that support is not associated with higher levels of knowledge. If anything, support may be *inversely* related to knowledge (Table 3). In Boston, respondents with low knowledge favored nuclear energy by four to one while those with high knowledge were equally divided. In the three reactor sites respondents display a similar tendency, but the relationship is not significant.

TABLE 3 Knowledge and Attitude toward Nuclear Energy (in Absolute Numbers)

	Boston (n = 243)			3 Nuclear Sites (n = 300)		
Knowledge	Favor	Opposed	No Opinion	Favor	Opposed	No Opinion
High	38	37	--	37	34	3
Medium	76	50	1	81	40	7
Low	30	7	--	55	35	6
	X^2 test: $p < 0.01$			X^2 test: $p = 0.30$		

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[1] The questions, each with multiple choice answers, were as follows: What fuel is used for nuclear power generation? (Choices: magnesium, coal, uranium, bauxite.) Which of the following words are associated with nuclear power? (Choices: photosynthesis, fission, gyroscope, fluoride.) What percent of the total electricity produced today in this country comes from nuclear power? (Choices: 5-10%, 20-25%, 50-55%, 75-80%.) Radioactive wastes remain dangerous for a period of (choices: less than 5 years, 100 years, 1,000 years, more than 10,000 years). The major accident which can occur in a nuclear plant now operating is (choices: an explosion, core meltdown, ruptured fuel cell, damaged isotope).

Given the overriding importance of sex in attitudes to nuclear energy, the data were next disaggregated to examine the role of knowledge for both men and women. Despite the numerous differences between Boston and the three reactor sites, and between the attitudes of men and women, the results consistently reveal that increased knowledge was positively associated with greater opposition to nuclear energy among both men and women (Table 4). It is appropriate to point out, however, that the context in which knowledge is acquired is crucial. Knowledge is now acquired largely through media accounts which have been highly critical of nuclear energy management in recent years.

Other research also calls into question the view that greater knowledge produces a more favorable attitude to nuclear energy. In the Oak Ridge study, no relationship was found between information levels and support or opposition, but the test of information used was specific factual data about a particular plant rather than the technology itself (Sundstrom *et al.*, 1977, pp. 39-40). A study of college student attitudes toward breeder reactors also found no relationship between knowledge and attitude (Clelland and Bremseth, 1977, pp. 31-32). Perhaps the most judicious assessment at this point is that empirical support is lacking for the argument that opposition stems from ignorance and for the argument that greater information will change attitudes.

Our research also included an analysis of the changing public assessment of nuclear plant safety over the course of one year (the respondent located his or her evaluation on a scale of "very safe," "somewhat safe,"

TABLE 4 Sex, Knowledge, and Attitude toward Nuclear Energy (in Absolute Numbers)

		Boston (n = 243)		3 Nuclear Sites (n = 300)	
Sex	Knowledge	Favor	Opposed	Favor	Opposed
Men	High	33	26	31	18
	Medium	53	23	47	17
	Low	15	1	25	6
		X^2 test:	$p < 0.02$	X^2 test:	$p = 0.20$
Women	High	5	11	5	16
	Medium	23	27	34	23
	Low	15	6	30	29
		X^2 test:	$p < 0.05$	X^2 test:	$p = 0.20$

"not so safe," or "dangerous" for the earlier and the present points in time). The results reveal (1) a rather surprising amount of change (55 of 240 Boston interviewees and 56 of 300 interviewees in the three reactor sites had changed position); (2) the change moved in both directions, a fact not surprising given the conflicting information generated by the nuclear debate, though the clear preponderance (by two to one in Boston and over four to one in the reactor sites) was toward a perception of greater danger; and (3) most of the change was gradual (one step-movement of a possible three) rather than precipitate.

Since level of education provides perhaps the best single measure of the indivudal's accessibility to new sources of information and the ability to sort through conflicting evidence, our research explored relationships between education and changes in the individual's perception of nuclear plant safety. Interestingly, in the three reactor sites, where the salience of the nuclear issue is high, the supply of information rich, and knowledge more rooted in experience, there was no significant difference in the propensity to change among the various educational groups (Table 5). But in Boston, more remote from the reactors, where the salience of the issue is therefore lower, there is a clear tendency for greater change and for changes toward an assessment of greater danger in more highly educated groups. The universal trend (statistically significant) in both surveys, and especially at reactor sites, is toward an assessment of increased danger. Moreover, among reactor sites the one longest established and also the subject of greatest controversy (Indian Point) had the greatest number of changers (22 percent compared to 15.5 percent at the other two) and showed a greater proportion (20 of 22 compared to 21 of 31 at the other two) of changers moving toward a perception of greater danger. Not surprisingly, this growing sense of danger in Indian Point has resulted in the lowest level of public support in any North American site we have studied to date.

The present research, in short, not only does not support but directly contradicts the conventional wisdom as espoused by nuclear proponents. Rather, our assessment indicates that many individuals, and women especially, tend to link nuclear energy with nuclear weapons and cancer and to experience strong anxiety over this connection. Further, as individuals become more knowledgeable about nuclear energy and its risks, at least in the context of existing information sources, opposition tends to increase rather than diminish.

The Vietnam Analogy

National antinuclear leaders have adopted the Vietnam (or Watergate) analogy to explain how the struggle against nuclear power will be won. Viewing the results of the California referendum, for example, Ralph Nader concluded: "And I might say that one out of six Americans was critical of nuclear power a year ago, and just like Watergate and Vietnam the people will prevail" (Nader, 1976). The analogy rests on the argument that continued support for nuclear energy, as for Vietnam, is a function of systematic half-truths and cover-ups fed to an unsuspecting and trusting public. The Union of Concerned Scientists has explained

TABLE 5 Propensity and Direction of Evaluation Change (in Absolute Numbers)

Location	Education	Proportion of Changers	Direction of Change	
			More Safe	More Dangerous
Boston (n = 243)	High school diploma or less	7 of 60	5	2
	Some college	15 of 66	4	11
	4-year college degree	10 of 56	4	6
	Education beyond 4-year degree	23 of 57	7	16
	X^2 test: $p < 0.01$			
3 reactor sites (n = 300)	High school diploma or less	30 of 150	5	25
	Some college	12 of 82	3	9
	4-year college degree	9 of 34	2	7
	Education beyond 4-year degree	5 of 30	0	5
	X^2 test: $p < 0.70$			

its recent change of emphasis from the analysis of technical issues to the critique of the integrity of the regulatory process as follows:

> It appears to us now . . . that full and complete disclosure of the nature of nuclear power research and the often unnecessary aggravation of the risk resulting from the way the program has been managed would have led to substantial restrictions in the program's rate of growth. The present size of the nuclear program is therefore in large measure a consequence of the distortion of research and concealment of results (Ford and Kendall, 1975, p. 27).

The argument of the nuclear opponent differs somewhat from that of the proponent. Opponents contend that public support for nuclear energy is not simply the product of inadequate information but the inevitable result of the deliberate duping of the public. Were the public to be in full command of the facts concerning nuclear risks, the danger of proliferation, economic questions, and uranium availability, then the strong support would evaporate. There is also the suggestion of the "snowball" nature of opinion change--that as events run against nuclear energy the pace of change will quickly accelerate into a major shift of public sentiment against nuclear energy.

In terms of public opinion formation, the "snowball" concept has some theoretical base. Mazur (1977, pp. 69-71) provides some conceptual understanding of how opposition to a technological innovation arises. In his view, opposition proceeds through a number of stages, beginning with the dissent of local leaders from projects in their communities. The media become interested and allow the public to become a spectator. As the dispute increases, the public acquires a heightened sense of danger and public opposition grows through a network of personal relationships.

At the national level, Mazur's first several stages have already occurred in the nuclear controversy--there is active elite opposition and acrimonious debate, interested mass media, and the public as spectator to the debate. And while there is evidence of a growing sense of danger in citizens, it has not yet been sufficient to overcome the long-standing perception of substantial benefits. The Louis Harris (1975, 1976) polls identified two major sources of public support for nuclear energy--the excellent safety record to date and the public confidence in scientists and the regulators in keeping the safety problems in check. Given the low probability/high consequence character of nuclear risks, a rash of major accidents is not likely over the next several years. Hence any broad changes in public attitudes will depende upon an erosion in the public's high regard for regulators on the one hand and greater awareness of the disagreement among scientists on the other. Figure 2 schematically represents our assessment of the tactics currently in use.

Widespread disagreement in the scientific community is ineffective without public visibility. Enter the "war of signatures" in which both nuclear advocates and opponents have tried to outdo the other in the

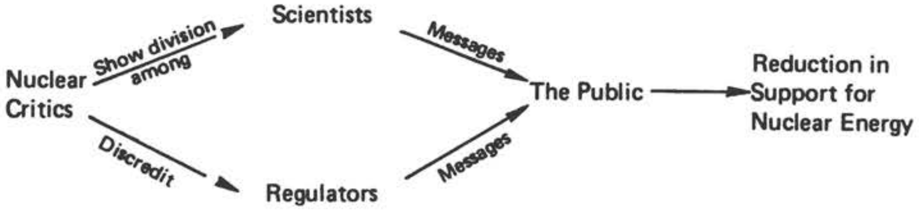

FIGURE 2 A representation of anti-nuclear tactics.

number of scientists who will sign petitions on nuclear power (Boffey, 1976). At the same time, since regulators are, at least publicly, nearly uniform in their support for nuclear energy, the current effort to discredit the integrity of the regulatory process could, if successful, destroy public confidence in the safety of nuclear plants.

The other interesting development in antinuclear tactics occurred in the summer of 1977 when a new organization, Mobilization for Survival, organized a vigil at a number of nuclear sites to commemorate the anniversary of Hiroshima. The specific linking of nuclear power plants with the use of nuclear weapons can be expected to heighten public fears as well as to broaden the base of nuclear opposition. By 1978 Mobilization for Survival planned a coordinated national program of civil disobedience at selected nuclear facility sites.

But the Vietnam analogy, if examined carefully, suggests some cautions. Perhaps the most striking characteristic of public opinion toward Vietnam was the sluggish pace of emerging opposition and the resiliency of a core of basic support (Mueller, 1971). There appears to be some evidence that public attitudes to nuclear energy may not change quickly. Between the onset of the energy crisis in September 1973 and April 1975--a period of intense mass-media coverage of nuclear safety issues (see Figure 1)--public opinion was, at least in the aggregate, remarkably stable. If our survey results are at all representative of the American public as a whole, underlying this veneer of stability is a great deal of shifting and sorting out of opinion. Despite a net flow toward an increased assessment of danger, there is an important counterflow. Then, too, most of the shifting is incremental in degree; the pace of change is gradual. The results from seven state initiatives (Table 2), coming after an intense exposure of the public to information and claims from a variety of positions, turned out very similar to national poll results. The reinterviews in the Oak Ridge study found substantial stability in attitudes (Sundstrom *et al.*, 1976, pp. 16-21); and a study of attitudes toward a nuclear waste repository revealed that, while women were much more influenced than men by the controversy, the latter's attitudes were more persistent (Mazur and Conant, 1977). In the absence of major changes in the perception of benefits and risks, and with a continuation of confusing claims and information, opinion changes will likely continue to be offsetting and relatively stable in the aggregate. There is still considerable public support for technology, and hence prophecies of gloom, like Panglossian optimism, may be illusory (La Porte and Metlay, 1975). Whereas some converts can readily be made among societal elites, large-scale attitude conversion in the absence of some dramatic event may prove to be extremely difficult.

PROSPECT

If our interpretation is correct that the environmental movement enjoys a high degree of resiliency and that the current bases of nuclear opposition are as much ideological and symbolic as site-specific, then it is likely that public opposition to nuclear energy at both the local and national level will not dissipate in the near future. Nor is it likely that the increases in safety assurance possible over the short run will significantly reduce the scope or intensity of such opposition. Given the unique challenge of nuclear energy to the environmentalist, opposition will not shift easily to another target. Despite the 1976 defeats at the polls, the national antinuclear organizations have obviously dug in to do battle over at least the next several years. The national debate over energy policy will certainly continue for at least the near term, and states and cities are already flexing their muscles for a more significant role in policymaking in the coming years.

But if our projection of a sluggish pace of attitude change is correct, then time may be the greatest enemy of the nuclear opponent. Barring a catastrophic event or a major public reassessment of the benefits of nuclear energy, the probable erosion in current national support for nuclear energy may prove insufficient to stem the tide of nuclear energy growth. In the scientific community, increased attention to the comparative analysis of risks of other fuel cycles, and especially that of coal, appears favorable to nuclear energy. The recent sabotage of the Alaskan pipeline, major oil spills, the controversy over liquefied natural gas facility siting, and continuing air pollution have also demonstrated convincingly that *all* energy sources involve some societal risk. Despite the lack of new reactor orders in recent years, the nuclear program continues to grow from past momentum; some 65 plants are now operating, and another 77 are under construction. If the conservation and coal components of the Carter energy program fall short in their contribution, nuclear energy could profit from the resulting blackouts and brownouts. Moreover, there is the very real possibility that a new energy crisis, or new domestic or international problems, could squeeze the nuclear energy controversy off the national agenda or provide alternative targets for social protest.

As for local conflicts, current developments suggest conflicting changes. On one hand, standardization of plants and prescreening of sites so that a bank of environmentally approved locations will be available for new nuclear plants should expedite the licensing process. Moreover, many of the new plants will be "piggy-backed" onto existing plants and may therefore invite less local opposition. On the other hand, it is clear that the states in particular are asserting a new role in nuclear power policy and regulation. The national search for waste repositories has already ignited strong opposition from many state and local communities lying on waste transportation corridors. Table 6 shows the impressive record of recent state legislation on the radioactive waste issue. This extensive state intervention will provide nuclear opponents with new opportunities for leverage.

Finally, the maturation of nuclear opposition has international ramifications. The United States has to date been the major exporter of the nuclear debate; the terms and much of the supporting evidence for nuclear opposition have had American origins. But as the recent importation of European site-occupation tactics at Seabrook, N.H., Barnwell, S.C., and Rocky Flats, Colo., suggest, the worldwide growth of nuclear opposition can be expected to provide new sustenance to antinuclear forces in America. A societal consensus on nuclear energy still appears to be a distant prospect.

TABLE 6 Radioactive Waste Management: State Legislation, May 1978

State	Major Hazard or Impact Studies	Demonstrated Technology Required	Waste Storage						Transportation						Institutional Development		
			Notification Required	Permit, License or Bonding	Perpetual Care Fund	Legislative or Gubernatorial Approval	Requires State Regulation	Ban	Notification Required	Permit, License or Bonding	Requires State Regulation	Legislative or Gubernatorial Approval	Tax on waste	Ban	Radiation Control	Transport Control	Storage or Disposal
Alabama																	
Alaska																	
Arizona							L				R						
Arkansas									R		R						
California		LL		L			L	LLL		L	L						
Colorado	R							R									
Connecticut										L	L						
Delaware																	
Florida				L													
Georgia							LR								L		
Hawaii		R		L													
Idaho	RR						R										
Illinois					L		LL									L	
Indiana																	
Iowa				L					L						L		
Kansas				L			L				L						
Kentucky	RR			L	L	L	L			L					L		LL
Louisiana	RRR		RR	R			L	L							R		
Maine		L		L													
Maryland				L						L	L				L	L	
Massachusetts	LL																
Michigan																	
Minnesota						L	LL					L					
Mississippi															L		
Missouri																	
Montana							L	L							L		
Nebraska										L							
Nevada							L										
New Hampshire																	L
New Jersey			L				LL			L					L		
New Mexico	RLL				L		LL	L							L		
New York																L	
North Carolina									L								
North Dakota																	
Ohio																	
Oklahoma	L																
Oregon								L									
Pennsylvania	R																
Rhode Island							L				L				LL		
South Carolina																	
South Dakota	R					L											
Tennessee	R																
Texas							L										
Utah								L									
Vermont						L					L				[illegible]	[illegible]	[illegible]
Virginia	R			L	L										[illegible]	[illegible]	[illegible]
Washington							L								[illegible]	[illegible]	[illegible]
West Virginia															[illegible]	[illegible]	[illegible]
Wisconsin															[illegible]	[illegible]	[illegible]
Wyoming				LL	LL		L								[illegible]	[illegible]	[illegible]

L = One Law

R = One Resolution

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III.
INTERNATIONAL IMPACTS

SOCIAL WELFARE AND ENERGY INTENSITY: A COMPARATIVE ANALYSIS OF THE DEVELOPED MARKET ECONOMIES

by

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PREFACE

This research was supported by funds from the National Research Council, the Michigan Agricultural Experiment Station, and the Ohio Agricultural Research and Development Center. Denton E. Morrison, Lee Schipper, Henry I. Kohn, Allan Mazur, Otis Dudley Duncan, Charles T. Unseld, Christoper K. Vanderpool, Frederick L. Frankena, and Ted L. Napier gave helpful comments on previous drafts of the manuscript. Olivia Mejorado, Judith Davinich, James Hatch, Nancy Schwart, Linda A. Buttel, and Susan Roggelin provided invaluable research assistance.

INTRODUCTION

For decades social scientists have largely accepted the notion that society's energy consumption and level of development are basically synonymous because of the high energy requirements of industrial technologies. Social scientists in turn have noted the obvious fact that the social welfare of nations is intimately related to the level of society's development and economic activity. The apparent link between these two notions is that energy scarcity or reduction in energy consumption must result in a demonstrable deterioration of the quality of life in advanced industrial societies such as the United States.

However, it is now becoming apparent that the industrial societies of the world differ considerably in terms of the amount of inanimate energy required to produce a given amount of goods and services (Makhijani and Lichtenberg, 1972; Schipper and Darmstadter, 1976; Schipper and Lichtenberg, 1976; Biswas, 1974; Foley, 1976). A fundamental question involved in formulating rational energy policies for the advanced industrial societies thus concerns the ranges of socioeconomic equity and quality-of-life conditions that can be achieved at given levels of energy consumption and energy intensity. In addition to this, we need to expand our knowledge concerning the social structure and demographic features that shape a society's overall energy intensity.

The major question to be addressed by this research concerns whether favorable equity and life-style circumstances among the advanced industrial societies are compatible with reductions in the overall energy intensity of economic activities. (The ratio of kilograms of coal-equivalent to Gross National Product [GNP] in U.S. dollars will be our measure of energy intensity.) In doing so, the study can provide some preliminary insight into, for example, the conceivable social welfare "costs" resulting from socially or naturally induced energy scarcities that would compel reduced energy intensities among the developed industrial nations. Likewise, an exploration of social welfare correlates of energy intensity among a large number of nations can provide insight into the debate over whether the enhancement (or maintenance) of social welfare requires exponentially increasing energy supplies (and, hence, political and economic encouragement of unrestricted development of energy resources).

The present study may be considered an extension of preliminary research by Mazur and Rosa (1974), who examined the associations between energy consumption and life-style indicators among the developed market economies and found generally insubstantial correlations. They 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" (Mazur and Rosa, 1974, p. 609). This paper seeks to further develop the notions of Mazur and Rosa by comparing nations, not only in terms of absolute levels of energy consumption in relation to social welfare (which their study adequately accomplished), but also in terms of energy intensity in relation to social welfare. As such we hope to provide more tangible estimates of the options developed market economies have--or do not have--for curbing energy consumption without major social dislocations.

While not the major focus of this paper, the possible roles of various antecedent factors which shape energy intensity among the developed societies are also explored. This discussion provides a review of previous research conducted by the author (Buttel, 1977, 1978). The major purpose for doing so is to provide perspective on the nature of social changes required to reduce energy intensities among the developed market economies.

This report is couched in terms of national energy intensity--energy consumption per unit of GNP--rather than energy efficiency for both stylistic and theoretical reasons. It is technically true, of course, that the energy intensity of a task or activity may be considered the inverse of its energy efficiency; i.e., increasing energy efficiency means decreasing energy intensity (Schipper and Darmstadter, 1976). However, as Schipper and Darmstadter (1976) suggest, "efficiency is most usefully cast in an economic context, where cost minimization strategies embrace economic use of all resources, of which energy is a critical, but not the sole, component." Since these criteria cannot be met by the crude energy/GNP ratio, it is felt that energy intensity provides the best characterization of that measure. Further, characterization of that measure as efficiency or inefficiency may not accurately depict the circumstances that apparently account for cross-national variations in the ratio. A given society might well exhibit relatively efficient use of inanimate energy given the structure of that society and the range of alternatives available to it. To label such variations in energy use either efficient or inefficient may obfuscate the role that energy plays in a social economy. For these reasons, this study will be conceived in terms of energy intensity relative to GNP, rather than energy efficiency.

METHOD

The data base for the present study consists of cross-sectional and longitudinal data for 25 nation-states that the United Nations considers to be developed market economies (United Nations, 1973). Cross-sectional data are presented for most variables for two years--1955 and 1970. For these variables, indexes of change are computed. In the case of indicators for which 1955 or 1970 data were missing, 1965 data were instead used exclusively. The 1965 data are more complete and accurate than either of the other two years; and, since it was the 1955 data, if any, that usually were missing, using 1970 data along with the 1965 numbers would invite comparisons that would be relatively unreliable because of the short time span. In all cases, 1955-1970 change scores are indexes of *rates of change* (in percent), i.e.,

$$\frac{T_2 - T_1}{T_1} \times 100.$$

The major independent variable of this study, as noted above, is energy/GNP as an indicator of energy intensity. This ratio is hardly a novel measure--having been employed with sufficient frequency to generate a critical literature (Berndt and Wood, 1974, 1975; Schipper, 1975; Schipper and Darmstadter, 1976; Schipper and Lichtenberg, 1976). While the energy/GNP measure appears to be the most appropriate one for comparative analysis of nations, the reader should nevertheless be aware of the conceptual imitations inherent in this aggregate ratio, as well as the conceptual and measurement problems in both its numerator and denominator.

It is recognized that an energy/GNP ratio disguises important national differences in climate, industrial mix, major historical circumstances (e.g., the historic expensiveness of energy), and other factors that presumably have decisive impacts on aggregate energy intensity. Recent studies have shown however that, compared to the U.S., Japan and some Western European nations exhibit lower energy/output ratios in particular sectors and tasks by using policies and technologies that would be adaptable to U.S. conditions (Darmstadter, Dunkerly, and Alterman, 1977; Schipper and Lichtenberg, 1976; and for discussion of these, National Research Council, 1979, chap. 8). Social scientists have long been aware of the measurement problems involved with both the numerator and denominator of the energy-intensity variable. GNP has frequently been criticized for its limitations as a measure of social welfare (Heller, 1972). Nevertheless, GNP appears to be the most appropriate measure of the magnitude of goods and services produced in a society--particularly in light of its general availability among most nations. The energy consumption data that compose the numerator of the energy-intensity ratio refer to "apparent gross inland consumption of commercial fuels and water power" (Taylor and Hudson, 1972; see also Schwartz, 1975, pp. 195-198). Such a classification contains a number of possible sources of invalidity. Noncommerical sources of energy (e.g., wind and solar power) are excluded, and not all energy resources sold in a given nation during a given year are consumed as fuel (e.g., some are consumed for manufacture in petrochemicals). However, it would seem that these problems are not serious--particularly among the developed industrial societies--in that most energy is commerically supplied and the great bulk of energy resources is disposed of as fuel (Schwartz, 1975).

The scores for each developed nation with respect to the energy-intensity ratio are given in Appendix A. Data there are provided for 1955, 1965, and 1970, and for the rate of change from 1955 to 1970.

Three additional independent variables were employed in the analysis of factors related to social welfare indicators: GNP per capita, total energy consumption (in kilograms coal-equivalent) per capita, and electrical energy production per capita.

In the case of GNP per capita, the data are provided along with comparable statistics for energy intensity, i.e., for the same years, and with respect to 1955-1970 changes. Also, each social welfare indicator--measured cross-sectionally for the most recent year for which data are available (either 1965 or 1970) and longitudinally over the 1955-1970 time period--is regressed on energy intensity and gross national product per capita (again measured cross-sectionally and longitudinally). This is done to provide insight into the net effects of energy intensity on the quality-of-life measures, holding GNP per capita constant. (See Tables 2 through 5, below.)

Product-moment correlations between total energy consumption per capita and electrical energy production per capita and the social welfare indicators are given in Appendix C. These data are provided for purposes of comparison, both with the data relating to energy intensity in this study, as well as with similar data reported elsewhere by Mazur and Rosa (1974).

This study employs 50 social welfare indicators as dependent measures,[1] grouped into 6 largely arbitrary categories: (1) health, health care, and nutrition; (2) education and culture; (3) equity; (4) general satisfaction; (5) economic and consumption; and (6) violence and social strife. These categories are based, in part, on Mazur and Rosa's (1974) classification, but attempt to go beyond their universe of indicators by adding categories (3) and (6) above as entirely new clusters of variables. The composition of each category of indicators can be ascertained from the tables that follow, and the source for each variable is given in Appendix B.[2]

The selection of the dependent variables, not unlike their grouping into categories, was somewhat arbitrary. The United Nations, the ultimate origin of most data employed herein, is limited in its ability to collect and compile social statistics, and it is quite understandably selective and biased in the types of data deemed worthy of compilation. Nevertheless, the social welfare indicators employed here were selected primarily because of their general connection with the socioeconomic equity focus of the questions that were laid out at the beginning of the paper. A broad range of indicators was chosen to assess relationships of energy intensity to social welfare and conditions of socioeconomic equity of industrial populations.

Appendix B also reports those variables for which high levels of skewness dictated natural logarithmic transformations. Such transformations were made in order to approximate the normal distributions required for regression analysis (see Hibbs, 1973). Missing data cases were

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[1] While I term the social welfare indicators the "dependent variables," I do so only to indicate the structure of multivariate analysis tables. This terminology is not meant to convey the assumption that the causal direction of inference is always from energy intensity to quality-of-life conditions. Indeed, a number of indicators are logically conceptualized as contributors to energy intensity, e.g., automobiles per capita and housing density. The inclusion of such indicators is justified, however, because of my desire to provide a relatively thorough replication of Mazur and Rosa (1974) (automobiles per capita was one of Mazur and Rosa's economic indicators), and to include as broad a range of social-welfare indicators as possible. For both the bivariate and multivariate relationships between energy intensity and the quality-of-life indicators I prefer a "shared variance" rather than "causal" interpretation.

[2] To some readers, the selection of social welfare indicators may appear far too arbitrary to draw any clear-cut conclusions. Again, the purpose in examining a wide variety of indicators was largely to respond to the frequent sweeping assertion by proponents of energy growth that reduced energy consumption would result in the deterioration of all or nearly all favorable aspects of life in the developed societies.

eliminated from all statistical computations. The tables report the ranges of missing data cases and the median number of cases for statistical operations.

Finally, it is useful to discuss the rationale for limiting data analysis and inferences to the "developed market economies." First, the United States clearly has a developed market economy, and it is felt that generalizations from other developed market economies are most germane to the U.S. situation. Second, it is assumed that possible changes in U.S. energy consumption and intensity are unlikely to be sufficiently drastic to drop the plane of societal production to the levels currently experienced by most Third World nations. Since the range of conditions experienced by the developed market economies is the most probable range within which the U.S. will move in the forseeable decades, inferences about possible social changes in the U.S. are best derived from a comparative analysis of other developed market economies.

THE STRUCTURE OF ENERGY INTENSITY

A major assumption of this study is that variations in energy intensity among the developed market economies (as well as among other nations) are not random, but are rooted in characteristics of social structure. Understanding this structure will help applied social scientists to fathom the *social changes* necessary to achieve reduced energy intensities among societies such as the United States (assuming for the present that these changes would not appreciably erode standards of living in the developed industrial nations). Before the analysis of the data, a brief review of research into the factors shaping energy intensity will be presented.

A number of demographic characteristics of nations may be presumed to be related to energy intensity. Perhaps the most obvious social structural characteristic related to energy intensity is the level of production (which may be indexed by GNP per capita). The higher the level of production of goods and services in a society, the more these production processes would seem to entail use of inanimate energy resources (Odum, 1971; Schwartz, 1975). Another structural characteristic related to level of production although not entirely determined by it is the percentage of national product from the agricultural sector, which can be viewed as an indicator of the economic system's diversification beyond primary production activities. The greater the diversity beyond primary, or agricultural, production, the more one might anticipate increased energy intensity.

Urbanization has been viewed as a factor accounting for variations in the intensity of inanimate energy use. Several social and ecological scientists have argued that the concentration of people in space entails higher energy inputs (Odum and Odum, 1976; Marquis, 1968; Koenig and Edens, 1975). Urbanization involves progressive insulation of populations from natural, renewable energy flows (e.g., the photosynthetic role of agriculture). In addition, the concentration of people and energy flows in large places tends to create problems--for instance, waste disposal and water purification--that in turn must be "solved" by employing additional inanimate energy.

As alluded to briefly above, the role of agriculture in production activities may help to shape national energy intensity. Three specific indicators of the nature of agricultural systems and the relation of agriculture to the larger society have been examined. Each presumes that mechanized, capital-intensive, large-farm agricultural systems require more inanimate energy subsidies than do labor-intensive, small-farm systems (Cottrell, 1955; Perelman and Shea, 1972; Stockdale, 1976).

Many social scientists and ecologists have been critical of extensive military activities because they tend to consume high levels of inanimate energy resources (Pirages and Ehrlich, 1974, pp. 151-156; Heller, 1972, p. 21). It is thus anticipated that societies that allocate a large proportion of their economic and natural resources to defense expenditures will exhibit higher energy intensities than societies that deemphasize military expenditures.

Lastly, size of national territory may be expected to exhibit a positive relation to energy intensity. Size or scale of production activities has been found in other studies to entail a monotonic increase in energy-per-unit requirements (Tummala and Connor, 1973; see also Schumacher, 1973), and we may expect the same type of relationship to hold for territorial units such as societies.

Data relating to these hypotheses are presented in Table 1.[3] These data show that, as expected, level of production (GNP per capita) is most closely related to energy intensity among the larger sample of 118 nations. However, GNP per capita has only a small relation to energy intensity among the developed market economies. Within the developed societies, agriculture's share of production is much more closely associated with energy intenstiy than is overall level of production. Similarly, we find urbanization and measures of allocation of resources to military expenditures substantially and positively related to energy intensity among the larger sample of nations, and essentially unrelated to the dependent variable among the developed societies.

The most consistent relationships across both groups of societies are the associations between agricultural structure, agricultural composition of production, and energy intensity. Societies with capital-intensive, mechanized, large-farm agricultural systems tend to be the most energy intensive. Territorial size proves to be positively related to energy intensity among the developed market economies, as anticipated, while there is no such relationship among the 118-nation sample.

These relationships were explored further with multivariate analysis. The multivariate analysis, however, was inhibited by multicolinearity and parameter estimation problems deriving from high intercorrelations among several independent variables (see, for example, Gurr, 1972). Nevertheless, a cautious interpretation of the results suggests that they largely parallel the product-moment correlations just discussed. When GNP per capita is held constant, agricultural share of Gross Domestic Product (GDP), urbanization, and percentage of male labor

[3] Additional details concerning the theoretical rationale for variables in Table 1, measurement of variables, and selection of the 118-nation sample are given in Buttel (1977, 1978).

TABLE 1 Product-Moment Correlations Between Selected Independent Variables and Energy Intensity, 118 Nations and 25 Developed Market Economies, Circa 1965

	Sample	
Independent Variable	118 Nations	25 Developed Market Economies
GNP per capita	.678[a]	.087
Agricultural share of Gross Domestic Product	-.655[a]	-.517
Urbanization	.615[a]	.083
Percent of male labor force in agriculture	-.517[a]	-.407[a]
Agricultural mechanization (tractors/1,000 economically active in agriculture)	--	.314
Average farm size (hectares arable land/ 1,000 economically active in agriculture)	--	.415[a]
Defense expenditures, per capita	.634[a]	.094
Defense expenditures as percent of GNP	.202[a]	-.022
Territorial size	.004	.326[a]

[a] The product-moment correlation coefficient is statistically significant at the .05 level. Dashes indicate that the variable is unavailable or that there are excessive missing data cases.

SOURCE: Buttel (1977, 1978).

force in agriculture continue to exhibit major multivariate relationships with energy intensity among the 118-nation sample. Also, territorial size proves to have the positive relationship to energy intensity theoretically anticipated when GNP per capita is held constant. Among the developed market economies, the four variables relating to agriculture, plus territorial size, continue to have major direct effects on energy intensity when GNP per capita is controlled.

These results support the notion that energy intensity is systematically related to certain social structural and demographic characteristics. Since these relationships tend to accord with our theoretical expectations, at least in part, we may have increased faith that the energy intensity measure is a meaningful indicator of national patterns of energy use.

SOCIAL WELFARE CORRELATES OF ENERGY INTENSITY

The remainder of the data presentation pertains to the major research question of this paper--the nature of associations between energy intensity and social welfare in the developed market economies. The data base from which generalizations are made is quite large, so the emphasis will be primarily on major patterns in the data.[4]

Table 2 presents product-moment correlations between energy intensity and selected social welfare indicators among the 25 developed nations. Table 2 also includes correlations between GNP per capita and the quality of life indicators for purposes of comparison. As noted earlier, data for 1965 are given if data for 1955 or 1970 were unavailable.

The results generally suggest only modest associations between energy intensity and social welfare indicators. With respect to health, health care, and nutrition indicators, nations with high energy intensities appear to enjoy no advantages over low energy intensity nations. Certain education and culture indicators prove to have positive relationships to energy intensity (particularly educational expenditures as a percentage of GNP, newspaper circulation, and ownership of radios and televisions). However, the majority of education and culture indicators exhibit small or negative correlations with energy intensity.

None of the socioeconomic inequality indicators has a large association with energy intensity. These data are particularly important in light of the concerns of many social scientists that reduced energy intensities among the developed societies might well result in sharpened inequalities. On the basis of the data given in Table 2, it may be argued that developed nations with low energy intensities show no tendency toward high socioeconomic inequality relative to nations with high energy intensities. Essentially the same pattern of modest relationships of social welfare indicators with energy intensity pertain to the remaining categories of indicators (general satisfaction, economic and consumption, and violence and social strife).

Table 2 does show a greater tendency for GNP per capita to influence quality of life than does energy intensity. GNP per capita exhibits significant relationships with indicators in all six social welfare categories, with high GNP per capita associated with "favorable" scores (e.g., high life expectancy and low divorce rate) in nearly all cases.

Table 3 extends our analysis of social welfare and energy intensity by reporting correlations between 1955-1970 rates of change of the independent variables and dependent variables. Table 3 has a restricted group of social welfare indicators because some data are unavailable

[4] The statistical tests employed in this study should be interpreted with caution. Since this study attempts to deal with the universe of all developed market economies (and the universe of all societies with respect to the data in Table 1), tests of significance are inappropriate for purposes of hypothesis testing (see Morrison and Henkel, 1970). However, tests of significance have been included to assist in interpreting the data, but they should of course be employed with caution.

TABLE 2 Product-Moment Correlations Between Energy Intensity and Gross National Product Per Capita, and Selected Social Welfare Indicators, Developed Market Economies

Social Welfare Indicators	Energy Intensity 1955	Energy Intensity 1965	Energy Intensity 1970	Gross National Product Per Capita 1955	Gross National Product Per Capita 1965	Gross National Product Per Capita 1970
Health, health care, and nutrition						
Grams protein per capita per diem		-.22			.42[a]	
Calories per capita per diem		.06			.53[a]	
Hospital beds per capita		.16			.29	
Physicians per capita	-.41[a]		-.39[a]	.20		.32
Nurses per capita		.22			.70[a]	
Dentists per capita	-.20		-.01	-.02		.37[a]
Pharmacists per capita		-.20			.14	
Life expectancy	.37[a]		-.36[a]	.52		.44[a]
Infant mortality	.18		-.09	-.66		-.33
Cancer deaths per capita	-.27		.51[a]	.19		-.10
Heart disease deaths per capita	-.19		.46[a]	.33		.19
Hypertension deaths per capita	-.12		.32	.15		-.17
Ulcer deaths per capita	-.32		.25	-.05		-.36[a]
Auto accident deaths per capita	-.33		.41[a]	.06		-.11
Education and culture						
Educational expenditures per capita		.18			.95[a]	
Educational expenditure as percentage of GNP	.26		.52	-.03		.40[a]
Adjusted school enrollment ratio		.11			.54[a]	
Unadjusted school enrollment ratio		.26			.61[a]	
Enrollment in higher education		-.04			.47[a]	
Literacy		-.24			.71[a]	
Book titles per capita per year	-.20		-.20	-.07		.26
Cinema attendance per capita per year	.28		-.23	.24		-.12
Newspapers per capita per year	.16		.42[a]	.58[a]		.21
Radios per capita	.19		.39[a]	.88[a]		.34[a]

Television receivers per capita	.19		.58[a]	.26		.41[a]
Telephones per capita	.18		.10	.89[a]		.84[a]
School enrollments 2d level	.74		-.02	.03		-.18
School enrollments 1st & 2d levels	.13		-.01	.58[a]		-.22
Inequality, equity						
Smallest size of population with 50% of income		.06			.63[a]	
Gini index of income inequality (No. 1)		-.00			-.53[a]	
Gini index of income inequality (No. 2)		.27			-.26	
Smallest number of farms with 50% of the land		.04			.17	
Gini index of land inequality		.22			-.12	
Kuznets index of income inequality		.31			-.32	
Entropy coefficient of income inequality		.26			-.25	
Sex discrimination in primary education		.15			.10	
Sex discrimination in secondary education		.03			-.03	
Sex discrimination in higher education		-.25			-.02	
General satisfaction						
Divorces per capita	-.44[a]		.16	-.17		.39[a]
Manufacturing work hours per week	.12		.08	-.23		-.51[a]
Suicides per capita	-.45[a]		.32	-.01		.01
Population density		-.12			-.28	
Population growth rate	.06		-.07	.28		-.18

TABLE 2 Continued

Social Welfare Indicators	Energy Intensity 1955	1965	1970	Gross National Product Per Capita 1955	1965	1970
Economic and consumption						
Automobiles per capita	.35		.27	.84[a]		.84[a]
Housing density	-.02		.25	-.38[a]		-.22
GNP per capita	.16		.09	--		--
Unemployment rate	-.16		.35	-.12		.08
Violence and social strife						
Homicide deaths per capita	-.26		.30	-.13		-.07
Collective protest		.31			-.21	
Internal war		.39[a]			-.25	

[a] The product-moment correlation coefficient is statistically significant at the .05 level.

NOTE: N for the developed market economies varies from 16 to 25, with a median N of 24.

(particularly for 1955). Unfortunately, because 1955-1970 data were not consistently available, the inequality-equity indicators category is null for the 1955-1970 change data.

The results in Table 3 largely parallel the cross-sectional data presented in Table 2. There appears to be no discernible trend for increases in energy intensity to be associated with favorable social welfare conditions among the developed market economies. Further, many of the statistically significant correlations in Table 3 show that high rates of increase in energy intensity correspond with unfavorable social changes (e.g., higher rates of suicide and homicide). However, the rate of increase in energy intensity does appear to have some relatively consistent associations with improvements in health and health care (especially reduced mortality rates for cancer, heart disease, and other illnesses). Nevertheless, the rate of increase in energy intensity has a moderate, negative relation to change in life expectancy.

Although Table 2 shows that nations with high per capita GNP tend to have the more favorable quality of life circumstances, Table 3 suggests little association between rate of economic growth and improvement in quality of life during recent decades. In part, this may be because many developed societies have reached a "plateau" with respect to consumption and social welfare (e.g., when each family tends to have more than one car and two radios, very little improvement in these conditions is possible). However, persistent pockets of poverty in most, if not all, developed industrial societies argue against such a plateau notion. The fact does remain that the rate of growth in GNP per capita does not appear to bear a substantial, consistent relationship to rates of improvement in social welfare conditions (when these conditions are assessed in terms of mean distributions or on a per capita basis).

Table 4 reports regression estimates for the effects of energy intensity and gross national product per capita on the social welfare indicators. This is done to assess the net variance in the social welfare indicators attributable to energy intensity when GNP per capita is held constant. This is particularly important in light of the fact that GNP per capita comprises the denominator of the energy intensity measure; conceivably, bivariate relationships between energy intensity might be inflated because of the generally high association of GNP per capita with social welfare at the bivariate level.

The results in Table 4 are largely consistent with the bivariate data given in Table 2 above. Energy intensity tends to have relatively meager direct effects on social welfare (with most beta coefficients being ±0.50 or smaller). Also, many of the moderate relationships of energy intensity to social welfare indicators are "unfavorable," e.g., energy intensity shows a significant direct effect on death rate from cancer. Energy intensity is also related to high rates of suicide and homicide, and low levels of physicians per capita. In any event, the picture that emerges from the multivariate analysis of cross-sectional data is that energy intensity bears no necessary relation to favorable levels of social welfare and quality of life in the developed industrial societies.

Table 5 reports comparable multivariate analyses for the longitudinal data for 1955-1970. The results are again consistent with our previous

TABLE 3 Product-Moment Correlations Between Change in Energy Intensity and Change in Gross National Product Per Capita, and Change in Selected Social Welfare Indicators, Developed Market Economies, 1955-1970

Social Welfare Indicators	Energy Intensity	Gross National Product Per Capita
Health, health care, and nutrition		
Physicians per capita	.32	-.18
Dentists per capita	.13	-.06
Life expectancy	-.33	.40
Infant mortality	-.06	-.14
Cancer deaths per capita	-.40[a]	.19
Heart disease deaths per capita	-.38[a]	.30
Hypertension deaths per capita	-.37[a]	.23
Ulcer deaths per capita	-.36[a]	.10
Auto accident deaths per capita	-.36[a]	.06
Education and culture		
Educational expenditure as percentage of GNP	-.20	.10
Book titles per capita per year	-.16	-.18
Cinema attendance per capita per year	-.16	.14
Newspapers per capita per year	-.26	.27
Radios per capita	.04	.00
Television receivers per capita	-.20	.20
Telephones per capita	.29	.37[a]
School enrollment, 2d level	.24	.19
School enrollment, 1st & 2d levels	.08	.09

General satisfaction		
Divorces per capita	-.31	-.33
Manufacturing work hours per week	-.05	.03
Suicides per capita	-.47[a]	.06
Population growth rate	-.26	.12
Economic and consumption		
Automobiles per capita	.13	.41[a]
Housing density	.19	.08
GNP per capita	-.33	--
Unemployment rate	.31	-.77[a]
Violence and social strife		
Homicide deaths per capita	-.44[a]	.04

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[a] The product-moment correlation coefficient is statistically significant at the .05 level.

NOTE: N for the developed market economies varies from 16 to 25, with a median N of 24.

TABLE 4 Regression Estimates for the Effects of Energy Intensity and Gross National Product Per Capita on Selected Social Welfare Indicators, Developed Market Economies, 1965 and 1970

	Energy Intensity			Gross National Product Per Capita		
Social Welfare Indicators	Beta	b	S.E.b	Beta	b	S.E.b
Health, health care, and nutrition						
Grams protein per capita per diem[a]	-.268	-6.614	4.700	.451[b]	6.769	2.861
Calories per capita per diem[a]	.003	1.949	138.139	.526[b]	236.916	84.095
Hospital beds per capita[a]	.132	.206	.318	.280	.264	.191
Physicians per capita	-.352	-.3116	.1755	.380[b]	.0001	.0001
Nurses per capita[a]	.122	.254	.341	.681[b]	.801	.192
Dentists per capita	-.006	-.0218	.7673	.375	.0005	.0003
Pharmacists per capita[a]	-.208	-.448	.467	.152	.196	.281
Life expectancy	.248	.0201	.0211	.425[b]	.0001	.0000
Infant mortality	-.104	-.2899	.5730	-.326	-.0003	.0002
Cancer deaths per capita	.530[b]	.6833	.2368	-.129	-.0001	.0001
Heart disease deaths per capita	.535[b]	.9233	.3100	.176	.0001	.0001
Hypertension deaths per capita	.387	1.2189	.6237	-.182	-.0002	.0002
Ulcer deaths per capita	.401[b]	1.3328	.6143	-.362[b]	-.0004	.0002
Auto accident deaths per capita	.418[b]	1.0400	.4893	-.140	-.0001	.0002
Education and culture						
Educational expenditures per capita[a]	.065	.182	.197	.938[b]	1.540	.115
Educational expenditure as percentage of GNP	.632[b]	3.7846	.8641	.386[b]	.0008	.0003
Adjusted school enrollment ratio[a]	.026	.838	6.051	.540[b]	10.128	3.480
Unadjusted school enrollment ratio[a]	.300	9.080	4.846	.629[b]	12.166	3.244
Enrollment in higher education[a]	-.081	-.152	.351	.474[b]	.531	1.545
Literacy[a]	-.304	-13.697	6.102	.740[b]	20.078	3.671
Book titles per capita per year	-.149	-.3385	.5189	.165	.0001	.0002
Cinema attendance per capita per year	-.244	-.3819	.3715	-.064	-.0000	.0001
Newspapers per capita per year	.437[b]	.8863	.3885	.183	.0001	.0001
Radios per capita	.364	.7424	.3873	.323	.0002	.0001

Television receivers per capita	.701[b]	1.2738	.2302	.393[b]	.0003	.0001
Telephones per capita	.034	1.4737	5.1129	.838[b]	.0131	.0019
School enrollment, 2d level	.114	.3864	.7233	-.160	-.0002	.0003
School enrollment, 1st & 2d levels	.107	.3306	.6567	-.208	-.0002	.0002
Inequality, equity[a]						
Smallest size of population with 50% of income	-.105	-2.168	3.882	.654	7.573[b]	2.177
Gini index of income inequality (no. 1)	.149	3.696	5.057	.570	-7.929[b]	2.840
Smallest number of farms with 50% of the land	.078	.219	.753	.185	.297	.433
Gini index of land inequality (no. 2)	.200	9.505	12.224	.080	-2.184	6.986
Gini index of income inequality	.276	.061	.055	-.269	-.039	.035
Kuznets index of income inequality	.318	.057	.043	-.323	-.037	.028
Entropy coefficient of income inequality	.262	.070	.066	-.258	-.044	-.043
Sex discrimination in primary education	-.076	-.006	.017	-.138	-.006	.011
Sex discrimination in secondary education	.037	.019	.123	-.040	-.012	.073
Sex discrimination in higher education	.128	.105	.191	-.298	-.133	.104
General satisfaction						
Divorces per capita	.245	.6568	.5139	.400[b]	.0004	.0002
Manufacturing work hours per week	.059	.5513	2.0751	-.465[b]	-.0016	.0008
Suicides per capita	.378[b]	1.2183	.6515	-.0004	-.0000	.0002
Population density[a]	-.097	-.488	1.032	-.273	-.827	.621
Population growth rate	-.196	-.3634	.4118	-.210	-.0001	.0001

TABLE 4 Continued

	Energy Intensity			Gross National Product Per Capita		
Social Welfare Indicators	Beta	b	S.E.b	Beta	b	S.E.b
Economic and consumption						
Automobiles per capita	.182	.0528	.0323	.835	.0001	.0000
Housing density	.008	-.0195	.5319	-.299	-.0003	.0002
Unemployment rate	.303	.8251	.7518	-.005	.0000	.0002
Violence and social strife[a]						
Homicide deaths per capita	.437[b]	2.0594	.9222	-.076	-.0001	.0003
Collective protest	.338	1.853	1.129	-.249	-.831	.688
Internal war	.422[b]	-2.855	1.327	-.289	-1.192	.809

[a] 1965 data; all others, 1970.

[b] The unstandardized parameter estimate is at least twice as large as its standard error.

NOTE: N for the developed market economies varies from 16 to 24, with a median N of 23.

observations that increased energy intensities in the developed nations have not corresponded with demonstrable improvements in the quality of life and social welfare. The beta weights given in Table 5 are almost all smaller than ±0.40 (with respect to energy intensity's direct effects on social welfare indicators). Likewise, the rate of increase in economic growth in the developed countries shows little relation to improvements in the quality of life.

The pattern that emerges from these analyses of the relationships of energy intensity to social welfare and socioeconomic equity in advanced industrial societies, then, is that *present* relationships show little or no justification for high (and increasing) energy intensities for purposes of enhancing such conditions. We must emphasize *present* since the data cannot directly assess historical trends or future patterns of social change. Nevertheless, it should be pointed out that Appendix C's presentation of correlations between total energy consumption per capita and electrical energy production per capita with the same indicators provides additional support for the notion that many social welfare conditions do not bear an immutably positive association with energy consumption. In fact, Appendix C suggests that energy consumption is associated in a statistically signifidant manner with high divorce rates, high suicide rates, high rates of death from diseases such as cancer, heart disease, hypertension, and auto accidents, and so on. The dominant pattern in Appendix C, to be sure, is a moderately positive association of energy consumption with favorable quality of life. However, reductions in energy use by way of reduced energy intensity of major production and consumption activities would not appear to substantially threaten the advantages industrial societies offer in terms of health care, education, and other aspects of life-style.

CONCLUSIONS

The results of the analysis indicate that the link between energy use--conceptualized and measured in terms of energy intensity--and quality of life is less pronounced than often assumed by many observers of the advanced industrial societies. More specifically, both cross-sectional and longitudinal data indicate that reduced aggregate energy intensities of production and consumption need not result in a massive deterioration of the quality of life. Indeed, industrial societies with low energy intensities frequently exhibit more favorable social welfare conditions than those with higher energy intensities.

This summary is not meant to imply the sweeping claim that there are no apparent lower limits to energy intensity that remain compatible with favorable social welfare circumstances. The reader should remember that the sample of 25 developed market economies has a restricted variance in energy intensity and higher mean levels of energy intensity than the sample of less developed nations (Buttel, 1978). However, within the *range of energy intensities exhibited by the developed market economies*, movement within these parameters does not appear to covary with discernible changes in life-style. Nevertheless, the data examined above should encourage caution on the part of those who make the opposite

TABLE 5 Regression Estimates for the Effects of Changes in Energy Intensity and Gross National Product Per Capita on Changes in Selected Social Welfare Indicators, Developed Market Economies, 1965-1970

	Energy Intensity			Gross National Product Per Capita		
Social Welfare Indicators	Beta	b	S.E.b	Beta	b	S.E.b
Health, health care, and nutrition						
Physicians per capita	.293	.2380	.1901	-.071	-1.0494	3.4664
Dentists per capita	.127	.2696	.4868	-.013	-.5609	9.5911
Life expectancy	-.190	-.0276	.0441	.312	.6430	.6283
Infant mortality	-.124	-.0010	.0175	-.183	-.2768	.3444
Cancer deaths per capita	-.376	-.0269	.0151	.063	.0882	.2984
Heart disease deaths per capita	-.313	-.0277	.0186	.198	.3460	.3661
Hypertension deaths per capita	-.330	-.0341	.0220	.125	.2542	.4336
Ulcer deaths per capita	-.366	-.0397	.0234	-.021	-.0451	.4612
Auto accident deaths per capita	-.386	-.0358	.0199	-.064	-.1168	.3923
Education and culture						
Educational expenditure as percentage of GNP	-.179	-.5816	.7355	.052	3.3181	14.4960
Book titles per capita per year	-.262	.0208	.0186	-.288	-.4164	.3384
Cinema attendance per capita per year	-.124	-.0031	.0066	.092	.0345	.0992
Newspapers per capita per year	-.188	-.0184	.0214	.212	.4091	.4220
Radios per capita	.051	.0040	.0179	.016	.0238	.3529
Television receivers per capita	-.145	-.0271	.0420	.154	.5690	.8278
Telephones per capita	.440[a]	.0129	.0056	.519[a]	.3001	.1108
School enrollment, 2d level	.337	.0386	.0246	.303	.6851	.4853
School enrollment, 1st & 2d levels	.120	.0046	.0184	.134	.2128	.3616

General satisfaction						
Divorces per capita	-.471[a]	-1.5230	.6198	-.496[a]	-31.6152	12.2145
Manufacturing work hours per week	-.041	-.0176	.1159	.016	.1186	2.0386
Suicides per capita	-.509[a]	.0533	.0212	-.113	-.2339	.4181
Population growth rate	-.242	-.0204	.0197	.065	.1066	.3819
Economic and consumption						
Automobiles per capita	.296	.0146	.0099	.507[a]	.4919	.1949
Housing density	.246	.0180	.0163	.180	.2586	.3213
Unemployment	-.015	.0011	.0145	-.780[a]	-.9156	.2361
Violence and social strife						
Homicide deaths per capita	-.474[a]	-.0497	.0217	-.114	-.2349	.4273

[a] The unstandardized parameter estimate is at least twice as large as its standard error.

NOTE: N for the developed market economies varies from 14 to 24, with a median N of 23.

sweeping claim--that maintenance or improvement in living standards inherently requires escalating energy consumption and energy intensities of economic activities.

As noted above, the reader should bear in mind that the data base employed herein is limited in a variety of ways. First, cross-national data, even for the relatively developed societies, frequently exhibit errors and biases of various sorts (Gurr, 1972). Second, not all possible arenas of life-style and social well-being (particularly social psychological indicators such as alienation or political efficacy) have been explored, because of lack of suitable data. Third, and perhaps most important, the data base for this study is limited in providing concrete evidence of exact routes to and results of reduced energy intensities. For example, the data do not suggest that all routes to reduced energy intensity will be egalitarian (or at least nonregressive) in their socioeconomic impacts (see Stretton, 1976). Further, the data provide little sense of institutional mechanisms that mediate between variations in energy supply, demand, and consumption, and social well-being. These will be critical areas of research in future decades.

The results of this study may appear to contradict the distributional/ equity impact studies of the recent "energy crisis." For example, Schnaiberg (1975), Morrison (1977), and others have presented evidence that reduced energy supplies and escalations in energy prices in the U.S. had more dramatic, unfavorable impacts on the lower economic strata than on the relatively affluent strata. The same result has applied to the lower strata of non-OPEC nations (Morrison, 1977). How then can the regressive, inegalitarian impacts of the recent energy shortage be reconciled with cross-national data showing little if any tendency for the less energy intensive developed nations to be relatively less egalitarian than the more energy intensive group?

At the outset, there appears no reason to believe that the structure of life-style and well-being indicators in relation to energy intensity was altered during the 1970-1974 interim. Secondly, while it is possible to argue that the regressive impacts of the energy shortage in the U.S. has been overemphasized, it appears that the data advanced for the regressivity claim are sufficiently consistent and supportive of it (see especially Morrison, 1977). It seems more likely that the regressive distributional impacts of the energy crisis were due less to any inherent tendency for reduced energy consumption and intensity to cause quality of life deterioration, than to the concurrence of the energy crisis with (and likely exacerbating influence on) general recession and austerity in the U.S. It is important to remember that the reduced energy availability experienced during the 1974-75 energy crisis occurred in a context of no structural change in the economy and society. The energy crisis was too short-lived to alter fundamental energetic parameters such as predominant transportation modes, structure of the labor force, composition of production, and so forth. The energy crisis likely had such regressive equity impacts because there was no fundamental change in an otherwise energy-intensive production/consumption system. In other words, the energy crisis did not foster significant institutional alterations on behalf of the deprived strata to address and modify the distribution systems of the social product.

These considerations suggest that equity and social welfare should be viewed more as a matter of political and governmental outputs and of conflicting ideologies than of any necessary correspondence with energy consumption or even aggregate levels of GNP per capita (once a fairly high level of GNP per capita is obtained). This again underscores the observation that while reduced energy intensities among the developed nations may engender social dislocations, such social changes need not be viewed as inherently inegalitarian or destructive of social and economic development.

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APPENDIX A Energy Intensity: Expressed in Kilograms Coal-Equivalent Energy Consumption Per Dollar (U.S.) Gross National Product, 25 Developed Market Economies, 1955, 1965, and 1970, and Percent Change, 1955-70

Country	1955	1965	1970	Percent Change 1955-70
Australia	2.85	2.38	2.04	-28.44
Austria	3.08	2.04	1.98	-35.68
Belgium	3.69	2.63	2.45	-33.71
Canada	4.62	3.13	2.79	-39.60
Denmark	2.07	1.96	2.01	-2.51
Finland	2.40	1.54	2.08	-13.14
France	2.17	1.54	1.49	-31.34
Greece	1.10	1.14	1.21	10.57
Iceland	1.78	1.61	2.04	14.22
Ireland	2.18	2.33	2.46	13.16
Israel	1.57	1.56	1.53	-3.06
Italy	1.76	1.61	1.69	-4.23
Japan	3.06	2.08	1.97	-35.83
Luxembourg	--	2.33	6.49	--
Netherlands	2.31	2.08	2.27	-1.95
New Zealand	2.02	1.28	1.41	-30.07
Norway	4.69	1.89	1.96	-58.16
Portugal	1.64	1.28	1.03	-37.57
South Africa	9.93	4.56	3.85	-61.22
Spain	2.17	1.82	1.68	-22.73
Sweden	2.77	1.75	1.66	-40.11
Switzerland	1.89	1.15	1.17	-38.09
United Kingdom	4.11	2.86	4.52	9.97
United States	3.32	2.56	3.58	-22.21
West Germany	3.17	2.22	1.90	-39.91
Mean	2.93	2.05	2.25	-22.15
Standard deviation	1.77	0.72	1.18	22.05

NOTE: The mean percent change in energy intensity from 1955 to 1970 reflects a 45 percent rate of inflation in U.S. currency during this period of time.

SOURCE: Taylor and Hudson (1972); United Nations Statistical Yearbook, 1974 (United Nations, 1958-1975).

APPENDIX B Descriptions of Social Welfare and Energy Intensity Variables

	Sources		Transformation[a]			Rate of Change Score
Variable	1965	1955-70	1955	1965	1970	1955-70
Grams protein per capita per diem	Taylor and Hudson, 1972		NA	--	NA	NA
Calories per capita per diem	Taylor and Hudson, 1972		NA	--	NA	NA
Hospital beds per capita	SY 1971[b]		NA	ln	NA	NA
Physicians per capita		SY	ln	NA	ln	--
Nurses per capita	SY 1971		NA	ln	NA	NA
Dentists per capita		SY	ln	NA	ln	--
Pharmacists per capita	SY 1971		NA	ln	NA	NA
Life expectancy		DY	ln	NA	ln	--
Infant mortality		DY	ln	NA	ln	ln
Cancer deaths per capita		DY	ln	NA	ln	ln
Heart disease deaths per capita		DY	ln	NA	ln	ln
Hypertension deaths per capita		DY	ln	NA	ln	ln
Ulcer deaths per capita		DY	ln	NA	ln	ln
Auto accident deaths per capita		DY	ln	NA	ln	ln
Educational expenditures per capita	Taylor and Hudson, 1972		NA	ln	NA	NA
Educational expenditure as percentage of GNP		SY	ln	NA	--	--
Adjusted school enrollment ratio	Taylor and Hudson, 1972		NA	--	NA	NA
Unadjusted school enrollment ratio	Taylor and Hudson, 1972		NA	--	NA	NA
Enrollment in higher education	Taylor and Hudson, 1972		NA	ln	NA	NA
Literacy	Taylor and Hudson, 1972		NA	--	NA	NA

Book titles per capita per year		UY	ln	NA	ln	ln
Cinema attendance per capita per year		SY	--	NA	ln	ln
Newspaper circulation per capita		SY	--	NA	ln	ln
Radios per capita		SY	ln	NA	ln	ln
Television receivers per capita		SY	ln	NA	ln	ln
Smallest size of population with 50% of income	Taylor and Hudson, 1972		NA	--	NA	NA
Gini index of income inequality (No. 1)	Taylor and Hudson, 1972		NA	--	NA	NA
Gini index of income inequality (No. 2)[c]	Jain, 1975		NA	--	NA	NA
Smallest number of farms with 50% of the land	Taylor and Hudson, 1972		NA	--	NA	NA
Gini index of land inequality	Taylor and Hudson, 1972		NA	--	NA	NA
Kuznets index of income inequality	Jain, 1975		NA	--	NA	NA
Entropy coefficient of income inequality	Jain, 1975		NA	--	NA	NA
Sex discrimination in primary education	SY 1971		NA	ln	NA	NA
School enrollment, 2d level		UY	ln	NA	ln	ln
School enrollment, 1st and 2d levels		UY	--	NA	ln	ln
Telephones per capita		SY	--	NA	--	ln
Energy intensity		SY	ln	ln	ln	ln
Sex discrimination in secondary education	SY 1971		NA	ln	NA	NA
Sex discrimination in higher education[d]	SY 1971		NA	ln	NA	NA
Divorces per capita		DY	ln	NA	ln	--

APPENDIX B Continued

Variable	Sources		Transformation[a]			Rate of Change Score
	1965	1955-70	1955	1965	1970	1955-70
Manufacturing work hours per week[e]		SY	--	NA	--	--
Suicides per capita		DY	ln	NA	ln	ln
Population density	Taylor and Hudson, 1972		NA	ln	NA	NA
Population growth rate		SY	--	NA	ln	ln
Automobiles per capita		SY	ln	NA	--	ln
Housing density		SY	ln	NA	ln	ln
GNP per capita		SY	--	ln	--	ln
Homicide deaths per capita		DY	ln	NA	ln	ln
Collective protest[f]	Hibbs, 1973		NA	--	NA	NA
Internal war[f]	Hibbs, 1973		NA	--	NA	NA
Unemployment rate		SY	--	NA	ln	ln

[a] The "ln" notation indicates a natural logarithmic transformation was performed. The actual, untransformed scores were employed for all other variables in the regression analyses. "NA" indicates that transformation was inapplicable, in that data for a given period were not employed.

[b] "SY" refers to United Nations Statistical Yearbooks (United Nations 1958-1975); if no date, then various data years, 1957-1974. "DY" refers to United Nations Demographic Yearbooks (United Nations, 1966-1976). "UY" refers to UNESCO Yearbooks (UNESCO, 1965-1975).

[c] See Jain (1975) for a more detailed discussion of various indexes of income inequality.

[d] The sex-discrimination-in-education variables were measured by dividing a given male enrollment ratio (percentage of population enrolled at that level of schooling) by the female enrollment ratio.

[e] Manufacturing work hours per week were computed, in some cases, from data reported in terms of hours worked per day or month. In these cases, the daily data were multiplied by 5.5 and the monthly data divided by 4.3 so as to place all countries on a comparable weekly basis.

[f] "Collective protest" data were compiled by Hibbs (1973) and are a summated index of events such as riots, antigovernment demonstrations, and political strikes. "Internal war" is an index of events such as armed attacks, attempted and actual assassinations of political authorities, and antistate or intergroup conflicts resulting in large numbers of deaths. Hibbs notes that these two clusters of events have nothing to do with each other, and this relationship has been consistent over recent decades.

APPENDIX C Product-Moment Correlations Between Electricity Consumption Per Capita and Total Energy Consumption Per Capita, and Selected Social Welfare Indicators, Developed Market Economies, Circa 1965

Social Welfare Indicators	Electrical Production Per Capita	Total Energy Equivalent Per Capita
Health, health care, and nutrition		
Grams protein per capita per diem	.13	.23
Calories per capita per diem	.29	.46[a]
Hospital beds per capita	.31	.32
Physicians per capita	.04	.09
Nurses per capita	.59[a]	.68[a]
Dentists per capita	.53[a]	.37
Pharmacists per capita	.03	.02
Life expectancy	.29	.30
Infant mortality	-.64[a]	-.63[a]
Cancer deaths per capita	.27	.40[a]
Heart disease deaths per capita	.56[a]	.58[a]
Hypertension deaths per capita	.35[a]	.20
Ulcer deaths per capita	-.16	-.23
Auto accident deaths per capita	.42[a]	.58[a]
Education and culture		
Educational expenditures per capita	.78[a]	.87[a]
Educational expenditure as percentage of GNP	.62[a]	.67[a]
Adjusted school enrollment ratio	.33	.50[a]
Unadjusted school enrollment ratio	.41[a]	.68[a]
Enrollment in higher education	.18	.37[a]
Literacy	.48[a]	.48[a]
Book titles per capita per year	.27	.11
Cinema attendance per capita per year	-.03	-.27
Newspapers per capita per year	.64[a]	.59[a]

APPENDIX C Continued

Social Welfare Indicators	Electrical Production Per Capita	Total Energy Equivalent Per Capita
Radios per capita	.71[a]	.84[a]
Television receivers per capita	.42[a]	.46[a]
Inequality, equity		
Smallest size of population with 50% of income	.51[a]	.53[a]
Gini index of income inequality	-.26	-.42[a]
Smallest number of farms with 50% of the land	.08	.18
Gini index of land inequality	.04	.00
Gini index of income inequality	-.20	-.08
Kuznets index of income inequality	-.22	-.10
Entropy coefficient of income inequality	-.20	-.08
Sex discrimination in primary education	-.26	-.17
Sex discrimination in secondary education	-.14	-.01
Sex discrimination in higher education	-.01	-.18
General satisfaction		
Divorces per capita	.50[a]	.63[a]
Manufacturing work hours per week	-.50[a]	-.29
Suicides per capita	.40[a]	.40[a]
Population density	-.21	-.03
Population growth rate	.16	.13
Economic and consumption[a]		
Automobiles per capita	.74	.83
Housing density	-.58	-.60
GNP per capita	.79	.87

ENERGY AND INTERNATIONAL TRADE:
THE ROLE OF THE
MULTINATIONALS IN U.S. FOREIGN POLICY

by

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PREFACE

I would like to thank the Duke University Round Table on Science and Public Affairs for its generous support of this project; Charles P. Wolf for his careful and constructive criticism; and Virginia Wheaton, Joanne Smith, and Joyce Howsare for their patient and gracious assistance.

INTRODUCTION

The oil crisis and its aftermath dramatizes the coincidence of economic interdependence and economic nationalism that characterizes global affairs in the 1970's. The disruption of international energy trade arrangements, occasioned by the takeover of foreign oil production in 1973 by the Organization of Petroleum Exporting Countries (OPEC), triggered a wave of economically nationalistic energy policies. The realization of their dependency on foreign oil led many nations to strengthen state-owned oil companies, to establish bilateral arrangements with oil-exporting nations, and to impose restrictions on the activities of private, multinational oil companies.[1] This tide of economic nationalism engulfed United States policy makers as well.

OPEC's expropriation of oil production quadrupled the price of foreign crude oil. Because American oil companies are dependent on foreign crude, dramatic increases in the price of oil were passed on directly to American consumers. The price escalation sent shock waves throughout the American economy and called forth a flood of conferences and research reports on the nature and solution of the energy crisis.

These deliberations have reviewed global and national material resources (including man-made resources, such as energy technologies) as well as the institutional framework that has evolved to gather and distribute these resources. They have correctly recognized that a society and its energy systems interact and are mutually determining. Social impact assessments of energy projects have explored the range of possible energy futures available to our society and examined the impact of alternative energy futures on the structure of American society. They demonstrate that the choice of energy systems affects the degree to which economic and political power will be centralized; indeed that the choice helps determine the nature of our society.

Unfortunately, these studies give scant attention to the international and historical context within which such choices are made. This oversight is noteworthy because the arrangement of America's energy institutions is not merely a domestic issue, nor is it amenable to nonhistorical analysis. Regardless of how our national goals are redefined as a result of the energy crisis, their realization will be shaped by the international context of energy policy. Just as the balance of power among

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[1] There are already indications that nationalizing the production and distribution of energy results in inefficient allocation of resources and limits the availability of energy to oil-consuming nations. Referring to the nations of Western Europe, Vivian Lewis observes, "While they pay lip service to cooperation, the countries are in fact single-mindedly pursuing their own interests, often at their neighbors' expense, relying increasingly on their own national oil companies" (Lewis, 1978). Odell (1978) confirms the restraint of European economic nationalism on rapid development of Europe's oil reserves.

institutions within a society shapes the fabric of social life, the arrangement of institutions involved in international energy trade conditions the social and political order of national societies. The geopolitics of energy supply and demand, the scope of government intervention, and the role of private economic institutions in international energy trade mediate the direction and effectiveness of national energy policies.

The expansion of our approach to the energy crisis to include international and historical factors requires that we consider the reciprocal influence of U.S. foreign policy (of which our national energy policy is an important element) on the world energy market, and give special attention to the relationships, roles, and effectiveness of the public and private institutions involved in energy trade. America's oil companies, as strategic elements in the international energy system, provide excellent subject matter for such an investigation. They reveal the interplay between private economic interests and national political concerns that must be considered in any review of our international energy system. As critical links in the delicate network of international trade, they call attention to the central problem of energy foreign policy: bringing national needs in line with an interdependent global economy.

Method

The role of America's multinational oil companies in U.S. foreign policy is a highly controversial issue.[2] In order to place this issue in proper perspective we must examine the viewpoints of the actors in this international drama, which are shaped not only by their resource capabilities and the changing context of international relations but also by their nation's values. Thus, any evaluation of United States energy policy, or consideration of alternative futures, must take into account

[2] See, for example, Congressional Digest (1976); American Enterprise Institute (1977); New York Conference Board (1977). The relevance of this issue to energy policy questions is evident in the attention the issue has drawn in government circles: Federal Energy Administration (1975); Comptroller General (1978); U.S. Congress (1977); and Petroleum Industry Research (1977).

Recent studies reveal that much of the controversy and confusion surrounding the role of the oil companies is a product of bias and factual inaccuracy. Hobbie and Mancke (1977), for example, report that media perceptions of the oil industry are at variance with the studied conclusions of most economists; also see Ellis (1977).

not only the United States' geopolitical interests in the international arena but its unique perspective in understanding international events.[3]

I approach this question with the understanding that the "images" in our minds shape our understanding of the world, our interpretations and evaluations of others' actions, and our responses to those actions.[4] This approach recognizes that the relation between events and policy is never direct, but rather is always mediated by images of events. It directs attention to problems of meaning, motivation, and action. It highlights the role of national political ideals as major structuring principles of international reality, as well as the role of policy makers as contact points on the interface of domestic interests and the interests of other nations.

Like other actors, the energy foreign-policy maker operates in a specific "image climate" shaped by reference group values. This climate conditions the decision maker's learning process by providing conceptions of how the world operates. These conceptions have an element of validity insofar as they are the product of historical experience. Their simplicity, clarity, and basis in historical fact strengthen the hold these images have on the decision maker's mind. The rapid pace of social change and the special nature of crises, however, diminish the relevance of these conceptions. Moreover, the backward-looking approach to present and future problems afforded by such images can be and has been dangerous. To minimize such danger and to maximize the effectiveness of U.S. foreign policy with respect to multinational energy institutions requries that we catalog and analyze the dominant images that have shaped and continue to shape that policy. Cataloging and analyzing these images is the aim of this paper.

The inventory begins with an account of the international and historical factors most influential in determining America's energy institutions. This paper deals with postwar changes in oil supply and demand, the

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[3] This perspective was shaped by liberal values in a unique geographic and sociohistorical setting. My use of the term liberal here draws on Bramson's (1961, p. 16) definition: "By 'liberal' . . . I intend the classical doctrine of political and economic individualism . . . with its emphasis on rationality, equality, religious liberty, constitutionalism, majority rule. Associated culturally and socially with middle class hegemony, it has emphasized self-mastery, self-reliance, achievement, an orientation to the future and, above all, individuality."

This liberal perspective took shape in a unique setting. By virtue of their cross-Atlantic passage the Pilgrims removed themselves from the old feudal enemies in Europe and made possible the remarkable success of the liberal movement in America. The monolithic presence and remarkable success of liberalism as a guiding philosophy resulted in the acceptance of its principles as self-evident and true. When transported onto the international scene, this perspective assumes unique moralistic qualities that Hartz (1955) describes as "liberal absolutism."

[4] On the concept of "images" and its relevance for the study of policy issues, see Boulding (1966).

structure of the international oil industry, and the relationship of national governments and their policies to private, multinational oil companies. The last section of the paper addresses our current arrangements for dealing with these aspects of the energy problem and considers alternative approaches.

Truman Doctrine images regarding the role of private enterprise in the maintenance of global peace and the protection of the "American way of life" have shaped United States foreign policy since World War II. A brief history of this era can be divided into three distinct periods: 1947 to 1954, 1954 to 1970, and 1970 to the present. These three periods can be distinguished in terms of the supply and demand of oil, the structure of the international oil industry, and the degree of government intervention in the international oil industry. These elements have affected and been affected by international trade and national security concerns of United States foreign policy.

1947 TO 1954

Supply and Demand

Although energy was not itself a key issue in the postwar era, it did receive attention as an essential ingredient of economic development throughout the world. These economic development concerns were themselves inextricably linked to the national security concerns that dominated the Cold War. The war had left America's allies, both industrial and nonindustrial, severely weakened. The war cut these nations off from the exchange of raw materials, energy resources, and finished products vital to their economies. Of the allied forces, only Russia and the United States emerged from the war in relatively strong positions. This was due, in large part, to their self-sufficiency with respect to natural resources.[5] Their common condition of resource self-sufficiency did not, however, foster similar images of the future of the postwar world.

The United States advanced a view based on concepts of free international trade. From this perspective a system of global economic cooperation that provided participating members with fuel for their factories and markets for their goods was essential to political

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[5] Schurr and Netchert (1960, p. 45); Jacoby (1974, p. 11). America became a net importer of oil in 1949.

stability and lasting peace.[6] To the Russians, the redevelopment of traditional patterns of trade would benefit the economies of Western capitalist countries at the expense of underdeveloped Eastern European communist nations. These conflicting views gave rise to a series of confrontations between the United States and the Soviet Union. With regard to international trade and economic development, security and the low cost of energy became central issues in their rivalry to answer the growing demands of refurbished and nascent industrial economies.[7]

Industry Structure and Government Intervention

In 1947, with prewar failures of the government-sponsored Petroleum Reserves Corporation to negotiate the purchase of foreign oil concessions still fresh in their minds, United States foreign-policy makers encouraged American oil companies to compete for oil concessions outside of North America.[8] To meet the growing demands for oil on the part of reconstructed and developing industrial economies, and to facilitate their containment policies,[9] American foreign-policy makers acted to restructure the international oil industry to protect American interest in secure, low-cost supplies of oil (U.S. Senate, 1974, 8:4).

Toward this goal, the State Department and the National Security Council championed the expansion and stabilization of American companies' interest in foreign oil concessions. In 1948, the Department of Justice decided not to pursue the antitrust implications of the Aramco merger due to foreign-policy considerations (Church, 1977, p. 28). In 1950, foreign tax credit arrangements between American oil companies and Middle East regimes were approved by both the State and Treasury Departments on the grounds that they served the national interest (U.S. Senate, 1974, 8:341-378). In 1953, concerned that the state of affairs in Iran could possibly lead to Soviet domination of Iran and its oil fields, the National Security

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[6] Freeland (1972, p. 16). In his report, Herbert Hoover (1947, p. 2) advised President Truman that, " . . . the whole economy of Europe is interlinked with the German economy through the exchange of raw materials and manufactured goods." Henry Stimson framed the problem of economic reconstruction in terms of American political values: "One hope for the future is the restoration of stable conditions in Europe, for only thus can concepts of individual liberty, free thought and free speech be nurtured. Under famine, disease and distress conditions, no territory or people will be concerned about concepts of free speech, individual liberty and free political action" (Stimson and Bundy, 1946, p. 594).

[7] On the importance of Middle East oil to the United States and its allies, see U.S. Senate (1974, 7:124-125).

[8] On the exclusionary policies of the British government in the Middle East oil fields during the first part of the 20th century, see Jacoby (1974, pp. 25-48).

[9] On the origins and nature of containment policies, see Gaddis (1972, pp. 199-206), Jones (1955), and Kennan (1951, p. 99).

Council approved the formation of a consortium of multinational oil companies to market Iranian oil following the overthrow of the Mossadegh government (U.S. Senate, 1974, pp. 297-300). This action advanced the goal of containment, strengthened multinational control of oil supplies and enabled American oil companies to acquire access to Iranian oil reserves (U.S. Senate, 1974, 9:46).

Images

The role assigned to American oil companies in the years immediately following World War II was shaped by U.S. foreign policy images regarding the function of private enterprise in international trade. These images rested on a belief in the peace-keeping functions of the free market system.

> For throughout history, freedom of worship and freedom of speech have been most frequently enjoyed in those societies that have accorded a considerable measure of freedom to individual enterprise.
>
> The pattern of international trade that is most conducive to freedom of enterprise is one in which the major decisions are not made by governments but by private buyers and sellers.[10]

This view is a sort of Marxism in reverse. It accepts the Marxian premise that material conditions determine man's nonmaterial life, but draws a different conclusion. Whereas Marxism sees competitive capitalism as a source of conflict, U.S. foreign policy in the postwar era portrayed the freedom of private enterprise as a source of peace. This perspective reflected the government's belief that a world of state-controlled, planned economies would so restrict free trade that America's own democratic way of life would become subject to the imposition of garrison-like state controls (U.S. Senate, 1948, p. 76; U.S. House, 1951, p. 367). It mistakenly assumed that multinational economic institutions could be relied on to perform the political functions associated with the task of protecting U.S. national security.

The role defined for American oil companies by U.S. foreign policy images answered the domestic concerns of a war-weary citizenry and complemented the economic needs and capabilities of the multinational corporations. Policy decisions, such as the approval of tax concessions, advanced the security of American oil companies' access to Middle East oil reserves. It maintained the stability of Middle East nations friendly to the United States without exacerbating domestic tensions over the

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[10] Truman (1947, p. 483). The Depression and the renewal of global hostilities culminating in World War II had convinced national leaders that economic isolation and poverty endanger world peace and foster the spread of authoritarian governments.

direct extension of foreign aid.[11] By diverting revenue from the U.S. Treasury to Middle East sheikdoms, the foreign tax credit arrangements of the American oil companies enabled foreign-policy makers to support friendly nations without having to "travel the perilous path of annual, politically unpopular, congressionally appropriated foreign aid" (Church, 1977, p. 31).

The successful entry of American oil companies into the international oil industry advanced the goals of U.S. foreing policy in several ways (U.S. Senate, 1974, 8:5). The U.S. government's intervention enabled the major American oil companies to strengthen their positions in the already highly concentrated international oil industry. The dismemberment of exclusionary control, accomplished by government sponsorship of major oil company interests, served U.S. energy policy goals by increasing the geographical diversity of oil supplies.[12] This heightened competition among oil producers, thereby enhancing prospects for secure supplies of cheap oil. As institutional representatives of the "American way," oil companies served as the vanguard in the Cold War of ideas between capitalism and Soviet communism. As buffers against state-controlled economies, they protected the freedom of the individual against the restrictions of collectivism. As agents of economic growth, the oil companies offered underdeveloped countries escape from the conditions of economic isolation and poverty that, according to U.S. foreign policy images,[13] threatened world peace and fostered the spread of authoritarian governments. In so doing, the oil companies contributed to the political stability of the Middle East as a whole, strengthened U.S. ties with individual Middle East countries, and thereby enhanced the ability of the U.S. to resist Soviet expansion and influence in the area. In addition, by supplying Western Europe's energy needs on terms that were favorable to their balance of payments and economic growth, the multinational oil companies protected the security of American interests as well as those of its allies.

Just as the role of the U.S.-owned oil companies advanced the ideals of U.S. foreign policy, so did U.S. foreign policy complement the structure and function of the oil companies as multinational corporations. Although new transportation and communications technologies provided the necessary conditions for the expansion of the multinational empire, global

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[11] Elmo Roper summarizes American public opinion of U.S. international responsibilities in the following manner: "While they wanted to prevent the spread of Communism and help countries that were in need, they were not eager to foot the bill for such efforts" (Roper, 1957:177). On Congressional budget-cutting and foreign policy during this period, see Gaddis (1972, pp. 344-346, 356).

[12] See Jacoby (1974, pp. 100, 172-212), who demonstrates that the postwar burgeoning of American oil enterprises, made possible by governmental intervention, had the effect of facilitating access to oil concessions for independent oil companies. Rather than resulting in increased concentration of the oil industry, governmental intervention had the effect of increasing the heterogeneity of the oil industry.

[13] See discussion above, p. 334.

entrepreneurship was made possible only as a result of considerable government intervention (U.S. Senate, 1974, 8:4). This intervention established the pattern of the postwar U.S. empire which was one not of political control but of economic dominance.[14] This dominance was established by gaining access for American-owned companies to the performance of economic functions abroad. Reasoning that the interests of American oil companies coincided with U.S. national interests (U.S. Senate, 1974, 5:13, 7:101), U.S. government policy makers acted to transfer control of the international petroleum industry to America's multinational oil companies.

Just as this policy sprang from foreign policy images regarding the role of private enterprise in international trade, so too did it complement the needs and abilities of multinational corporations. It minimized the risks and maximized the profits associated with foreign investments by American-owned multinational corporations.[15] The unique capabilities of the multinationals--their ability to insulate political problems, their flexibility, their vast expertise, and their logistical superiority --enabled them to respond to the extremely complex demands of international trade in a manner that no single global power could possibly have matched (U.S. Senate, 1974, 9:77-78; Comptroller General, 1978, pp. 36, 62).

The congruence of these geopolitical and institutional elements with images of U.S. foreign policy produced the empirical "proof" of postwar foreign policy "pudding." That is, the transfer of control over the international energy supplies to private multinational corporations provided secure access to low-cost oil for the reconstruction of the global political-economic order.

1954 TO 1970

Supply and Demand

Between 1950 and 1970 world energy consumption more than tripled (Jacoby, 1974, p. 49). In addition, there was a shift in the energy consumption pattern from coal to oil and natural gas. The rapid development of national transportation systems, chemical fertilizers, and electric generating stations triggered this dizzying spiral of petroleum consumption throughout the world (Schurr and Darmstadter, 1976, p. 5). National security interests directed the course of this growth. In Western Europe, coal production was virtually abandoned and the expansion of oil refinery capacity was promoted under the Marshall Plan. The lower cost of energy

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[14] For a discussion of this issue, see Huntington (1973, pp. 343-344).

[15] On the role of the U.S. government intervention abroad in the reduction of risk associated with investment in politically unstable, underdeveloped countries, see U.S. House (1951, pp. 380-381). For a discussion of how such overseas expansion affects multinationals and the societies that sponsor them, see Moran (1973, pp. 372-375).

derived from oil, as compared with coal, lowered the cost of industrial production and thereby enhanced the position of European industry in international trade (Prodi and Clo, 1975, p. 3). The expansion of domestic refinery capacity saved foreign exchange by permitting the importing of lower priced crude oil instead of higher priced refined products. In addition, the expansion of domestic refinery capacity protected the security of petroleum product supplies for national markets.

The growing demand for oil generated by these forces was answered by the multinational oil industry's expansion of petroleum supplies and by dramatic growth in the number of independent suppliers available to consuming national economies. From 1953 to 1972 the international oil industry became "more heterogeneous with respect to the size, nationality, goals and policies of its member firms."[16] In addition, in order to protect domestic producers, the U.S. government imposed a quota system on oil imports in 1959, thereby increasing the supply of oil available to the rest of the noncommunist world (U.S. Senate, 1974, 9:138). In this manner, the combination of national security considerations and private competition led nations and oil companies to expand their oil reserves to such an extent that by the late 1950's a substantial excess capacity existed in all divisions of the oil industry (Jacoby, 1974, p. 79).

Structure: Organizational and Technological Changes

The existence of excess capacity and changes in the organizational and technolgoical structure of the oil industry combined to reduce the economic power of the major oil companies to advance U.S. foreign policy interests as outlined in the Truman Doctrine. Technological progress in the areas of transportation, refining, and communications worked to shrink international space and diminish the risks that would have otherwise limited competition and precluded the entry of independents into

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[16] Jacoby (1974, p. 172). In his analysis of changes in the structure of the oil industry Jacoby observes: "Whichever measure is applied, concentration diminished markedly during the period from 1953 to 1972. According to the criteria proposed by Professor J. S. Bain, the industry structure changed from one of moderately high to low concentration in exploration concessions; from high or very high to moderate concentration in the sales of petroleum, ownership of crude oil production, and proven reserves; from moderately high to moderately low concentration in the ownership of crude oil refining capacity and the volume of sales of petroleum products; and from low to very low concentration in the ownership of tanker transportation capacity." Likewise, the Comptroller General (1978, p. 31) reports that competition in the international oil industry is healthy: "We met with eight nonmajor oil companies that were involved in OPEC countries to determine their views on the major companies' relationships with OPEC countries. Several of these companies spoke confidently of their ability to compete with the majors. None of the companies indicated that the majors enjoyed advantages which precluded competition."

the international oil industry. Just as technological progress facilitated the entry of independents into the international market, so did advances in international communications speed the development of information networks that allowed oil-producing countries to monitor the strategic position of their natural resources in the global economy.

The emergence of the independents stimulated rapid development of new petroleum concessions, undermined the major oil companies' control of the international supply system, and bolstered the bargaining position of oil-exporting governments. In addition to the entry of independent oil companies, this period witnessed the reentry of the Soviet state oil monopoly into the international oil industry. In many large markets the Soviet state oil monopoly acted as a price leader in driving down the price of oil.[17] The unique advantages of the politically motivated Soviet oil export trust further diminished the major oil companies' power to control price and supply (Jacoby, 1974, p. 163).

Reductions in Middle East oil prices, made by the major oil companies in the face of growing surpluses and increasing competition among suppliers, triggered the formation of OPEC in 1960. This organization, a coalition of important oil-exporting nations, resolved to replace international market forces with national political considerations as determinants of the price and supply of oil. Although the oil-producing countries that formed OPEC differed significantly in cultural attributes, political systems, and stages of development, they shared the common goal of decolonization and modernization. International political control of oil resources was a means to achieve these goals. Thus seen, the formation of OPEC was an attempt by formerly colonized, underdeveloped nations to advance their status in the international system.[18] This action by the oil-producing nations signalled to the world that the era of private, corporate management of the world's oil reserves was drawing to a close. OPEC nations and the multinational corporations both realized that the oil companies' bargaining power was a function of supply and demand. As the structure of the international oil market changed, the major oil companies would continue to lose their power to shape the economic and political context within which they operated.

Images

U.S. foreign-policy makers failed to comprehend this new reality. America's history of energy self-sufficiency, the superior efficiency and productivity of American companies, and faith in the rewards of research and development expenditures made it difficult for policy makers and the general public to imagine that a group of underdeveloped nations could threaten the U.S. economy or jeopardize our national security (McKee, 1975, p. 80). The consensus among policy makers at this time was that the

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[17] On fears of Soviet penetration of Western oil markets, see U.S. Senate (1974, 5:257-258).

[18] For a discussion of international relations in terms of social stratification, see Nettl and Robertson (1968).

performance of political duty (the advancement of U.S. national security interests) could be entrusted to private economic organizations. This simplistic view reflected the highly favorable condition of a geographically diversified oil surplus that characterized the international energy market of the 1950's and 1960's.

So long as the oil surplus of the 1960's allowed multinational oil companies to play one oil-producing country against another, and the price and supply of oil continued to be reasonable and secure, the oil companies continued to have sufficient power to negotiate on behalf of the consumer states. As a result, in spite of recurring conflicts in the Middle East during this period (and the obvious energy supply implications of those conflicts), the U.S. State Department developed no explicit policy to cope with changes in the structure of the international oil industry. Rather, it left the formulation of such policy in the hands of the oil companies (Wilkins, 1975, p. 166).

> During this period [1960's] the U.S. government basically remained in the background and did not attempt to influence or control international supply arrangements. In fact, the capacity of the U.S. government to monitor, much less respond to, changes in this important industry diminished significantly (Krueger, 1975, p. 61; U.S. Senate, 1974, 9:122).

Although emerging changes in the structure of the international oil industry had the effect of making the world economy more interdependent, U.S. foreign policy designed to cope with the heightened vulnerability of such a global system had not yet been formulated. In this policy vacuum, the multinationals ruled by default as arbiters of international political power. Meanwhile, the gap between U.S. foreign policy images of the role of private oil companies and the reality of the international oil industry's changing structure widened during this period. The consequences of this conflict between image and reality became apparent when Libya exploited the competition between independent and major oil companies in 1970.

1970 TO THE PRESENT

Just as World War II was a turning point in the development of the world economy, so did the years 1970-1974 signal a change in the nature of international political and economic conditions.

> Like World War II, this was another historic watershed, separating the old era of inexpensive oil and enterprise control of industrial strategy from the new era of expensive producing countries (Jacoby, 1974, p. 9).

Supply and Demand

In addition to technological and organizational changes, three postwar trends in the supply and demand of oil combined to create a context in which the oil-producing countries were able to realize their bargaining power: (1) the dramatic growth in energy consumption, (2) the rising share of petroleum within the total of energy consumed, and (3) the rising share of Eastern Hemisphere oil in accommodating the global demand for petroleum (Darmstadter and Lansberg, 1975, pp. 16-17).

Prior to 1960 the oil countries lacked the economic clout and the political cohesion to assert their demands on the international stage. "The existence of a buyer's market, the self-sufficiency of the U.S. as a producer and consumer of oil, and the dominant position of the major oil companies" (Lenczowski, 1975, p. 60) limited the strength of the oil countries. By 1972, however, growth in global consumption of oil, the entry of the independents into the international oil industry, and increasing U.S. dependence on oil imports reversed these conditions.[19] These changes brought the oil-producing states to the center of the international stage.

Structure: Changes and Crisis

The first actor on the scene was Libya, a nation where competition between majors and independents had accelerated to the point that it could be exploited by the host government (U.S. Senate, 1974, 5:107). Libya's position was strengthened by the closing of the Suez Canal as a result of the 1967 Arab-Israeli war. This closing worked to Libya's advantage because its oil doesn't have to go through the Canal to get to Europe. The failure of the U.S. government to support the oil companies in their negotiations with Libya revealed their vulnerability and exposed them to a round of "leap-frogging" demands by other oil-producing countries. The oil companies made a concerted attempt to resist the upward spiral of OPEC demands, but this attempt was undermined by the confused and confusing efforts of the U.S. State Department to support it.[20] The outbreak of the Arab-Israeli war in 1973 and the ensuing embargo confirmed the extent to which the OPEC's efforts to wrest control of oil from multinational oil companies had succeeded.

Following the 1973 oil crisis, oil-consuming nations realized that oil companies no longer had the power to negotiate on behalf of the consumer states. Although the oil companies retained control of the

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[19] The increasing dependence of the U.S. on Middle East imports dimished America's capacity to stabilize upsets in the world market as a supplier of last resort. On the relation of domestic energy policy to international markets, see Darmstadter and Landsberg (1975, p. 27); and U.S. Senate (1974, 7:143).

[20] U.S. Senate (1974, 5:19-21). On the failure of U.S. foreign policy in this case, see Oppenheim (1976-77) and Comptroller General (1978, p. 32).

refining, marketing, and transport of oil, strategic decisions regarding the production and processing of oil were no longer economic decisions made by multinational oil companies but had become political decisions made by governments of the oil-exporting countries.[21]

In the wake of this realization regarding the demise of the multinational empire, a series of bilateral agreements between consuming and producing nations were drawn up. In Europe, the crisis hit at a time when the long and arduous process of forming a European community had yet to be completed. In the absence of adequate supranational political arrangements for coordinating European energy policies, the various European nations were left to their own devices. The realization of their individual dependencies on the oil-exporting nations and the multinational oil companies for their oil supplies led many European nations to impose restrictions on the autonomy of the oil companies. In addition, several European nations moved to strengthen state-owned oil companies. As in Europe, the oil crisis highlighted Japan's dependence on oil imports and forced it to strengthen government-affiliated oil firms and to seek bilateral agreements with exporting nations.[22]

The U.S. foreign policy response to the oil crisis was that America's dependence on Middle East oil threatens the national security of the United States and of those nations dependent on the U.S. for the protection of their economic, political and military interests (Penrose, 1975). President Nixon launched Project Independence to free the U.S. from this dependence on unreliable oil supplies. At the same time, consumer groups and public leaders called for the divestiture of the major oil companies, in the belief that the resulting increased competition would encourage the search for new supplies of oil at lower prices.

In addition to triggering a wave of bilateral agreements and economically isolationist policies on the part of the industrialized nations, OPEC's reform of the structure and function of the international oil market sparked the creation of a complementary transnational organization, the International Energy Agency (IEA).[23] This supranational organization, composed of oil-consuming, developed, noncommunist countries, has authority in the event of future oil shortages to replace the oil companies as monitors of the supply of oil to consuming nations.

These responses to the oil crisis reflect the impact of that crisis and its message to the world that historical images of the international oil industry and established ways of behavior in that arena are no longer

[21] On the unique attributes that distinguish oil-exporters as a cartel from other materials producers, see Krasner (1974); for a discussion of the multinational oil companies as willing accomplices to cartel action, see Adelman (1972-73).

[22] On the failure of European integration in the aftermath of the 1973 oil embargo, see Prodi and Clo (1975); for a more recent account of this disunity and its implications for international oil trade, see Lewis (1978) and Odell (1978).

[23] Lantzke (1975, pp. 217-228). The Comptroller General (1978, p. 45) notes that the IEA is dependent on the multinational oil companies for the successful performance of its newly created functions.

appropriate. The strictly political nature of these responses demonstrates that little erosion of national sovereignty sentiments and little development of internationalism has occurred since World War II in spite of the growing interdependence of the global economy.

IMAGES OF THE FUTURE: ECONOMIC NATIONALISM OR GLOBAL INTERDEPENDENCE?

Divestiture Proposals

The emergence of the energy crisis following the OPEC takeover in 1973 called forth evaluations of images regarding the role of multinational companies in international trade. Proposals to break up the multinational oil companies have been advanced by those who see the oil crisis as a justification and opportunity to change the structure of our society's institutional arrangements for energy production and distribution. Calls for divestiture of the major oil companies stem from the belief that the resulting increased competition will dissolve the concentration of the international oil market. This view assumes that OPEC's strength as a cartel rests on the cooperation of the major oil companies. By breaking up the majors' overseas operations we can force the OPEC countries to deal with a larger number of potential buyers and thereby reduce the pricing power of the cartel.[24]

These proposals recognize that domestic energy policy has foreign-policy implications. For it is only by lessening the size of U.S. oil imports that other nations can have reasonable hopes for continued supplies of oil. However, this approach neglects short-term problems that cannot be ignored if our national security is to be maintained. The development of new energy resources is a long way off. For the foreseeable future the U.S. will continue to depend on imported oil and, for the foreseeable future, reliable access to that oil will pose national security problems. Proposals to break up America's multinational oil companies and disperse their functions among a number of smaller companies would increase, rather than lessen, the vulnerability of American consumers to foreign oil price and supply decisions.

Such proposals neglect the competitiveness of the international oil industry as it is currently structured,[25] and overestimate the limited

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[24] Sampson (1975:304). For an evaluation of this strategy, see Haring and Roush (1976).

[25] The Comptroller General (1978, p. 31) report is informative in this regard: "About 16 percent of OPEC's production is exported to the United States. Although it is generally perceived that a handful of majors are responsible for most of OPEC's imports to the United States, in actuality the majority of the imports were provided by 28 other U.S. oil companies." For a statistical overview of the competitiveness of the international oil industry, see Trinkle (1976, pp. 6-9); also see Jacoby (1974, p. 173).

ability of small companies (the creatures of proposed divestiture) to advance oil-consumer interests. It is the absence of adequate short-term substitutes for OPEC oil that accounts for OPEC's price-setting ability. Increasing the number of purchasers will not alter this condition and may actually strengthen OPEC's bargaining position. One probable result of divestiture would be a reduction of oil companies' abilities to finance exploration of new, non-OPEC oil supplies during the years required to restructure the industry.[26] This would reduce rather than increase pressures on OPEC to lower oil prices.

Divestiture of American oil companies would succeed in altering the balance of power among our domestic political and economic institutions. It would not, however, diminish the importance of the role performed by integrated companies in international trade. Nor would it reduce their impact on the American economy.

> Dismantling the American oil companies will mean simply that their important role in world petroleum logistics will be taken over by the large integrated foreign companies like British Petroleum, Royal Dutch Shell, E.N.I., Compagnie Francaise des Petroles, and Mitsubishi Oil Company Ltd. (Ritchie, 1976, p. 1154).

The flexibility, expertise, and logistical abilities of integrated companies insure that they will continue to be important elements in the exploration, refining, and distribution of oil.

It is ironic that, at a time when other nations are exploiting the benefits of vertical integration, advocates of divestiture seek to eliminate this source of comparative advantage. In arguing for dismemberment, these advocates are calling for a reduction in the power of private economic institutions to check the nationalistic policies of state-planned economies.

To say that private, multinational oil companies provide a check against the growth of economic nationalism does not imply a faith in market forces or support for windfall profits.[27] Private economic power can be exploitative, and there is need of political remedies for such exploitation. Yet foreign governments do not view dismemberment as the appropriate approach to the reorganization of energy trade. Instead, foreign governments collaborate with private industry to strengthen the export capacity of these integrated firms. Government subsidies, in the form of low-interest, long-term loans and attractive export credits,

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[26] Ritchie (1976) provides a detailed analysis of the consequences of divestiture in terms of: a) increased operating costs, b) increased costs for U.S. consumers, c) transition costs, d) implications for the economy and domestic energy development, and e) costs to stockholders and bondholders.

[27] For an overview of the profitability of the oil industry, see U.S. Senate (1976); also see Federal Energy Administration (1977).

have become a normal part of national industrial policy abroad (Economist, 1977). Rather than abandon the integrated oil companies, foreign governments have strengthened their role as instruments of national policy. By transforming international economic competition into a test of national wills, these policies of economic nationalism have elevated the role of political power in international trade.

One has only to look back at the disastrous consequences of inward-looking economic policies of the 1930's to realize that politicization of international trade arrangements threatens the precarious vitality of the global economy and the stability of political relations among nation-states. A world of state-controlled oil companies would so restrict free trade that the security of access to oil supplies at stable prices would be jeopardized. Energy trade policies inspired by economic nationalism threaten the stability of the global political-economic order as the era of oil shortages approaches.

> As the world moves to supply shortfalls, single-country oil companies competing with each other would make it harder for the shortage to be borne more or less evenly among consumer countries. The international majors, responding to consumer pressure from many countries, spread the pain evenly during the 1973 embargo--as the I.E.A. plans to do in any future shortage.
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> But the potential effectiveness of the I.E.A.'s Oil-Sharing Agreement is being threatened by the growth of the European national companies (Lewis, 1978).

Indeed, these policies will bring the era of shortages closer to hand (Odell, 1978).

Validity of Postwar Images

In this context, U.S. postwar foreign-policy images regarding the relationship between the role of multinational oil companies in international trade and U.S. national security seem hauntingly appropriate. As Montesquieu observed, it takes a power to check a power. In the wake of divestiture, the ability of America's private oil companies to provide a check against the politicization of international trade would be severely reduced. The limitations of small oil companies would allow OPEC nations to manipulate their huge capital reserves and global options in a way that would threaten our economic stability and our national security. Already OPEC negotiation of bilateral arrangements with oil-hungry state firms has diminished our ability to stabilize the balance of power in the Middle East.

Moreover, politicization of international energy trade will result in inefficient allocation of resources. In contrast to the multilateral nature of the private distribution of petroleum, bilateral government-to-government negotiations are fraught with examples of political decisions that have overridden market considerations of oil supply and demand (U.S. Senate, 1974, 9:77). Bilateral trade is often discriminatory and, by its very nature, less flexible than the multilateral arrangements developed by private, multinational corporations. Their apolitical dedication to efficiency and profit avoids the problems of government-to-government negotiations that are subject to primarily political considerations (Vernon, 1975, pp. 252-253; Comptroller General, 1978, p. 36).

This flexibility allows multinationals to meet the uncertain demands that the energy crisis poses for the global economy. For the only thing that we know for certain about the future of the energy market is that we are running out of low-cost energy resources. This thread of certainty runs through a web of uncertainty regarding the prospective development of new energy technologies. Because the central task of foreign policy is to reduce uncertainty and to insure against the occurrence of events that would have severe costs, the inclusion of multinationals as a part of any coherent energy foreign policy is essential. In an era of uncertainty, we must be open to change in order to meet and comprehend new, unforeseen challenges. This openness is best accomplished through the decentralization and diversification of institutions. Maintaining the viability of the private sector in international trade is in our (as well as other nations') national interest. This approach to energy trade shuns the isolationism and economic and political crises occasioned by the centralization of energy planning in government agencies. The maintenance of multilateral trade enables national sovereignty and multinational enterprise to coexist. That this is so can be seen in the case of Third World countries.

Trade with government-owned and government-controlled enterprises, such as the Soviet oil trust, is less attractive to Third World countries in at least one regard. Because all of the decisions of these governmental corporations pass through a central mechanism, they are capable of more abrupt shifts in their trading policies and partners than are the multinational firms (Vernon, 1975, p. 256). Moreover, the diversity of multinational oil companies, majors and independents, guarantees a better bargaining position for the host country and heightens the probability that the energy technologies and supplies available to them will be suited to their specific needs.

In short, the continued presence of multinational oil companies complements, rather than opposes, the realization of national self-interests and the vitality of nation-states.[28] For although the problems of overpopulation, pollution, and the diminishing supply of materials are global, national governments are the only organizations with the resources and administrative structures to act upon information regarding these problems. Likewise, they are the only social systems that can accurately assess the relevance of energy technologies and the adequacy of supplies for their societies' needs. They alone can effectively articulate and negotiate the provision of these needs with multinational corporations. Indeed, their ability in this regard is a result of the growth of the multinationals and the complementarity of functions performed by

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[28] The section that follows draws heavily on Huntington (1973).

these two organizations. As the multinationals have grown, their need for access to the territory of nation-states has also grown. The increased value of this access has contributed to the strength of national governments that control access to domestic resources and markets. Hence, as the OPEC nations so clearly understand, the growth of the multinationals has not challenged the nation-state but has reinforced it.

Just as it is in the interest of multinationals to maintain access to national markets, so is it in the national interest of every nation-state to resolve problems of energy resources that threaten the quality of life and political stability of its society. In this light there are three good reasons why U.S. foreign policy must accommodate the continued presence of multinationals in the international energy market: (1) no single nation has a monopoly on the several areas of energy research, development, and distribution that are of potential importance to the various economies of the world; (2) different countries have different needs and different resources; (3) the magnitude, scope and duration of the energy problem are indeterminate and beyond the resources of any single nation or group of small, nonintegrated oil companies.

The Government Role

All of this is not intended to play down the need for an enhanced governmental role in energy foreign policy. Indeed, it was our policy makers' abdication of political responsibility to the multinationals that contributed to the energy crisis we are currently muddling through. The failure of our policy makers to monitor and respond to changes in the relation of their images to the changing structure of the international oil industry precipitated the energy crisis of 1973. It blinded America's policy makers to changes in the structure of the international oil industry, and to the limitations that those changes imposed on the oil companies' abilities to perform foreign policy functions. Since then, nationalization of oil production has further reduced multinationals' ability to perform the political functions assigned to them during the postwar years. Clearly, an enhanced governmental role in executing energy foreign policy is necessary.

Government agencies must be upgraded so that they can effectively monitor international energy transactions. This will enable policy makers to assess whether our nation is reducing its dependence on foreign oil. Such oversight must inform policy makers of the extent to which foreign oil-producing nations are increasing their leverage on the downstream activities of oil companies and the extent to which companies are obtaining competitive prices for foreign oil.[29]

The government must also work to reduce our heavy dependence on imported oil. The United States, as the world's largest consumer of oil, has an important role to play in developing alternative energy sources and effective conservation programs (Knorr, 1977, p. 120).

[29] For a discussion of this program, see Corrigan (1978, p. 357).

There are areas of energy research, development, and dependability that any holistic energy policy (one that places our domestic energy crisis in its international setting) must allocate strictly to the government. Government policy has primary responsibility where: (1) there is a high degree of national security involvement; (2) the social costs and benefits differ widely from private costs and benefits; (3) the enterprises are very large, protracted, or risky; or (4) the undertakings would strengthen competition in the energy industry (Resources for the Future, 1968, p. 142). The government also must direct the accumulation of strategic reserves of oil and formulate rationing schemes in the event of national emergency.[30]

In addition to its supervision of these domestic programs, the U.S. Government must exercise its substantial influence on international energy policy. Through organizations such as the International Energy Agency and the World Bank, the government can address the energy problem as an occasion to unify the oil-consuming nations rather than divide them. The International Energy Agency provides a forum for U.S. policy makers to strengthen multilateral approaches to the problem of oil-supply interruptions (Bosworth, 1978, pp. 9-10). By supporting an expanded role in energy development for international financial institutions such as the World Bank, the United States and other participants can facilitate the flow of private capital and technology into non-OPEC nations to develop their indigenous resources. These multilateral aid programs can improve the global balance of energy supply and demand, dilute some of OPEC's price-setting powers, and remove the barriers to economic development posed by the high costs of oil imports. The multilateral nature of these arrangements joins the interests of industrialized and developing countries. The impartial role performed by the international financial institutions alleviates friction between private investors and host governments (Bergsten, 1978, p. 9).

The government's role in international energy policy is not, however, limited to participation in multilateral arrangements. It can expand its bilateral aid programs to promote development of energy sources in non-OPEC developing countries and monitor the terms of agreements between LDC's and American oil companies to assure that they are fair and satisfactory to both parties. Moreover, U.S. policy makers must maintain an ongoing dialog with the OPEC countries to insure that their oil production and pricing policies take account of the world's vital need for adequate supplies at stable prices.[31]

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[30] Recent investigations suggest that poor planning and bureaucratic mismanagement imperil the achievement of our strategic reserve objectives; see Vanik (1978).

[31] On the importance of our bilateral relations with Saudi Arabia, as the price leader of OPEC, see Corrigan (1978, pp. 336-339); and Erickson, Spann, and Winokur (1976, pp. 27-33).

CONCLUSION

The images governing our national energy policy must place the energy crisis in its international context. In our evaluation of alternative energy systems it is not enough to look at the impact of various types of energy systems on the balance of power among the institutions within our society. We must also pay attention to the impact of the balance of power among international institutions on our domestic society. This is necessary because the restraints on national action imposed by the international context shed a different light on the centralization-decentralization issue in national energy policy. Technologies and institutional arrangements that appear to have centralizing effects when examined from a perspective that views our domestic society as a closed social system may be seen to protect social freedom and diversity of action when examined within the context of the international order.

This paper embraces the view advanced by advocates of divestiture that decentralization of our institutional arrangements for energy production and distribution is socially desirable. It takes exception to the institutional changes that these advocates propose to realize that goal. In the quest for decentralized, "appropriate" energy systems, we cannot wish away our short-term dependence on capital-intensive technologies and multinational institutions. Nor can we ignore the limitations that changes in the global political-economic order impose on our attempts to decentralize energy systems. Small may be beautiful in certain domestic contexts, but, given the current structure of the international oil industry, any reduction in the ability of America's multinational oil companies to check the cancerous growth of economic nationalism would be disastrous.

The growth of economic nationalism has elevated the role of political institutions, in the form of integrated national firms, in international trade. These political institutions are, by their very nature, less conducive than private economic institutions to the reduction of transaction costs and barriers to competition. This paper recognizes that the amount of economic power in the hands of multinational oil companies is considerable and has called attention to the need to reduce the scope of their political role in international affairs. Nonetheless, the costs of their operations reflect the action of market forces more realistically than do the costs of operations of integrated national firms that threaten to seize control of international energy trade in the event of divestiture. At a time when the need for the efficient use of resources is paramount, we must preserve those institutional arrangements that check the amount of economic decision-making power vested in centralized political systems. To do otherwise would result in the inefficient development and distribution of energy resources, would threaten our national political and economic interests, and would jeopardize the stability of the global political order.

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NUCLEAR WASTE:

INCREASING SCALE AND SOCIOPOLITICAL IMPACTS

by

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PREFACE

This is a revision of a discussion paper submitted to the Committee on Radioactive Waste Management, Commission on Natural Resources of the National Research Council, in September 1976; it was done independently of the committee and was not commissioned by it. Subsequent to its submission to the Committee on Nuclear and Alternative Energy Systems it was printed in Science (July 7, 1978, 201:22-28). Ames Research Center, NASA, under grants NGR 05-00300421 and NGE 05-003-471, supported work underlying this paper. I thank G. Rochlin, W. P. Bishop, P. Craig, D. Metlay, H. Feiveson, J. Bartlett, K. N. Lee, R. Schuller, and S. Zwerling for helpful comments and N. Michelsen and C. Winter for assistance.

SPECULATIONS ON SOCIOPOLITICAL CONSEQUENCES

Introduction

Planning for radioactive waste management has been criticized primarily because estimates of potential environmental damage have been inadequate[1] and, secondarily, because the impact of radioactive waste management systems on social and political development has been ignored.[2] Here I address the latter consideration and begin by noting several speculations that have colored the public debate about the social and political consequences of radioactive waste management. Implicit in each speculation is the expectation of a large-scale waste management system. I then propose some first steps toward providing a firmer basis for estimating social, economic, and political, as well as environmental, impacts of managing increasingly large volumes of radioactive wastes. The argument calls, first, for developing reasonably detailed descriptions of each of the waste management systems that might be used and, second, for estimating the organizational requirements for each of these systems when they are faced with increasingly large volumes of waste. In addition I suggest that for each potential waste management and organizational system, estimates be made of the chances that human beings would be exposed to radioactive hazards.

Speculations

Most frequently, questions about the management of radioactive wastes are associated with what might be called the "1,000-year problem." That is, how can we develop highly reliable, socially acceptable technical systems that are so effective that they will nearly eliminate for at least 1,000 years the long-term risks to those generations who will not benefit from the processes that produced the risk.[3] These are, of course, very important problems, but there are a number of equally important, more immediate matters. These are, in a sense, the "10-year problems"--those associated with the handling of spent fuel, especially if reprocessing is involved, during the 10 years or so before wastes can be safely stowed away in permanent repositories--and they involve the shorter-term social, economic, and political consequences likely to result from actually developing the organizational systems required as the scale of radioactive waste production and management greatly increases.

Discussions about the shorter-term consequences of radioactive waste management have stimulated some unsettling speculations about the various effects on social, economic, and political aspects of life were a "plutonium economy" or any large nuclear economy actually to be developed.[4,5] A notable characteristic of these speculations is the anxiety seemingly related to the effects of increasing scale in the operations of radioactive waste management systems. Below I summarize these speculations in a form often used in the debate. I do not argue for their accuracy in fact, rather that they derive mainly from what information is readily available.

Speculation 1. The extraordinary toxic and long-lived properties of radioactive wastes require a nearly fail-safe performance not only from the facilities in which they are processed and ultimately stored, but also from all of the people involved in the processing. As the volume of wastes increases, the most crucial scarce resource may well become the people who are highly skilled and who can be motivated sufficiently to perform continuously at extraordinarily high levels of reliability, even though it is likely that the jobs will generally be routine and boring on a day-to-day basis. Monetary reward may not of itself be sufficient, after a certain level, to assure the contribution of the very capable people likely to be needed. Therefore, special measures will probably be necessary to gain their wholehearted and enthusiastic performance. This may mean quite special and probably costly recruiting and training programs; programs that could result in a kind of paramilitary force with great élan and dedication which by virtue of its elite character could bestow considerable social prestige to the "U.S. Radioactive Waste Disposal Service." It is not too much to imagine a growing cadre of "sanctified garbage watchers" concerned primarily with security and the maintenance of order.

How large a cadre of people would be necessary to operate the various technologies of waste management is uncertain. As the volume of waste grew, its size might become considerable. The prospects of such a situation stimulates concern about the effects of a large paramilitary force on democratic institutions and indicates that both the financial and the sociopolitical costs should be seen as part of the total costs to society of achieving a mature plutonium economy.

Speculation 2. The construction and operation of a large-scale system of radioactive waste-processing and storage facilities is likely to effect unsettling changes in the communities and regions involved. By virtue of the size and the special transportation and security requirements of these facilities, the communities and regions adjacent to them might have to place extraordinary demands on their public services. Rapid development often requires equally rapidly increased public services to meet the needs of the new residents, often disrupts the orderly development of the community, and greatly affects the character of community life. This is especially germane to the impact of radioactive waste-processing and storage facilities because they are almost certainly to be located in areas of limited, dispersed populations. In an era of increasing skepticism, especially in smaller communities, about the values of economic and population growth, the imagined effects of rapid growth raise considerable anxiety.

Speculation 3. The economic benefits of increasingly large-scale waste-processing programs are not obvious and have been questioned.[6] In an economic sense, local communities often gain a measure of benefit if the new facilities actually increase the number of jobs available to those already residing in the affected communities. But it is not clear that radioactive waste-processing and storage operations automatically provide employment of this kind. Most of the new jobs may well require people with special training in waste processing who must be brought into the community. The economic benefits to the affected communities may thus be reduced.

At the national level, the costs for the total radioactive waste-processing system have not yet been estimated. The capital investment for reprocessing and waste solidification facilities, transportation systems, storage mines, or ocean disposal operations will probably be substantial. When combined with the investments necessary to construct and operate the nuclear plants, the cost to the nation as a whole may be unacceptable. It has been estimated, for example, that it may cost from $2 billion to $10 billion or more to dispose of the wastes already produced by the military.[7] These moneys will come from the tax rolls. Furthermore, on the basis of the nuclear waste industries' performance to date, it is conceivable that, even though there are no plans for such a subsidy, a sustained public subsidy of the management of commercially generated waste could become necessary. Again, these costs should be added to the tally in determining the total costs of nuclear energy.

Speculation 4. Continued expansion of waste-processing facilities is likely to stimulate increased conflicts between environmentalists and the federal government and between the states and federal agencies. If nuclear facilities became widely distributed, opposition from those communities near the areas of greatest hazard--the facilities, transportation routes, and the ultimate disposal sites--might spread and coalitions of communities-in-opposition might result.[8]

Dilemmas in the relation between government and the public are also evident.[4] Any disclosure that radioactive materials have escaped from the system, or the report of any event that could be interpreted as leading to a potential escape, is likely to prompt strong reactions from people living in the areas of waste-processing or storage facilities. Yet the failure immediately to disclose such an incident increases the public's distrust, and raises questions about the veracity of the governmental agencies or private firms involved. This poses a nearly "no-win" situation for both the operators and regulators of waste facilities.

At the international level the United States might have to confront both the problems of nuclear proliferation and the opposition of some other countries if plans for waste disposal came to include the seabed or outer space. Recent presidential decisions regarding the limitation of breeder reactor development and indefinite delay in construction of reprocessing facilities is indicative of the first problem.[9] When and to what degree spent fuel will be reprocessed, thus changing the character of the wastes, is uncertain. It seems reasonable to expect that continued efforts will be made to perfect both these technologies and that the logistics of the waste management processes will thereby become more complicated. Furthermore, disposal of radioactive wastes outside the limits of the United States could open the government, at least in the short term, to propaganda attack from countries antagonistic to U.S. interests. International reactions to U.S. waste disposal policy will certainly depend on whether international waters or outer space are involved.[10]

Speculation 5. Many of the suspected longer-term social and economic consequences of a radioactive waste management system that has become a part of a plutonium economy, or any other highly expanded nuclear economy, cause deep fears in the public, even though such consequences are so difficult to estimate with much confidence.[11] The wastes generated by the military have already created significant management problems[12] and the development of fast breeder reactors as well as the use of light-water reactors (LWR's) would compound this situation. Because of the greatly increased scale of the system and increased volumes of the wastes generated, significant changes in social attitudes could result.[4,11] The growing awareness of the legacy we are leaving to future generations could arouse in the public an increasingly high level of anxiety, and perhaps guilt, and this could lead to an increasing emphasis on security and monitoring systems designed to detect, limit, or prevent any inadvertent or intentional release of radioactive materials. But even with great concentration of effort, it seems reasonable to expect a significant escape of radioactive waste sometime in the next quarter century. As this possibility increases with the scale of operation, major changes in our thinking about civil liberties may take place. In a fully developed plutonium economy, the institition̲s responsible for nuclear energy production and waste management may assume a degree of importance equal to most of the other agencies within the government. During the next decade, more information will become available on the long-term genetic effects of radiation and the migration of radioactive materials through the food chain. If developments in this area proceed like those in other areas of ecological and health studies, this information may reveal a more complex and dangerous situation than is now apparent, and may lead to greatly increased public pressure for governmental regulation and surveillance and complicate the processes of governance.

Assumptions Hidden

Clearly, high levels of uncertainty shape the character of each of the above speculations; uncertainties stemming in part from lack of systematic information about the actual operational requirements of radioactive waste management as the volume of wastes increases in proportion to the spread of nuclear power plants themselves. At present, environmental impact statements[13] provide only limited technical engineering information about the production and disposal of radioactive wastes. Feasibility studies, limited again to engineering considerations, implicitly deal with a relatively small volume of wastes. There is no explicit consideration available to the public of the operational or managerial requirements as the number of nuclear reactors increases. Nor are there any credible economic and social estimates that take into account large-scale increases in nuclear energy production.

Citizens who are drawn into considering public policy issues surrounding radioactive waste management are left to infer information on the basis of individual experience and intuitive projection. But neither those opposed to nor those supporting current plans for radioactive waste disposal have made explicit their assumptions about these operational requirements and impact projections. The assumptions remain inchoate, the product, one could suspect, of perhaps unconscious resolution of the deep uncertainties involved; resolution, indeed "over corrections," in terms of the particular fears and value preferences of the contestants.

I will now outline the types of information that must be provided if the uncertainties now plaguing the debate on radioactive waste management are to be reduced. The scale of proposed operations is central to this exercise, and a way of ordering the ranges in scale is suggested. I will also discuss the operational information that is necessary for assessing the social impact of radioactive waste management and will propose the development of an index of social exposure to radioactive hazards.

ASSUMPTIONS IN ESTIMATING THE EFFECTS OF INCREASING SCALE

The challenge of radioactive waste management is directly related to the amount of wastes produced in various forms by commercial reactors and by military activities. To provide a frame of reference for this discussion, I will describe three stages in the development of a plutonium economy; these stages will serve to bracket the extremes of operational data that are needed for more comprehensive analysis of various waste management options.[14] The numbers used, especially for Stage 3, may include unrealistic estimates and are presented for illustrative purposes only.

Stage 1. Problems of the 1980's. Regardless of what the future brings for nuclear energy developments, there is already a very significant radioactive waste management problem. By the end of 1977, the inventory of curies of important nuclides generated from military and from commercial operations was almost equivalent.[15] That is, the wastes from these two sectors, even though the volume of wastes from the commercial sector is now only a fraction of that resulting from military development, are roughly equal in the degree of radiation hazard they represent. It is estimated that by the 1980's there will be some 450,000 tons of high-level wastes in solid form produced by the military. The volume of commercial waste will begin to rival the military wastes by the end of the century.[16] Thus, at a minimum, it will be necessary to manage the high-level and low-level wastes already produced from both military and commercial activities as well as the wastes to be produced by those LWR's likely to be put into operation within the next few years. Plants under construction or well through the licensing process will probably be completed in the 1980's. The resources already invested in construction and the commitments made concerning those reactors that are near the end of the licensing process are so great that termination of their construction and operation is unlikely. The economic losses would be too high and the political penalties too great.

To the domestically produced wastes should be added the wastes that the United States may import in the future through "buy-back" agreements with nations whose nuclear developments this country has encouraged. I will assume here that the United States will continue to seek a reduction in the risk of plutonium diversion and of further nuclear proliferation as well as to limit environmental damage, especially to the sea. Thus, the 1980's stage will have to allow for the federal government risking considerable political damage at home and importing the wastes produced by nuclear plants built and fueled by U.S. companies for foreign powers.

In sum, the problems facing the 1980's depend on the amounts of waste: (i) already on hand from military and commercial operations, (ii) to be produced by the some 58 nuclear-fueled power plants already in operation at the end of June 30, 1976, (iii) to be produced by the some 80 plants now under construction and the 20 plants with stated construction starting dates,[12] and (iv) the wastes to be bought back from the up to 50 plants either on-line or on order in other nations that have been or will be supplied with fuel from U.S. firms.[17] Even if there is no further expansion of nuclear power and the plants producing wastes are not replaced after their expected 30-year lifetimes, the management of waste will have to continue for at least the next 40 or 50 years, that is, the lifetime of plants to be built in the near future plus the "10-year" handling time.

Stage 2. Problems of intermediate expansion. Here I assume an expansion of LWR's considerably above the level in Stage 1 but still well below the stage of maximum foreseeable expansion. Stage 2 includes the waste from the some 250 reactors that could be built in the United States if a rate of growth of about 5 percent per year were realized through the year 2010. To this number of reactors should be added those, say, 75 reactors that might have been built, with fuel provided, for foreign powers through the year 2010 from which the United States would import radioactive wastes. Military-produced wastes must also be included in the total for each stage.

The estimate of 250 total reactor units in the United States by 2010 is based on the assumption that environmental and other regulatory objectives are met. I also assume that the operational problems in constructing and operating these plants are solved and that the major difficulty is that of obtaining sufficient capital resources actually to construct the facilities.

One important source of anxiety concerning nuclear energy production is the social and economic consequences of rapid as compared to more moderate growth. Here I assume a growth rate of about 5 percent per year, but a significant addition to the analysis would be a comparison of the differences in operational requirements, and hence social and economic impact, were the growth rate to be markedly less--say, about half the maximum feasible rate. I would then have to assume that the level of 250 reactor units within the United States and 75 reactors abroad would be reached 30 years later, in 2040.

Stage 3. Problems of maximum foreseeable expansion. Here I assume that within the United States a *plutonium* economy, based in part on the fast breeder reactor, has been developed nearly to its maximum extent and that the technical, as well as regulatory and political, problems involved with the fast breeder reactor have been solved. Because of the somewhat different processing methods required for the wastes from breeder reactors, additional and perhaps complicating operational requirements will have to be met. I assume then that some 600 reactors--300 LWR's and 300 fast breeder reactors--have been built and that the United States has agreements to buy back wastes produced by some 150 LWR's fueled by this country and operated by foreign powers. As with Stage 2, the matter of growth rate is crucial. One analysis should be based on the assumption that the 600 domestic and 150 foreign reactors are in operation relatively rapidly, say by 2050, and a second analysis should be based on the assumption that this level will be reached more slowly, say by the year 2100.

These numbers of waste-producing reactors could be too low (there have been much higher estimates in some projections) or too high, given President Carter's policy announcements regarding the fast breeder. But for my purposes these figures illustrate the dimensions of the analytical problem and could easily be adjusted in further calculations.

Analysis of the Stage 3 problems will necessarily be highly subjective in many respects because it is impossible to make accurate predictions of future conditions. Nevertheless, such an analysis must be conducted in order to provide a broad spectrum of information on which policy makers and the public can base their decisions. Analyses in terms of the three stages I am suggesting, within the context of the optimistic assumptions of a benign political environment, will provide "base-line" data; any upward deviation from the assumptions noted above will work to increase the resources necessary for radioactive waste management programs in the future.

OUTLINE FOR THE DEVELOPMENT OF OPERATIONAL ESTIMATES

The Waste Management Process

The complex character of radioactive wastes from military activities and commercial nuclear energy plants (including LWR's and fast breeder reactors) confounds the problems of providing the information necessary to estimate the impacts of actually carrying out measures to dispose safely of these wastes. To limit this discussion, I will use the following brief description of radioactive waste management processes as a template for a more detailed discussion of the operational information.

Phases of Radioactive Waste Management

Regardless of the specific methods used in managing radioactive wastes, some variation of the sequence of steps or phases outlined in Table 1 is followed. It should be possible to develop, for each particular combination of technical possibilities in the waste management process, operational estimates of what level of effort is required for each phase. While the decision to reprocess wastes may be deferred or never made, inclusion of the reprocessing and partitioning of wastes is useful for analytical purposes. For completeness, analysis involving a nonreprocessing option should be conducted in which the waste must be disposed of in the form of spent fuel.

Here I will not attempt to summarize the great amount of work that has been done on exploring the various combinations of technical processes that might be used in converting spent fuel and irradiated equipment associated with fuel fabrication, reprocessing, and solidification of waste materials into a form that could be safely stored for thousands of years; suffice it to say that careful description of the technical alternatives is necessary to proceed to the next step.

TABLE 1 Phases of Radioactive Waste Management Process

1. Collection of various waste forms
   - a. Spent fuel (if designated as waste)
   - b. Mine tailings, fabrication plant wastes
   - c. Decommissioned plants and other irradiated equipment
   - d. Low-level wastes from reactors
2. Initial handling prior to reprocessing
   - a. On-site storage and packaging
3. Reprocessing of spent fuel (with variations for military and commercial wastes)[a]
4. Interim storage
5. Solidification
6. Long-term to ultimate disposal

[a] This phase should include partitioning of actinides if space disposal option is analyzed.

SOURCE: U.S. Nuclear Regulatory Commission. 1976. Environmental Survey of Reprocessing and Waste Management Portions of the LWR Fuel Cycle. Washington, D.C.: U.S. Nuclear Regulatory Commission (NUREG-0116), p. 4-3.

Essential Operational Information

Two types of operational data are essential: first, functional analyses of the activities necessary to carry out a particular phase and, second, analyses of level of resources (personnel, funds, support facilities, for example) necessary to realize each function. Again, to reduce the complexity of this discussion, I will reduce both types of information to a relatively short list of activities and resources. Other items can be added as refinements become appropriate.

Functions

In order to develop any radioactive waste management system, four functions have to be satisfied: construction of the facilities, operation of these facilities once construction is completed, transportation of wastes to and from various facilities, and finally, monitoring and surveillance of internal systems and external approaches to ensure security against accidental and intentional releases of radioactive wastes. It is clear from the different engineering requirements of various waste-processing alternatives that these four functions would be implemented in quite different ways depending on the alternative employed. Choices among the various types of ultimate disposal and the number and location of disposal sites would have a particularly significant effect on variations in the transportation and surveillance requirements. For example, disposal of either high-level or transuranic wastes in geological formations, say in salt domes, implies a much different network of transportation than would disposal of such wastes in deep-sea burial sites in the mid-Atlantic. Different regions would be affected, different security problems would require solution, and different regulatory requirements would be necessary. Similarly, the choice to dispose of high-level wastes in outer space would have much more dramatic consequences for particular functional activities because the partitioning of high-level, reprocessed wastes would be necessary. There are many more examples, of course, but those I have given are sufficient to show that alternative methods of waste processing and of waste disposal cannot be compared without more detailed information about the particular activities necessary to construct and operate facilities, to transport within the system various forms of waste, and to provide security for often quite different situations. The information that is obtained should include, at minimum, estimates of the time involved, the likely geographic dispersion of activities, the type of skills needed for successfully carrying out each function, and the complexity of the internal coordination required. There are also a number of administrative functions which should be added to these more operational activities but, for the sake of simplicity, I will not include them here.

Resources

Once there has been a reasonably clear explication of these functions, it will be necessary to provide, for each phase of whatever technical options are under consideration, estimates of the resources--manpower, financial, and logistical--necessary to carry out each function at desired levels of reliability. This is the most important step in arriving at information from which inferences about the social, economic, and political impacts of different radioactive waste management systems can be drawn.

First, manpower requirements should be calculated in terms of the number of employees necessary, and the variety of occupational specialties and their number in terms of skilled, semiskilled, and unskilled personnel. Several other types of data concerning manpower questions are also important, but they are more difficult to provide in the absence of information about the actual locations of radioactive waste-processing and storage facilities. These data include estimates of the likely dispersion of housing for workers over the areas adjacent to the facilities and the proportion of workers who would be employed locally and those that would be "imported" from outside the region either from within the United States, or, as is the case abroad, from foreign countries.

Second, financial resources should be estimated, including the amounts of capital investment needed; the amounts and proportions of payroll that would be disbursed through local facilities as opposed to facilities elsewhere in the country; the money likely to be spent for purchasing equipment and services locally compared with those purchased outside the region; and, finally, the likely proportions of income received from taxes, on the one hand, and from private sources or users, on the other. Though more problematical, some estimation of the industrial groups or government agencies that would be likely to participate in the construction and operation of expanding radioactive waste facilities would be significant. Since such involvement will perforce increase the economic and social influence of these groups or agencies, information about the likely participants and the magnitudes of financial resources allocated to them for these developments would help to clarify the public debate.

Finally, an estimate of the logistical requirements and material needs for each phase of technical application is also necessary. This is important for the special equipment or rare natural resources that will be required as well as for the more plentiful materials such as steel, concrete, and water.

Function-Resource Matrix

If one combines the functions and the resource elements into a matrix as shown in Table 2, one can see that for each function a series of estimates can be worked out for the resources necessary to carry out that function. These should be combined for each waste management alternative as it would be implemented for each of the three stages of waste production, that is, from Stage 1, the 1980's, to Stage 3, the maximum foreseeable expansion. If one now estimates such a matrix of resources and functions for each of the six steps in radioactive waste management (see Table 1), one begins to build up a body of data that can be used in the social comparison of various technical alternatives. Much more useful comparisons than are now possible could be made between the radioactive waste management systems involving, say, disposal in a geological medium contrasted with entombing wastes in mid-ocean. Of course, more refined analyses should be done of the differences within a particular mode of various numbers of specific sites.

These kinds of operational data can usefully be divided into those dealing with the requirements likely to be necessary for implementing the development of local facilities and those associated with the relations among local facilities. One of the most important segments of these analyses is the determination of the differences in local impact

TABLE 2 A Matrix of Resources and Functions for Six Phases in Radioactive Waste Management Shown in Table 1

Operational Requirements	Functional Activities for Each Phase			
	Construction	Operation	Transport	Security
	(1)	(2)	(3)	(4)
Manpower (1)	A_{11}	A_{21}	A_{31}	A_{41}
Financial (2)	A_{12}	A_{22}	A_{32}	A_{42}
Logistical (3)	A_{13}	A_{23}	A_{33}	A_{43}

compared with the impact of increasingly widespread and intensified networks of waste producers and processors as the volume of wastes grows. It may well be that as the size of the network grows, problems associated with transportation coordination and regulation will increase more rapidly than problems of local impacts.

Even at this subjective level, comparisons between various radioactive waste management options suggest considerable variations in social, economic, and political impact. And there is great uncertainty about the particular character of changes in these areas. Information of the types proposed above would provide an improved basis for comparison, but additional data are necessary for meaningful social assessments to be made; namely, data on the risks of humans and other organisms being exposed to radioactivity as the scale of nuclear energy production increases.

INDICES OF SOCIAL EXPOSURE TO RADIOACTIVE HAZARDS

The very long-term toxicity of radioactive materials is at the root of the public's concern about the present and future use of nuclear energy.[18] Thus the controversy over radioactive waste management centers on which methods of disposal will most nearly eliminate the possibility of ever exposing human beings to these radioactive materials. Although some information is available on the potential biological insult from actinides, including the potential genetic effects of exposure and the possibility of migration of radioactive materials through the food chain, there is little information on which to base discussions of the advantages and disadvantages of the different organizational strategies for waste management. The larger the volume of waste materials and the more varied its composition, the larger and more complicated the total system is likely to be; and the more complicated the system, the more we are prone to imagine that, if anything can go wrong, invariably it will at some time or other. This bit of organizational folklore--Murphy's Law--is a belief shared by many Americans.[19] If the consequences of error may be very damaging, as in the case in point, the force of the implication of Murphy's Law is greatly magnified.

Since different waste management systems have different levels of complexity and, therefore, different probabilities of potential breakdown, more information should be available on the operational reliability of sociotechnical systems as their scale and internal complexity increases.[20] Thus, for each alternative waste management system, and for each phase and scale of each alternative, indices of social exposure to radioactive hazards are needed. Index building across various technical options for various organizational designs would, along with cost estimates, provide a much better basis for comparing alternatives.

Such indices would combine two probabilities: first, that a system might fail sufficiently to allow the escape of radioactive materials and, second, that if there were an escape of materials, human beings might be exposed to both short-term and long-term radiation.[21] There has been some analysis relevant to these concerns, but it deals mainly with the ultimate disposal segment of the radioactive waste management sequence.[22] While this is, of course, crucial for long-terms risks of exposure, it does not address the very complex and often lengthy processes involved in the intermediate steps required in various processing alternatives before final entombment is accomplished. In terms of the public's concerns about radioactive wastes, the shorter-term organizationally related problems must also be addressed. Such indices could perhaps be developed from materials already included in various safety analysis reports and environmental impact statements, in which case the task would be considerably eased.

In proposing such index building, the problems of accuracy in forecasting must be kept in mind. These entail the difficulties of translating probability estimates into sensible meanings for those who might use them.[23] Analysis of the relations between technical and human performance would need to be quite explicit. These analyses would aid greatly in uncovering the unconscious assumptions about human performance of both technical and social analysts and would improve not only the quality of research but also the development of and debates on policy. Such an analysis of exposure risks might also reveal segments of the process that could be redesigned in order to decrease the possibility of exposing humans to radioactive hazards;[24] and permit both error-identifying and error-containing processes to be designed into the waste management system at the outset.[20,21] In this technological area, perfecting the system through trial-and-error learning has very limited utility.

ESTIMATING SOCIAL CONSEQUENCES: CONCLUSION

In this article I suggest that information of a type not now available or perhaps not yet assembled for public use should be provided both to improve the quality of policy development in selecting an acceptable radioactive waste management system and to inform the public debate concerning such systems. The type of information and analyses described herein should be sought from industry, the U.S. Department of Energy, and the U.S. Nuclear Regulatory Commission by citizens and policy makers alike. But I hasten to say that information is not of itself sufficient to assure greatly increased predictive capacity.

Improved social, economic, and political prediction requires a reasonably well-formulated and tested theory of social, economic, and political dynamics that could be used to interpret data, much as engineering data can often be interpreted on the basis of well-formulated scientific laws to predict the technical dynamics of a complex engineering system. But a review of current developments in the social sciences would not reveal well-formulated conceptions of technology and social or political change. Rather, this is a relatively underdeveloped area and there seems to be little if any recognition within policy analysis circles of the significance of this limitation. Little has been done, for example, by the National Science Foundation, the Office of Technology Assessment, or the various technology-based government agencies to encourage research on these problems[25] and it has been in the interest of industry, at least until recently, to ignore what little can be said about such matters.

Potential Applications

More complete information concerning the operational requirements for large-scale, complex developments of different radioactive waste management systems could be a strong stimulus to achieving a better understanding of the relations between technological development and social and economic change. With such information, for example, it would be possible to begin the following analyses. First, for any level of likely technological development, say to result in the scale of operations described in the problems of intermediate expansion, what changes in existing financial and legal arrangements and public attitudes would be required to put such a technical system into operation? This centers attention on the required changes in political authorization and in the regulatory situation which would be necessary to achieve the technical results. It also provides at least one basis for judging the opportunity costs incurred and the expenditure of "political energy" which might be needed. Second, with the foregoing estimates being used as a basis, questions could be asked about the social and political consequences of having reached the level of technical performance expected with the attendant changes in economic and legal institutions discussed above. This two-step process seems to be within the capacity of today's social scientists and would add greatly to the clarity of debate and policy analysis.

More complete information about operational requirements concerning radioactive waste management will not necessarily result in a quick judgment that nuclear energy is preferable to other energy sources, nor will it necessarily result in ready public acceptance of nuclear energy. Critics or proponents of nuclear energy development may demand that the same types of information suggested herein for radioactive waste storage problems should be made available about the energy production end of the nuclear energy cycle. Likewise, more data on the operational requirements of coal production and other energy alternatives would be necessary to provide a fair comparison with nuclear energy economics. The crucial aspects of these studies would be the consequences of increasing the scale of operations necessary to achieve the production of energy (with the consequent production of wastes) at levels anticipated for the future. Such information would reduce some of the confusion based on intuitive and unspoken assumptions underlying the speculations about the changes that will be necessary to carry out particular nuclear energy and waste management options and the consequences of such changes. Such information would base the contest between the energy alternatives more substantially on judgments about who should benefit and who should be disadvantaged in the process of technological development.

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Estimates of the Volume of Radioactive Wastes

Year	Military	Commercial
	High-level	
1975	85 million gallons[a]	0.6 million gallons;[b] 0.07 million cubic feet[c] (spent fuel)
1985	65 million gallons[a] (450,000 tons in solids)	0.6 million gallons;[b] 0.25 million cubic feet[c] (spent fuel)
2000	70 million gallons[a] (485,000 tons in solids)	0.08 million cubic feet (HL solid waste); 2.0 million cubic feet[c] (spent fuel)
	Transuranic and low-level	
1974	42 million cubic feet	9 million cubic feet
1985	55 million cubic feet[d]	15 million cubic feet
2000	75 million cubic feet[d]	51 million cubic feet

[a] Sludge, salt cake, or terminal liquid.
[b] Stored at Nuclear Fuel Service, New York.
[c] Spent fuel if designated as waste.
[d] Depending on federal policy decision under review.

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IV.

AGENDA FOR ENERGY-RELATED SOCIAL RESEARCH

RECOMMENDATIONS FOR FUTURE RESEARCH ON THE SOCIOPOLITICAL IMPACTS OF ENERGY

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INTRODUCTION

The energy crisis of 1973-74, which continues today in somewhat abated form, was not the first in recent memory. Its predecessor was the energy crisis of 1958--essentially a rapid deterioration in the competitive position of indigenous coal relative to imported oil. The response was a widespread conversion to oil and retrenchment and contraction of coal production accompanied by substantially increased energy growth and import dependence. Scattered warnings were sounded, notably by E. F. Schumacher, but there had been alarmist cries of running out of one thing or another since the days of Malthus, and the discovery of extensive Alaskan oil and gas deposits promised to defer yet again the day of energy reckoning. One thing, however, has profoundly changed: in 1958, energy was a minor consideration; today it is a major preoccupation.

If the OPEC embargo was the crisis event, it is believed by many to have signaled a longer term, perhaps even permanent, shift from abundance to scarcity of energy resources. Whether the source of present difficulty is a steady draining of energy stocks or merely an artificial interruption of energy flows, certainly it is true that the era of cheap energy supplies has ended. Although the transition from exhaustible to renewable energy resources--which is estimated to require 50 years--may restore abundance, energy technologies such as nuclear fusion are likely to be anything but cheap. To some, approaching the limits to energy growth is a salutary reminder that we cannot forever go on living beyond our energy means; to others, limited growth's disguised blessing is decidedly a mixed one: oil price rises are perceived as having made more economical such capital-intensive supply technologies as nuclear as well as photovoltaics that were formerly less competitive. (That is, competitive by conventional standards; given enough government subsidies, the economics always come out right in the short run.)

Many skeptics persist in denying the existence of a real energy problem, instead preferring to place blame on governmental intervention, business profiteering or environmental obstructionism. Nevertheless, the energy problem seems to fit a more basic pattern. It is but the latest in a series of problems recently emerged or recognized that touch on human conditions in quite fundamental ways. Everything that we once took for granted--clean air and water, nourishing and pure food, plentiful natural resources--have somehow become difficult and problematic. Energy is only the most recent manifestation of this general tendency. Like the others, we may suppose that the *energy* problem is at bottom a *societal* problem--a problem of the way we lead our daily lives and conduct our public affairs.

If this diagnosis is accurate, it implies the necessity of life-style and value change, not only in energy use but in the whole complex of decisions and actions related to it. The argument runs as follows. The energy problem derives from cultural adjustment to a situation of energy abundance. Low-cost, high-quality energy supplies encouraged lavish, even profligate, use by industrial and residential consumers. Those supply conditions no longer prevail; the high use of low-cost energy has become increasingly inappropriate and basic changes are required in the many facets of our personal lives and social institutions linked to energy use. But those adjustments to conditions which have created the energy problem also stand in the way of achieving the necessary readjustments. Therefore, we must conclude that the *necessity* of change does not guarantee the *possibility* of change. It is to this paradox that our research efforts must ultimately be addressed.

To focus this statement of the energy problem more sharply, a number of issues (or research questions) can be posed:

1. Is there a real energy crisis, and if so, does solving it require basic or merely cosmetic social changes?
2. Why has opposition to nuclear energy arisen at a time of acute energy shortages?
3. Is there any necessary relation between energy use, economic growth, and the quality of life?
4. How can the historic increase in energy growth rate be arrested and reversed?
5. What social disruptions can be expected to accompany a transition to low energy growth and what are the institutional means for their mitigation?
6. What is the relation of energy policy to broader social goals (e.g., employment)? How many social concerns should energy policy attempt to address?
7. What institutions exist for determining and regulating energy demand? How can they be made more responsive?
8. What are the institutional requirements and capabilities for developing and managing different energy supply systems?
9. What is the role of government regulation vs. market allocation in meeting the energy problem?
10. How much emphasis should be placed on voluntary as opposed to mandatory conservation?
11. Is unemployment a necessary consequence of energy conservation? How can the equity impacts of conservation programs be offset?
12. Is conservation a short-term or a long-term strategy? What immediate energy savings can be achieved, and what savings depend on value and life-style changes?
13. Is conservation (e.g., home insulation) a one-time energy savings or can it be institutionalized (e.g., through basic alterations in patterns of energy use)?
14. What is the efficacy of nonmarket (normative, symbolic) incentives to conservation behavior? How can they gain social recognition and reinforcement?
15. What is the relation between conservation attitudes and actions?
16. How can the public be educated to greater energy conservation?

In what follows we undertake to raise these and related questions in orderly fashion and to propose a program of systematic research by which they can be answered.

Research Objectives

This is a progress report of ongoing efforts to formulate an agenda for energy-related social research. The work in progress is a mapping project or framework study whose purpose is to devise a coherent research strategy and to identify research areas of highest priority (Walker and Gould, 1977). Like previous efforts, the present objective is "identification of those areas of knowledge not directly related to hardware which would be of immediate importance in considering policies affecting energy production, conversion, and use," in order to develop "a coherent research plan capable of providing perspective over the entire energy system" (Landsberg *et al.*, 1974, pp. 4-5). Unlike most previous work in this area, the focus here is on the distinctively social (attitudinal, behavioral and institutional) components of energy related to technologic-economic factors. As Cetron (1974, p. 211) observes, "there has been very little study of the social implications of the energy crisis. Consequently, we find ourselves without social policies."[1]

This approach subscribes to "the basic proposition that one objective of social science research is to contribute to the determination of appropriate policies to maximize welfare, future as well as present" (Landsberg *et al.*, 1974, p. 78). The research objectives are therefore to be determined in large measure by the prospective uses and users of research findings. In the present context, this contribution would take the form of enlarging the range of viable energy options available to various policymakers and publics, and to the nation as a whole. Coupled with diminishing stocks of domestic oil and gas, the present impasse over nuclear and coal development is an open invitation to conceive alternatives for meeting real energy needs. The lack of demonstrably superior energy technologies and policies argues for analyzing the widest range of options. We simply don't know enough at this time to make conclusive energy choices, whose consequences may persist for generations. While research can never fully resolve energy policy questions, it may serve to reduce somewhat the degree of uncertainty surrounding them. Currently we are in the initial stage of this process, determining the objectives and nature of the proposed research, the character and quality of existing research, future points of departure, and research strategies. The research areas presented here are not yet well documented and specified, but they are thought to be significant and specifiable.

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[1] As evidence of the urgency for developing this research, Wilbanks (1977) cites the findings of four panels (Sociopolitical, Technology, Environmental, and Data & Analysis) of the Inexhaustible Energy Resources Study (U.S. Energy Research, 1977, Fig. 14) which ranked socioenvironmental impacts first in importance as criteria for evaluating alternative energy technologies. The fifth panel, Economic, ranked them 5-6th.

Criteria for the Formulation of Research Topics

Given these objectives, we propose six criteria for guiding the selection of research topics and the actual conduct of research.

- Research should not duplicate that being performed elsewhere by qualified professionals. Rather, projects should make a distinctive contribution from the standpoint of the special interests and abilities of social scientists. A corollary to this is that collateral research should be systematically reviewed and findings assimilated to our own framework.

- As in any scientific investigation, the research problem should be tractable--specifiable in concept and operational in terms of research methodology.

- To the greatest extent possible, and for all the benefits that accrue to systematic inquiry, research problems should be theoretically oriented, grounded, and directed. Efforts must be made to identify relevant bodies of theory and, where these are found deficient, to construct new theories.

- Research should be empirically based. One documented finding, such as the rated capacity of operating reactors (Komanoff and Boxer, 1977) may weigh more heavily than reams of rhetoric. At the same time, "the facts" in any analysis are relative to definitions and assumptions, and are subject to diverse interpretation. Data requirements will be established in relation to the analytic problem and the methodological approach(es) adopted. Since data availability places a definite constraint on research activity, the secondary analysis of existing data will necessarily enter into the research process.

- The research should be relevant to the formation and execution of public policy. It should hold out "prospects of rapid and substantial payoff through credible methods of implementation" (Landsberg *et al.*, 1974, p. 165). Responsiveness to the policy environment means reaching conclusions that are timely for purposes of policy decision and practical for policy action. Utilization is viewed as an integral part of any research strategy adopted. At the same time, we must recognize that we are embarking on a long-term research program; our time perspective should be lengthened accordingly.

- The bottom line (so to speak) is that reserach should be supportable financially and politically by interested policy makers and affected publics.

These criteria provide a basis for establishing priorities among research topics that are desirable and feasible.

Research Strategy

Choice of a research strategy for pursuing these objectives depends on both substantive and methodological considerations. Substantively, we have elected to concentrate on energy conservation. Reasons for this choice are not difficult to find. Conservation has been given a high priority by many experts (Dierkes and Coppock, 1977, p. 22) and is increasingly seen as a chief instrument of energy policy. For example, ERDA made conservation a priority concern in its last National Plan, on a par with energy supply technologies such as nuclear fusion. Similarly, the government of Canada has recently declared, "We are at a point in time when it is less costly to save energy than to produce more of it"--especially in light of the externalities incurred in energy production. Regardless of the fate of any particular supply technology, conservation is bound to be a major part of the future energy mix. Moreover, it is widely believed that conservation measures can make a significant early contribution to easing present supply constraints, and can buy time for developing and deploying advanced energy technologies. Whatever fraction of the energy budget that savings in use might contribute, the social aspect is paramount in energy conservation. Hence it is a most suitable candidate.

Methodologically, the scope of energy-related social research has two major dimensions, spatial and temporal. We recognize that energy problems comprise a spatial hierarchy from local to global; within that hierarchy, it seems preferable to begin at the local, or microscopic level and work toward more macroscopic considerations. This will create a firm empirical base for extending future studies to higher-level analyses. However, macroscopic considerations, such as the price of imported oil and the market for energy technology exports, can be expected to enter the analysis at many points.

The time frame for research should cover both short- and long-term efforts, allowing fully for their proper phasing and respective payoffs. The long lead times required to develop energy-supply systems and to implement effective conservation measures (e.g., in the turnover of inefficient housing stock, appliances, and vehicles) dictate a long-term program of energy-related social research. Because past decisions in other policy areas, often taken in disregard of energy use, have contributed to the present energy constraints, policy relevance of research findings will likely be greatest in the middle term. Opportunities for immediate applications should not be overlooked, however. Policymakers face immediate problems and want fast payoffs, and therefore find short-term projects attractive and relevant; therefore an application time of three to five years may not be unrealistic for some energy conservation proposals. The underlying causes of the energy problem are deeply rooted in the social constitution, however, and effective remedies for them entail value changes over a much longer time. We are just at the beginning of this long-term research, but it should be carried forward incrementally within a comprehensive framework of analysis.

We are concerned with three broad research topics: effects research, comprehensive assessment (the decoupling question), and the "two-paths" debate. Although more closely identified in current practice with hard-path energy development proposals (see below), effects research spans the entire policy-research domain. It is actively pursued in many research, development, and demonstration (RD&D) areas, and forms the background for most other proposed topics. Therefore it will be given first consideration here and treated in greater detail than the other two. Among other results, comprehensive assessment indicates the strength of association among the phenomena of energy use, economic growth, and quality of life.[2] The decoupling question suggests a weaker relationship among these phenomena than is usually assumed; *how* strong or weak is what is being questioned. The third--the "two-paths" debate--poses a choice of macro-alternatives in evaluating the implications of adopting a hard or soft energy strategy. (That is, logically; ideologically, value choices are made more on impressionistic than analytic grounds.)

Figure 1 represents this domain in the form of a relevance tree. It is not a decision tree of binary forced choices; there are many cross-linkages and spillovers, and a comprehensive reserach program must tackle the energy problem at many different points. Rather it aims to set out some directions for programmatic development. Filling in the fine structure will be a matter for intensive research, to be integrated in such a framework as this and detailed in a set of contextual maps (as roughly sketched in Figure 2 for one relation between energy systems and social systems). What follows here is intended only to suggest the range of contents falling under each main heading (illustrative subtopics are enclosed in parentheses). While the topics will be taken up successively, the many direct and indirect connections between them should be noted.

The nuclear branch of the hard path incurs some distinctive problems of social control and response, especially at the international level. Although they constitute an essential feature of social research, these problems will not be treated further in the present discussion. The non-nuclear branch can be further divided into fossil and nonfossil and subdivided into gas and oil, hydro and geothermal, and so on. As with the nuclear branch, the social aspects of concern pertain to the causes, conditions, and consequences of energy resource developments of various types, locations, and scales. For example, boomtowns characterize intensive, site-specific impacts most conspicuously exhibited to date in the case of western coal development. In any case, the secondary consequences of land disturbance and habitat disruption, climatic and health effects, economic and other institutional impacts potentially affect and react with direct social impacts. Because hard-path energy alternatives have received the greater emphasis in studies done to date, the balance of this paper will be devoted to tracing the soft-path branch, first with regard to conservation (technical efficiency, patterns of use, voluntary and mandatory conservation measures, and market and nonmarket incentives to conservation) and then with regard to alternative technology (renewable and nonrenewable energy resources).

[2] Much effects research is not comprehensive, however, and its site-specificity prevents clear recognition of these global variables on the policy level.

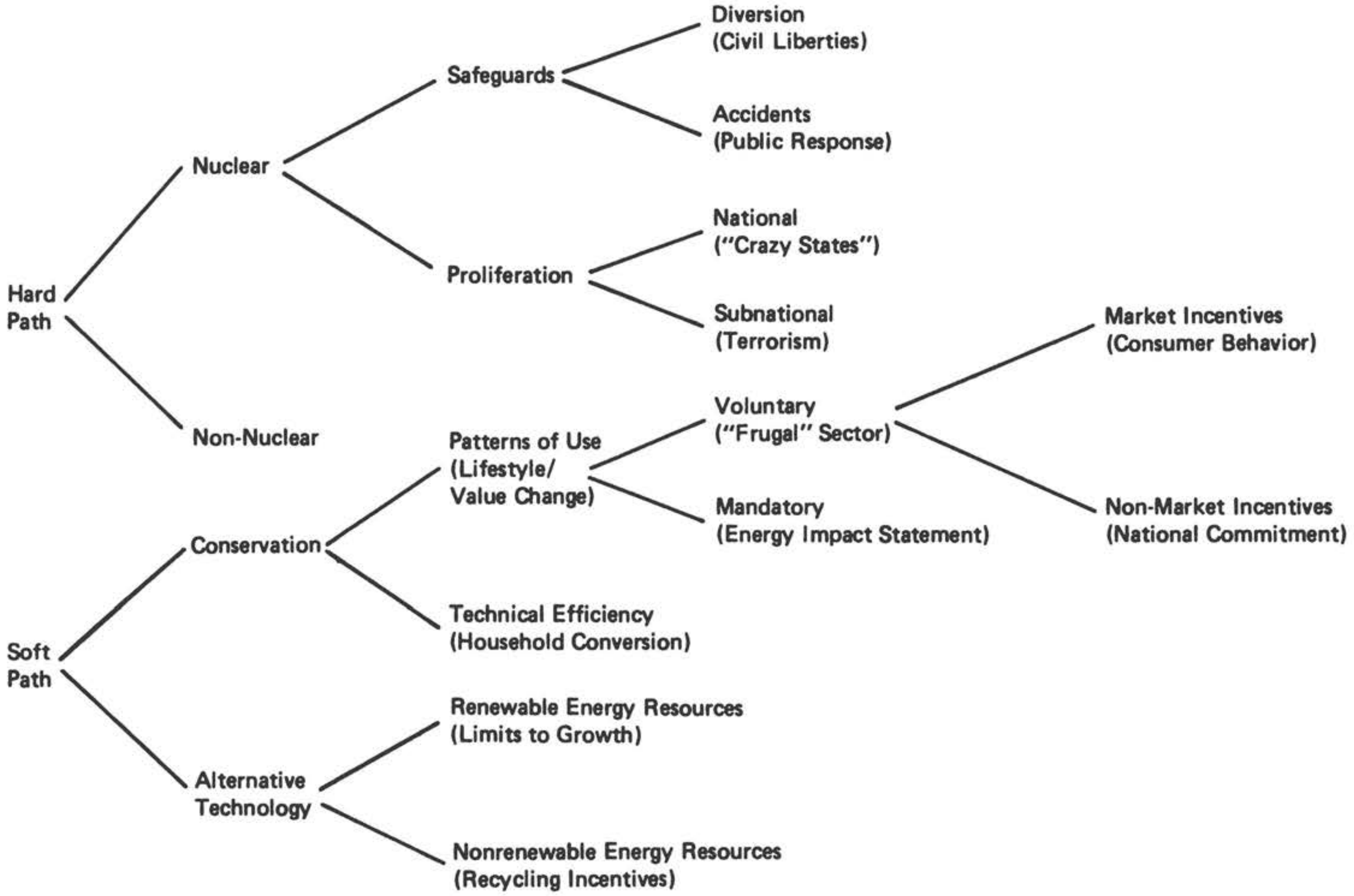
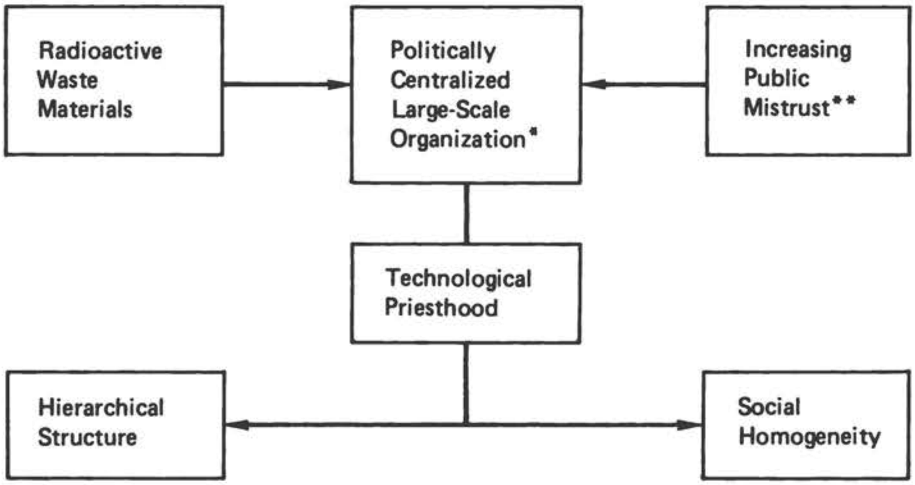


FIGURE 1 Relevance tree for energy-related social research.



Energy System Type: Nuclear (Fission)
Fuel Cycle Stage: Waste Management

Measures:

Variables:
Degree of Political Centralization
Degree of Hierarchical Structuring
Scale of Organization
Public Trust
Social Integration/Isolation
Social Characteristics (Homogeneity)

*Lovins (1976, p. 93).
**La Porte (1979).

FIGURE 2 Sample contextual map: radioactive waste and the "nuclear priesthood."

RESEARCH AGENDA

Socioenvironmental Impacts of Energy Development, Conservation, and Use

The socioenvironmental impacts of energy development--e.g., atmospheric buildup of CO_2--are of increasingly widespread concern. Thermal pollution is often said to constitute an upper limit to energy development using nuclear and fossil (but not solar) energy sources. More proximate limits are felt in the public's assertion of adverse environmental impact to oppose much energy-facility siting. Increasingly, energy is becoming the context of environmental concern. Conversely, environmental constraints are a major limiting factor in energy development, whether from the natural shortage of cooling water, for example, or from the imposition and enforcement of environmental quality standards. The contributions of social scientists should help to illuminate the complex relations between energy and environment and to inform decisions affecting them.

The general methodological approach taken for present purposes is one of comprehensive assessment, consisting of eight main steps: (1) problem identification, (2) formulation of alternatives, (3) profiling, (4) projection, (5) assessment, (6) evaluation, (7) mitigation, and (8) monitoring. (See Figure 3.) Ideally, the series would be applied to each subtopic in developing specific research designs and in synthesizing their cumulative results. Associated with each step are clusters of methodologies and techniques (see Figure 4), necessitated by the complexity and diversity of the energy problem. A corresponding requirement of methodological integration is further implied. Results of the application of one set of methods should serve the purposes of another set.

Problem Identification

This first step has already been initiated with the statement of the problem found at the beginning of the paper. Refinements involve determining from whose viewpoint energy supply is a problem--e.g., developed vs. developing countries, producers vs. consumers--and differences of interpretation arising from those different perspectives. Related questions include attempts to distinguish between projected energy demand and genuine energy need, again from the vantage points of different parties at interest. Methodological problems encountered at this step include identifying parties and weighing their respective claims.

Formulation of Alternatives

The range of alternatives is usually posed in terms of energy sources or supply systems--fossil, nuclear, solar, etc.--leading to a narrow comparison of their technical and economic feasibility. We wish, however, to consider additional alternatives, particularly the role of

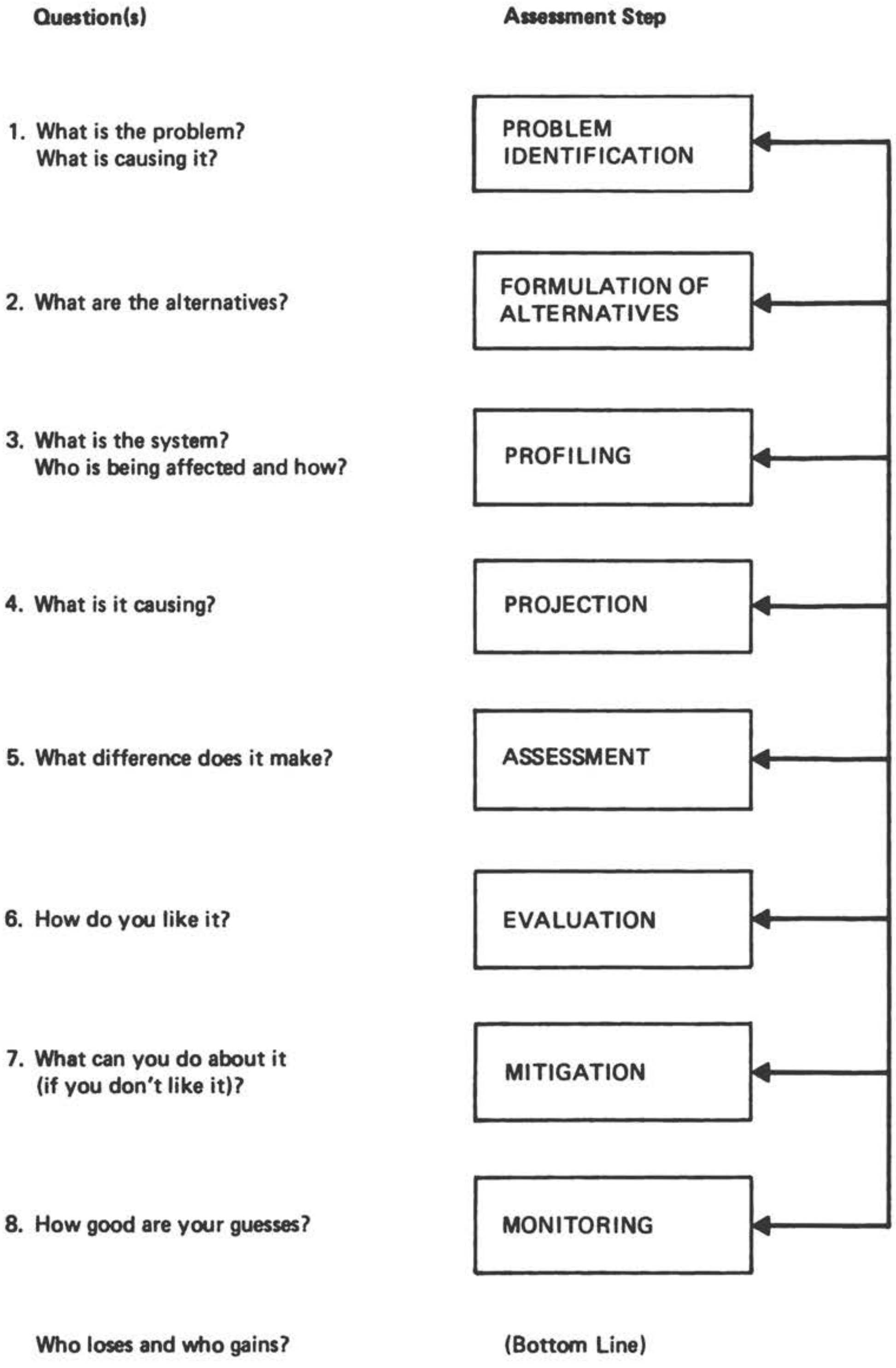


FIGURE 3 Social impact assessment: the main pattern.

Assessment Step	Operations(s)
0. Scoping (preassessment)	0.1 Determine impact area boundaries
	0.2 Establish time horizons
1. Problem identification	1.1 Identification of publics and concerns
	1.2 Perform needs assessment
	1.3 Determine evaluative criteria
	1.4 Formulation of social goals, planning objectives
2. Formulation of alternatives	2.1 Define set of "reasonable" alternative (corresponding to identified concerns)
	2.2 Determine change agents and instruments
	2.3 Characterize and describe technical systems
	2.4 Analyze for social (institutional/behavioral) components and correlates
	2.5 Analyze economic and environmental impacts for secondary social impacts
3. Profiling	3.1 Dimension impact categories
	3.2 Select impact categories
	3.3 Assign impact indicators
	3.4 Perform indicator measurements
	3.5 Compile social profile
4. Projection	4.1 Explicate "state of society" assumptions
	4.2 Perform trend impact analysis
	4.3 Conduct dynamic modeling exercise
	4.4 Estimate impact indicators values for alternative plans ("with and without" implementation)
	4.5 Perform cross-impact analysis
5. Assessment	5.1 Perform sensitivity analysis for alternative outcomes of alternative plans
	5.2 Describe and display "significant" impacts
6. Evaluation	6.1 Reidentify publics and concerns
	6.2 Reformulate evaluative criteria
	6.3 Rank and weight preferences for alternatives
	6.4 Perform tradeoff analysis
	6.5 Designate preferred alternative
7. Mitigation	7.1 Explore policy adjustment possibilities
	7.2 Devise mitigation plan
8. Monitoring	8.1 Establish monitoring program
	8.2 Measure actual vs. estimated impacts
	8.3 Feed back measurements to policy makers and publics

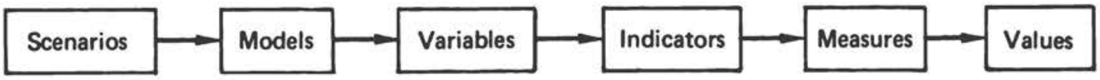
Now, associate and integrate general *methodologies*, specific *techniques*, relevant *data*.

FIGURE 4 Social impact assessment: methodological overview.

conservation in meeting energy demand. Moreover, we wish to broaden the range of considerations to include whole futures--not only what energy we use and how, but to what social ends. Candidates for this purpose are included in the following set of alternative scenarios:

- Business as Usual
- Accelerated Development
- Market Perfection
- National Commitment
- Zero/Low Growth
- All-Electric
- Maximum Choice
- Postindustrial Society
- Small Is Beautiful
- Technological Breakthrough
- Energy Independence
- Apocalypse
- OPEC Breakup
- Freezing in the Dark
- Energy Utopia

Each of these emphasize one or another aspect of the energy problem: Accelerated Development, the role of government RD&D; Market Perfection, the role of the private sector; Small Is Beautiful, the trend towards technological and institutional decentralization; and so on. Scenario analysis consists of ordering this set, establishing initial and boundary conditions, describing their elements and interactions, and estimating the probability and desirability of alternative outcomes. Further methodological development might proceed along this line:



Coupled with other methods of futures research, such as trend extrapolation and normative forecasting, and analyzed in terms of energy-related activities (decisions and actions), the explicit formulation and systematic variation of assumptions and predictions can yield some insight into policy issues and options. Most pertinent to the present study would be the disaggregation of gross alternative futures into sectors and subsectors.[3] Other methodologies, such as the event analysis developed in conjunction with peace research, also come into play, for example, in the event of a major (loss-of-life) nuclear accident or credible

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[3] Christopher Freeman of the University of Sussex's Science Policy Research Unit stresses "the need to relate 'macro' forecasts to the underlying 'micro' processes. . . ." For example, population projections need to be analyzed in terms of number, size, and composition of households. These in turn must be examined for their energy implications, e.g., preference for housing types of varying energy efficiencies (see Morrison, 1979; Williams, Kruvant, and Newman, 1979).

terrorist nuclear threat. In performing scenario analysis, previous research on alternative energy futures forms a natural starting point.[4]

Impact Assessment

Impact assessment focuses on technological, environmental, social, political, and economic aspects of alternative futures:

1. *Technological assessment*: sociotechnical systems characterization and description, including modelling, forecasting and accounting procedures.
2. *Environmental assessment*: environmental impacts of energy development (habitat disruption, land disturbance, etc.) and environmental constraints on energy development (natural and regulatory, the latter including formulation and enforcement of environmental quality standards).
3. *Social assessment*: institutional and behavioral causes, conditions, and consequences of energy development, use, and conservation (including needs assessment, psychological assessment, risk assessment, social indicators, trend forecasting, and impact analysis).
4. *Political assessment*: impacts of political uncertainty, public participation, social movements (the "environmental movement," etc.), public acceptance, policy analysis (arenas, objectives, options, constraints, strategies, etc.).
5. *Economic assessment*: economic benefit-cost analysis, generalized input-output analysis, capital investment, income (re)distribution, employment, equity, property value, industrial location, etc.

The interaction and interpenetration of these categories, across policy, program, and project levels and through preconstruction, construction, operation, and decommissioning phases of the planning cycle, are implied in comprehensive assessment.

In comparing alternatives, two principal analytic operations are profiling and projecting. The former involves designating a set of impact categories such as the following:

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[4] Because of the pervasive impacts of energy on society, energy alternatives must be viewed in the context of alternative societal futures--whole futures, conspicuously including life-style and value components. The alternative-futures approach permits us to consider value questions without prejudging them. Such alternatives would include not only promising energy supply technologies (e.g., solar electric) but also sustainable patterns of energy utilization (zero or low energy growth).

- System vulnerability
- Employment
- Risk of supply interruption and shortfall
- Equity
- Settlement patterns
- Life-style/values
- Accident risk (health and safety)
- Public acceptance

(Multiple) indicators are assigned to each category, and measures of their present values compose the data points of a baseline profile. Based on present trend data and future "state of society" assumptions (e.g., demographic projections), variations in this data set for each alternative future are determined in the profile projection step. These alternative outcomes of potential impacts resulting from the implementation of one or another alternative plan (scenario) are then subjected to evaluation.

Evaluation

Typical questions encountered at this step concern (1) the meaningful involvement of diverse publics in appraising potential impacts, (2) the formulation of evaluative criteria and grouping in self-consistent sets, (3) the degree of conflict or complementarity among goals in a multi-objective policy-planning process, (4) the tradeoffs between divergent policy objectives, and (5) the relative weights to be placed on preferences expressed by different publics. Evaluation methodology includes various techniques of judgment heuristics and decision analysis, such as multi-attribute utility theory (MAUT), applied to the assessed impacts in order to gauge the desirability of alternative outcomes. Impact mitigation and monitoring are logical extensions of this process. How well the whole series fits into operative policy planning and decision contexts will determine the usefulness of the exercise. Establishing those contexts and determining the decision rules by which they operate are matters for institution-building and institutional analysis.

The purpose of effects research was succinctly stated by the Federal Energy Administration: "rapid changes of any kind risk social, economic, environmental and public health effects that may be disruptive. However, by anticipating these consequences, it is possible to enhance our quality of life while reducing our demand on energy resources." "Effects research" is a misnomer, however, insofar as it implies merely isolating causes from effects; systematically relating the two is of main concern here. Another way of phrasing the research question is to ask, "What comes out of the plug besides electricity?" Applying the methodology of comprehensive assessment, we will employ a matrix whose axes are fuel-cycle stage and energy-system type. Table 1 illustrates this approach by showing cell entries for some potential social impacts of alternative energy systems. Suitably parameterized and estimated, these can be compared with similar assessments, for example, of ecological and health effects.

TABLE 1 Some Sociopolitical Risks from Energy Generation and End Use
[Note: * indicates a particularly important risk.]

Stage of the Fuel Cycle	Electric		
	Nuclear	Solar Thermal	Hydroelectric
Extraction	Land-use impacts -withdrawal of mine sites from other uses -legal impacts -land rights; access -aesthetic	1. Land-use impacts -aesthetic -legal impacts -boomtowns 2. Siting impacts	1. Aesthetic (loss of free-flowing rivers)* 2. Boomtown effects 3. Siting conflicts* 4. Land-use impacts* 5. Risks of accidents/sabotage*
Processing	Safeguards* -civil liberties -diversion		
Transportation	Safeguards* -civil liberties -diversion		
Generation	1. Safeguards* -civil liberties -diversion 2. Siting* -fiscal impacts -institutional impacts 3. Risk of accidents*		
Transmission	1. Land-use and aesthetic impacts; power lines. 2. System vulnerability*		
Waste disposal	1. Opposition to siting* 2. Long-term care/intergenerational impacts		
End use			
Whole-system risks	1. Arms proliferation* 2. Political conflicts over safety, economics, equity (local, national, international)* 3. Federal preemption* 4. Second-order health impacts		1. Local political conflicts* 2. Equity impacts 3. Federal preemption
	Inflated demand from inefficient energy utilization; greatest dissociation of costs and benefits; regional disputes*		

TABLE 1 Continued

	Electric			
	Fossil Electric			
Stage of the Fuel Cycle	Coal	Oil	Gas	Geothermal
Extraction	**1. Same as nuclear* (more widespread)** **2. Boomtown effects*** **3. Water shortages*** **4. Reclamation costs*** **5. Regional/local inequities***	**Spill impacts*** **-aesthetic** **-recreational**		1. Siting, land-use impacts 2. Land subsidence 3. Noise
		1. Foreign policy impacts* (wars, embargoes) 2. Land subsidence		
Processing		1. Refinery siting* 2. Tank-farm siting		
Transportation	**Accidents**	Pipeline & tankers -availability -safety -conflicts		
Generation	1. Regional equity disputes (mine site vs. remote conversion)* 2. Infrastructure investment			
Transmission	1. Land-use and aesthetic impacts; power lines 2. System vulnerability*			
Waste disposal	Capital intensity of control technologies*			
End use				
Whole-system risks	1. Second-order health impacts 2. Conflicts over safety, economics, equity 3. Intergenerational impacts (e.g., CO_2 effects on climate)			
	Capital requirements; inflated demand from inefficient energy utilization; greatest dissociation of costs and benefits; regional disputes; CO_2 and climate control			

	Nonelectric				
	Fossil Direct Use				
Stage of the Fuel Cycle	**Coal**	**Oil**	**Gas**	**Solar Heating and Cooling**	**Conservation**
Extraction	**Same as fossil electric***			1. Legal impacts -sun rights 2. Land-use impacts -sprawl	
Processing	**Same as fossil electric***				
Transportation	**Traffic generation**				
Generation	**Same as fossil electric***			1. High initial costs 2. Operation and maintenance risks	
Transmission				-Governmental intervention	
Waste disposal	Capital intensity of control technologies*				
End use		Transportation impacts*		Supply disruptions	
Whole-system risks	Second-order health impacts* 1. Regional disputes 2. Allocation problems 3. Intergenerational impacts (e.g., CO_2 effects on climate)			1. Backup requirements* 2. Regional imbalances	1. Capital costs -materials -redesign of industrial processes* 2. Institutional impacts 3. Curtailment -allocation (equity) problems* 4. Life-style impacts* 5. First-cost equity impacts 6. Civil liberties 7. Second-order health risks

Quantification of the social impact categories is an initial task in gaining comparability with other sets of impact data, but conversion of these categories to a common accounting unit remains problematic. This problem is further complicated in the case of energy conservation, which does not closely resemble more technologically based energy systems; hence the concentration of cell entries in the end-use fuel cycle stage. In addition, the hardness of assessed impact data must also be estimated and validation studies performed to measure the strength of association between variables, actual versus predicted outcome values, and the accuracy of parameter estimates (e.g., multiplier weights). A further stage entails developing the matrix as an input-output table and generating time series indicator data for dynamic analysis. This matrix approach also serves as a basic accounting framework for assimilating and comparing the cumulative results of other topical research and collateral studies.

The Decoupling Question

To what extent are energy use, economic growth, and quality of life mutually dependent, and to what extent are they independently variable? Three pair relationships--(1) energy use and economic growth, (2) energy use and quality of life, and (3) economic growth and quality of life--will be considered, together with their major components (standard of living, environmental quality and the like). Underlying all three is a general growth debate, the dimensions of which are broadly phrased in similar terms.

First, we might ask, what does it matter what the relationships are among them? The centrality of the decoupling question inheres in the conventional wisdom that energy growth is indispensable to economic growth, and economic growth in turn to enhanced quality of life. Much recent analysis, however, has demonstrated a weak association between these relationships. For example, the U.S. consumes roughly twice the energy that Sweden does to produce an equivalent Gross Domestic Product (GDP) per capita--and we may at least entertain the null hypothesis of an intransitive relationship.

If an appreciable degree of decoupling does in fact exist, this would considerably enlarge the range of policy options available to decisionmakers. For instance, the standard objections to reduced energy growth are that it will hurt employment or hinder economic growth. Our analysis will be aimed at determining whether, and to what extent, either might occur. It may prove to be the case that reduced energy growth actually creates employment opportunities, e.g., through the use of more labor-intensive production methods. On the other hand, were employment rates to suffer due to a vigorous conservation program, the policy response might be designed to compensate for this result through an expanded public works program, job retraining, or similar measures.

Energy Use and Economic Growth

The main reason for reviewing this topic is to evaluate the argument that any decline in energy use, say through conservation measures, will necessarily result in a lowered rate of economic growth and, by implication, a lowered standard of living. While historically there does appear to be a fairly direct correlation between energy use and growth of GDP, closer analysis (Schurr and Darmstadter, 1976) reveals significant deviations in the composition of energy inputs (toward greater use of electricity) and industry structure (toward the postindustrial economy). Moreover, the reliability of history as a guide is seriously compromised by the reversal in the long-term decline of energy prices. The general tendency is one of increasing economic growth with decreasing energy input per unit of production, although in recent years some European countries have shown an upswing in the energy-to-GDP ratio. These trends seem to confirm the Ford Foundation Energy Policy Project's finding that modest economic growth is compatible with continuing decline in primary energy input. Whether the postindustrial society might also stimulate energy-intensive consumer patterns, e.g., in leisure, is a further question for research (see Market Incentives to Conservation below).

Energy Use and Quality of Life

Asked what sacrifice was being asked of the American people under the Carter Administration's energy plan, Secretary of Energy Schlesinger replied, "Giving up belief in the idea of growth." The CONAES Consumption, Location, and Occupational Patterns Resource Group (1979), assumes, however, that energy use can be stabilized at present levels without deleterious life-style change. Indeed, extensive cross-national surveys (Buttel, 1979) and intensive case studies (Schipper and Lichtenberg, 1976) disclose only very partial correlation between energy-use and quality-of-life measures. As in the case of energy-GDP ratios, the relationships involved are convoluted and complex. We cannot safely assume at this point in the analysis that reduction or reversal in energy growth rates will adversely affect the quality of life.

One implication of these findings is that solving the energy problem should not become the crux of social policymaking in other areas of concern, such as employment. Regarding land-use patterns, for instance, Darmstadter (1976, p. 6) asserts that "here is an area of social concern, touching on matters of esthetics, recreation, open space, nonenergy resources (such as water), jobs, environment, and crime, and . . . to make energy the pivotal touchstone of policy is palpably foolish." In any case, it is generally accepted that energy conservation, like energy use, should be engaged in not for its own sake but rather in the service of attaining higher goals.

Economic Growth and Quality of Life

The linkage between economic growth and quality of life that is usually asserted is standard of living as measured by per capita GDP. The medium through which aggregate economic activity is converted to real personal income is, again typically, that of employment. Here conventional wisdom holds that increased energy use generates increased economic activity (a tenuous assumption, as we have just seen) which in turn generates economic opportunity and welfare through employment. At the level of the firm, however, increasing productivity has been characterized by the substitution of capital- and energy-intensive technology for labor. Since the employer's labor costs are the workers' wages, even if this tendency creates *aggregate* labor demand there is still a major problem of worker displacement and job dislocation. Hence, the cost-effectiveness of capital investment in energy development in generating employment would appear an extremely devious route compared with job creation through direct social legislation.

The dedication of capital investors to employment goals is questionable in any case. By and large, social costs are regarded as externalities of economic activity; as Paschen (1977, p. 29) observes, there is no "market for the quality of life." This being the case, we might very well imagine (as does Herman Daly [1979]) a decreasing marginal utility of the social welfare function with continued economic growth--an impression reinforced by the shifting emphasis from quantitative to qualitative growth. While proposals abound for internalizing energy and economic externalities--what might be called recoupling--the institutional means for achieving this result are not particularly impressive. Mostly they amount to passing increased production costs on to ultimate consumers, usually with regressive effects. The same may be said for environmental quality (a subset of quality of life) in relation to economic growth. It is conventionally held that economic growth makes available the surplus for environmental clean-up (and also income redistribution), and again how this translates to actual practice hardly inspires confidence. At a minimum, these assumed relationships call for closer analysis.

The "Two-Paths" Debate

In the energy field, a logical successor to the growth debate is the "two-paths" debate precipitated by Amory Lovins (1976) (see also Hammond, 1977). Briefly, Lovins argues that there are two opposing routes to solving the energy problem, the hard path and the soft path. Energy policies have promoted the hard path since World War II. Chief reliance is placed on developing capital-intensive and technologically advanced supply systems, particularly nuclear, to spur continued energy and economic growth. Alternatively, the soft path depends on environmentally benign technologies such as solar, early transition to renewable energy resources, and restraint on the side of energy demand. It is this soft path that Lovins recommends.

Two sides of the debate are represented by Lovins and Dennis Meadows on one hand and by Wolf Häfele and Wolfgang Sassin of the International

Institute for Applied Systems Analysis Energy Program on the other. According to Lovins and Meadows,

> . . . sociopolitical constraints provide the basic starting point for analyzing and further modification of the technological system. For the analysis no concept of a sociopolitical life-style can be solely expressed in terms of technology. But general notions of future sociopolitical prospects can lead directly to identification of preferred technologies (quoted in Sassin *et al.*, 1977, p. 2).

They go on to emphasize small-scale, decentralized technologies based on regional self-sufficiency of energy sources and a policy of zero energy growth to lend political stability. For their part, Häfele and Sassin contend that "the technological possibility to produce ample energy for all future [needs] indeed exists, practically eliminating raw material as well as environmental problems," and that the technological and sociopolitical aspects should be kept separate (Sassin *et al.*, 1977). By aggregating per capita energy requirements for a future world population of 12 to 13 billion, they conclude that only hard technologies can answer the need. Nevertheless, they construe the question of energy choice as political in nature, not scientific.

The terms of the debate appear to turn as much on questions of epistemology and values as they do on technical issues; hence, "a purely technical argumentation will not be able to bridge the gap between the general standpoints of 'hard' and 'soft' exponents" (Sassin *et al.*, 1977, p. 3). Clearly we are in the presence of one of Weinberg's (1972) trans-scientific questions, and settling it will largely be a matter of political determination. Nevertheless, research into its social aspects should serve to inform the debate; argument on this point has mostly been either technical or polemical.

A central issue in the debate concerns the compatibility of the alternatives posed. While Lovins argues that the two paths are mutually exclusive, other theorists have been concerned with finding some common ground between them, to aid in formulating an energy strategy that might effectively combine the best features of both. Sweden's Secretariat for Future Studies (1977) contends that the policy objective should be to open the widest range of energy options, and since the hard path has received greatest attention, corresponding effort should therefore be given to assessing the potentialities of a soft-path energy strategy.

Whether the hard or soft path or some combination of the two is finally chosen, the social assessment of energy alternatives is a topic for urgent studies. Discussion of the remaining research areas is meant to advance this dialogue. Following the soft path, there are two main lines of development: reducing energy demand through conservation measures (voluntary/mandatory, market/nonmarket) and increasing energy supply through innovation, adoption, and diffusion of alternative technologies. We will briefly examine these complementary approaches in turn.

Energy Conservation

Traditionally, the standard prescription for overcoming resource scarcity of any kind has been to increase supply. In the past few years an opposite strategy has come into prominence, namely, to reduce demand. While much discussion of the energy problem still centers on supply options, conservation of energy resources is receiving ever-greater attention. The effect of successful conservation measures will be the slowing of energy growth rates, with all the benefits ascribed to that (e.g., Landsberg *et al.*, 1974, p. 140). One of the chief attractions conservation supposedly offers is rapidity and ease of implementation, whereas many years are required to drastically expand conventional energy systems and to develop alternative energy technologies. How well these expectations will be fulfilled remains a question for empirical research.

As Landsberg *et al.* (1976, p. 138) note, "Until very recently it was taken for granted that the term 'conservation' when applied to energy referred to keeping primary sources in the ground or managing their extraction in ways to maximize their flow over time. Now a new usage has developed. It denotes efficiency in utilization, avoidance of waste in application." The two principal means for achieving conservation in this sense are improvements in technical efficiency and alterations in patterns of use. The authors go on to remark,

> It is probably not unfair to characterize most of the studies done to date as presenting rather idealized formulations of potential realizable energy savings--calculations based largely on physical or engineering efficiency criteria rather than qualified by policy feasibility, economic cost considerations, and questions of time phasing.

Like the research they propose, our own focuses more on the institutional and behavioral aspects of energy conservation. It should be evident however that technology-based approaches also involve social innovations and adaptations.

Proposed measures for energy conservation are typically presented by sectors; Landsberg *et al.* (1974, p. 44), for example, present the following:

Transportation
- Shift modal mix to energy-efficient modes
- Increase load factors, especially for urban travel
- Improve vehicle energy efficiency for autos, trucks, airplanes

Residential/Commercial
- Increase building insulation to reduce heating and cooling needs
- Use heat pumps or fossil-fired heating systems rather than resistence heat
- Use energy-efficient air conditioners
- Use total energy systems to provide both heat and electricity
- Pay closer attention to lighting levels

Industry

- Increase recycling of energy-intensive materials
- Improve energy efficiency of industrial processes
- Use waste heat from power plants near population centers for direct heat and process steam
- Use solid wastes as fuel

Not only are the feasibility and efficacy of these measures in need of institutional analysis, their behavioral consequences must be addressed as well.

Although conservation is universally admired as a means of reducing energy demand, the social costs of such programs and practices are less widely acknowledged. Potentially the greatest negative impact is on equity; considerable evidence has accumulated that conservation measures, like environmental protection measures, are regressive with regard to lower income groups (Unseld *et al.*, 1978). While income redistribution may not be a feature of such efforts, certainly not in the direction of increased inequality, special provisions may be required to offset their equity impacts. Health and safety are other categories of concern. Improved home insulation may reduce healthful ventilation, for example, and fostering small car purchases by means of gas mileage, horsepower, weight taxes, or weight rebates raises the question of vehicular safety. The obvious costs of car pooling are in reduced flexibility and convenience to personal schedules, but the broader question of social coordination measures, especially for voluntary conservation practices, also requires analysis (see below, Voluntary Coordination Measures).

Technical Efficiency

As previously noted, the preferred energy conservation strategy is to increase technical efficiency in utilization. Hagel (1976, p. 95) reflects this popular view:

> The most promising approach which could have a significant impact on long-term growth rates in energy consumption involves the implementation of policies designed to promote the accelerated development and commercial application of energy-efficient technology in both producing and consuming sectors. A major attraction of this approach is that it would minimize the demands of energy resources without requiring major adjustments in life-styles or living standards.

This approach has been made famous in another of Weinberg's phrases, the "technological fix." It is assumed to be consistent with prevailing social values and behavior, and therefore to represent an application of the "minimum change law" (Meinel and Meinel, 1976)--i.e., those initiatives succeed best which require the least social disruption. As a strategy of intervention, there is much to recommend it. Consider, for example, the difficulty experienced by communities and regulatory agencies in implementing transportation plans (parking bans, vehicle-free zones, bus lanes and the like). Compared to energy savings realized by changes in land-use practices, Darmstadter (1976, p. 6) estimates virtually identical results from a 35 percent improvement in the energy efficiency of cars.

The difficulty with such minimal change is that it is likely to result in only marginal improvement. In its last National Plan, the U.S. Energy Research and Development Administration (1976, p. 8) recognized that:

> Because conservation technologies are characterized by their large number, their diversity, and the relatively small energy contribution of any one--in contrast to major supply technologies--a broad, general strategic approach is required to stimulate the market introduction and implementation of these more diverse technologies.

Further, in order to match energy quantity and quality with total energy needs, it is necessary to apply efficiency measures systematically across sectors to various production, distribution, and end-use requirements.

Comprehensive assessment of conservation technologies must also factor in the social aspects of energy utilization. The behavioral specification of energy models in the household sector provides one example. At present, Hirst, Lin, and Cope (1977, p. 9) report, "Although the model captures some of the economic and demographic determinants of household fuel use, intangibles such as comfort, convenience, reliability, safety, attitudes of neighbors, and whatever else goes into decisions on household equipment choice and usage are not captured by our model." Estimating the social limits of the technological fix leads directly to the detailed study of patterns of energy use.

Patterns of Energy Use

Technical efficiency conforms to the minimum-change law inasmuch as people continue to use energy for the same purposes, but more efficiently. As a strategy of energy conservation for the short term, this approach has decided advantages. To the extent that conservation can be sold on grounds of technical and economic efficiency alone, no further inducements may be needed. In any case, the questions "Does it work?" and "Is it economical?" must be satisfactorily answered. As we have seen, however, there is some suspicion that cosmetic measures will not contribute significant energy savings and that people must radically change their patterns of energy use. It is argued that a zero/low energy growth scenario must invoke drastic measures that will profoundly alter the bases of human relations and social institutions. Thus a central research question is the degree of institutional and behavioral change that a serious conservation program must induce or coerce.

Before that can be addressed, a first concern must be to determine more accurately the existing patterns of energy use. While consumer surveys have multiplied in recent years (e.g., Morrison, Keith, and Zuiches, 1979), most of these confine themselves to objective user characteristics such as family and dwelling type. More interpretive categories such as value orientation and life-style preference should be the basis of further data collection and analysis. For example, Banz (1976, p. 117) outlines a procedure of life-style mapping to evaluate responses to drastic changes in energy supply: "The direct and indirect relations between current energy uses and existing life styles must be established; hypothetical life styles can then be delineated through the use of LSPs (Life Style Profiles) and analyzed in terms of their possible contribution to desired changes in patterns of energy consumption." Extremely detailed studies of Hong Kong have been conducted by Newcombe (1976); they stand as worthy precedents in this research area.

Once a more suitable and stable data base of existing use patterns has been laid, we will be in a better position to project social trends for different conditions of energy availability. Already there is some evidence to suggest that advanced industrial societies may be entering a phase of what Inglehart (1977) calls post-materialism. If this trend becomes definitely established, it may form a leading part of the value system of postindustrial societies. However this may be, the prediction of life-style and value changes as they affect energy use should be factored into the supply-demand equation. Future preferences for housing types, rates of household formation, and family size and composition are among the forces influencing future demand. A strategic approach to assessing their cumulative impacts may be to start with demographic projections (e.g., Morrison, 1979) and then consider probable and possible life-style and value implications.

Further questions of policy analysis and evaluation surround this whole topic. Energy policy pronouncements are generally sensitive to potential impacts on existing life-styles and values, and preserving them is a frequently asserted (though seldom-examined) policy objective. On the other hand, social reformers may seize on the energy crisis as yet another proof of the decadence and derangement of contemporary Western societies and as a lever for change in directions they deem to be desirable. Clearly what is at issue here is not so much energy policy as the image of the future, itself a reflection of current and changing values. This involvement of energy issues in questions of value should not be thought inappropriate since, as we have said, energy pervades all the structures of modern societies, including their value structures. It is a relationship whose intellectual clarification deserves and requires far greater research attention, however.

Voluntary Conservation Measures

The contribution of voluntary action to energy conservation is the main feature of interest here--more specifically, the conditions under which it can be motivated and mobilized through conservation programs and measures. Research should be directed toward determining how voluntarism can be made effective in designing and implementing conservation efforts. The criteria of effectiveness are systematic and sustained activity--both notoriously difficult to achieve through voluntary actions and associations. In examining this area, four topics command attention: (1) the emergence of the voluntary sector, (2) public acceptance, (3) centralization-decentralization, and (4) conservation education.

Emergence of the voluntary sector. Through sanctioned and spontaneous expressions of public participation, such as citizen-involvement programs mandated by law and the appropriate technology (AT) movement (see below), the voluntary sector has gained increasing recognition in recent years. Once believed a phenomenon peculiar to America--a nation of joiners--voluntary action has attained considerable prominence in European societies of today. The antinuclear movement and its remarkable success in redirecting national energy policies is perhaps the most striking example. This also draws the corollary that public participation feeds expectations of even greater participation and power sharing. A subsector of this general development is of particular importance to energy policy formation--the emergence of a "voluntarily frugal sector" (Elgin and Mitchell, 1977). Among other things, its appeal may reside in greater propensity towards self-regulation and lessened reliance on formal political controls. The extent to which this movement toward a conserver society (Valaskakis, Sindell, and Smith, 1976) is becoming general and influential is a topic for empirical research.

Public acceptance. Between mandatory and voluntary conservation measures, there appears an overwhelming preference for the latter on the parts of both politicians and the public. Low public acceptance of radical conservation measures can be attributed to an underestimation of the severity of the energy problem, but if the problem is long term, as many suppose, short-term "heroic" measures will not answer the need. Political support to sustain effective measures will crucially depend on public perceptions of equity in conservation policy formulation and conservation programs administration. The research task here is to discover the preconditions for broad social consensus on national energy policies and to gauge public willingness for their execution (see below, Nonmarket Incentives to Conservation). Of course, this applies to mandatory conservation measures as well.

Centralization-decentralization. There are many facets of this topic, e.g., economies and diseconomies of scale in technological and economic terms. On the side of energy technologies, it appears from statistical analysis that increased reactor size reduces operational reliability (Komanoff and Boxer, 1977), whereas solar technologies are at least as efficient in small arrays. This is properly a topic for technology assessment; our present interest is in relation to voluntarism. As a hypothesis we might suppose that institutional decentralization stressing voluntary action is necessary for effective conservation measures. There are many reasons why this seems plausible: less dissociation of costs and benefits at disaggregated levels of operation, the "fine tuning" of energy systems close to end users, etc. But these well-advertised claims of "Small Is Beautiful" proponents need to be evaluated rather than assumed.

Conservation education. It has been argued (Kaderali, 1976, p. 182) that "the ultimate success of energy conservation strategies will depend a great deal on the degree to which the energy conservation ethic has been instilled in the general population. Thus, substantial education programs must be carried out by all levels of government as well as private industry." A prime requisite for instituting such programs is value consensus across all levels and sectors of society, for as Schumacher notes, "the essence of education . . . is the transmission of values . . . ." Conservation does appear to meet the value test impressively, and its status as an educationl innovation seems promising. But this apparent identity of interests may turn to conflict once deeper levels of energy analysis are penetrated. The returnable bottle issue is but one instance where environmentalists and industrialists have clashed. How far consensus will bear analysis remains an open question.

Moreover, there is a tendency to substitute education for decision and action when contentious issues arise, especially those with implciations for major change. A further research question is whether conservation education (including mass communication as well as formal instruction) can lead to voluntary sacrifice and value change. Public information campaigns have been found ineffective compared to economic incentives, but this only prompts the question, What are the conditions, e.g., social reinforcement, symbolic rewards, for the effectiveness of such campaigns? It also implies the need for uniting market and nonmarket incentives to conservation in a self-consistent and mutually supportive fashion (see below).

Mandatory Conservation Measures

While strong preference is expressed for adopting voluntary conservation measures, there is considerable doubt as to the effectiveness of such measures. So while giving due emphasis to voluntarism, we must also look at the other side. The public expects and demands governmental intervention, and in the end, intervention means coercion. One of the more extreme proposals recently put forward (Backstrand and Ingelstam, 1977) is for government to limit consumption of meat and restrict car ownership, as well as to mandate greater efficiency in construction materials and in durability of consumer goods. While the imposition and enforcement of stringent controls (quotas, rationing, etc.) may be warranted and accepted in times of exceptional resource scarcity, a more reasonable course for normal times would be to institute a procedure similar to the environmental impact assessment process required in the United States under Section 102 of the National Environmental Policy Act of 1969 (NEPA).

Because of its apparent success in environmental protection efforts, the impact statement format has been prescribed for a wide range of public and private enterprises, including energy resource development. Kaderali (1976, p. 181) observes that, "Efforts to interject energy considerations into the daily decision making process are likely to increase over the next few years. This suggests that there exists a need to develop a process to identify and quantify the energy implications of policy decisions at all levels of government." A content to accompany this format has been suggested by Chen (1975). Such a procedure would necessarily be predicated on an established national energy policy, or on a policy at some other level congruent with the national interest. Apart from the evident difficulty in achieving consensus on national energy policy, there remains Darmstadter's (1976, p. 4) earlier objection: "The trouble with such approaches stems from the fact that energy consumption may be, and usually is, only one element within a wider range of production or consumption activity; consequently, by focusing solely on energy, misguided policy emphasis may ensue." Despite this caution, the suggestion of an "energy impact statement" appears sufficiently attractive to merit closer scrutiny.

In the arena of energy policy formation, then, the preferred strategy is a combination of voluntary actions and market incentives. Fullest reliance would ideally be placed on market allocation of energy supply and demand, with the government's role confined to correcting market "imperfections." This position is best stated by Kneese (1976) in what we have termed the Market Perfection scenario. Nevertheless, it is widely held that the market mechanism will not normally function to avert energy shortages and that sterner measures are required; this is said to be especially true in the case of conservation. Moreover, welfare considerations--of social justice, regional disparity, and the like --preclude a pure market solution. In treating energy resources as commodities, the criterion of economic rationality does violence to the social concerns bound up in their use and the social context in which allocation decisions must operate. For example, the key policy objective of internalizing energy externalities cannot be expected to obtain through unregulated market operation.

Besides compulsions or constraints (regulations and penalties), however, governmental intervention may also take the form of incentives (e.g., subsidies for weatherization, solar installation, mass-transit patronage), with preference once more accorded the latter. In fact, no single energy strategy is likely to succeed, and determining an optimum policy mix is really the pressing question. It is not a matter of either market allocation or government regulation, but of both in the proper combination--of allowing and enabling the nongovernmental sector to make its best contribution and supplementing that with political controls. Finding the right combination(s) then becomes the essence of governance in this as in other policy arenas.

Market Incentives to Conservation

Considering the social costs and limits of governmental intervention, it seems only prudent that a viable energy policy must allow for private sector participation and, correspondingly, for the legitimation of its interests. For instance, market operations are said to possess the advantage of not being perceived as infringing on life-style preferences. "Indeed, when such changes are, *ex post*, induced by market forces, the question of encroachment into subjective inclinations is not even relevant"

(Darmstadter, 1976).[5] Faulty perception of impersonal market forces may impede their translation to appropriate consumer responses, however; accurate signalling and detection of real energy costs are the mechanisms of rational consumer behavior. It is an empirical question how conscious consumers are of the relative energy efficiencies of products (materials, structures, appliances, services) they consume.

In a market context, the willingness to shift preference from energy-intensive to energy-efficient consumption patterns is naturally price-determined. Hence, Darmstadter (1976, p. 3) considers that "the minimum condition motivating adoption of an energy-conserving practice--whether by reducing energy input into a given output or activity, or by a shift in demand for less energy-intensive goods and services--is lower, or at least unchanged monetary costs."[6] While necessary and proper within this sphere of action, satisfying minimum conditions is not likely to provide sufficient incentive to energy savings for two reasons. First, expected price rises of energy-related goods and services may not greatly impinge on the marginal propensity to consume, at least among the affluent majority. Determining the actual extent of consumer response to price increases is a matter for elasticity studies. Second, the economic rationality of consumer behavior is embedded in an institutional matrix whose net effect may be to frustrate energy-conserving purchases and measures. The acceptance of "life-cycle costing" of housing and consumer durables appears to suffer from this kind of restriction. For this reason market-oriented conservation policies must alter institutional arrangements as well as offer price or tax incentives.[7]

[5] Hagel (1976, p. 102) argues that "mandatory restrictions on energy consumption will divert energy from uses that are more highly valued by consumers to uses that are less highly valued. Thus, from the viewpoint of consumer satisfaction, the government measures will yield a less socially desirable situation than would have prevailed in an unhampered market." He goes on to contend, "recommendations that the government intervene to reduce energy consumption beyond the levels that would prevail on the unhampered market appear to be motivated by the implicit, and somewhat paternalistic, assumption that consumers overvalue energy use."

[6] He adds, "But these monetary costs should be fully reflective of the environmental damage and other consequences which the energy user imposes on such common property resources as land, air and water. Where such consequences are not quantifiable, or where the very notion of quantification is tenuous, outright restraints, overriding the market solution, may be in order." Darmstadter also observes, "if one is willing to accept this formulation as a legitimate criterion for energy conservation, one should--conversely--permit intensification of energy use where such a change is also economically dictated."

[7] Incentives to energy-efficient consumption patterns have their counterparts on the side of producing units as well, both in terms of industrial process uses and in the marketing of products. The latter includes not only the commercialization of technological innovations in energy sources and systems but also the provision of conservation measures as a customer service. The research problem here is to assess the readiness or resistance that facilitates or thwarts entrepreneurial initiative and capital investment. Such assessment depends on far more detailed institutional analyses than have been systematically performed to date.

Findings thus far reported generally show the ineffectiveness of noneconomic inducements to conservation (Curtin, 1976, p. 58). Rebate payment as well as feedback on conservation performance appear necessary to achieve significant energy savings. Nevertheless, Sweden's Secretariat for Future Studies (1977, p. 133) asserts that the "illusory freedom to consume" must be replaced by more substantial and meaningful participation in the life of society than what the market will bear. A growing body of survey research attests that such a value change may now be under way. But as before, the linking of economic and noneconomic incentives would seem essential to a maximally effective conservation program.

Nonmarket Incentives to Conservation

As a working hypothesis, we may suppose that early adopters of energy-saving technologies are motivated primarily by nonmarket--that is to say, by ideological or "value"--concerns. Diffusion studies of these people's social characteristics and social values are needed to test this hypothesis; at a minimum however we can safely maintain that economic considerations do not play so major a role for early as for late adopters. (For one thing, early adopters may prepare the market for mass consumption by bringing about lower production costs and reduced unit prices.) This relationship is implied in the allegation that early adopters are members of an elite whose superior access to technical improvements poses an equity problem. At this point we must question how widely shared and broadly based are nonmarket incentives to conservation.

In the face of critical shortages of energy supplies, e.g., the gas lines of the winter of 1973-74, the natural gas curtailments of 1976-77, and the coal strike of 1977-78, there may be a readiness to sacrifice personal comfort and convenience and a willingness to accept the direction of government in seeking remedies. Nevertheless, the common experience of mutual sacrifice may quickly turn to recriminations against business or labor and rebukes to government. While there may be little doubt of the capacity to rise to the occasion of an energy crisis, the energy problem is a longer term proposition, which crisis management cannot basically alter. Indeed, averting crises is precisely the aim of energy policy.

Since the OPEC embargo, patriotic exhortations to conserve energy have repeatedly been sounded. The most arresting formulation of this sentiment is the phrase associated with President Carter's energy policy, "the moral equivalent of war." As well as personal sacrifice to the national good, implied in it is a unity of purpose and a mobilization of effort to achieve energy policy objectives. The type of political support requested may be called "national commitment." Inexact precedents are sometimes found in the Manhattan Project and Apollo Program, and a common prescription is for crash research programs in some field of energy technology. However, broad societal consensus on the aims worth pursuing is a precondition to forming national commitment.

At the point of end use, energy consumption is highly diversified and diffuse. In the absence of external enemies and clearly present dangers, the moral suasion of a call to national commitment must be judged tenuous at best. There is common assent on the need to conserve, and because of its ideological overtones solar energy may become a serious candidate for future national commitment. The instruments for framing and implementing national energy policy are mainly those of pricing and taxing legislation, however. Both tend to raise the salience of special interests and to submerge the national interest. Moreover, there is a fairly consistent tendency to separate personal from societal futures (Campbell, Converse, and Rogers, 1976); the linkage between individual actions and collective goals is a fragile one. Hence an urgent research question is how personal identification and social consensus can be more firmly joined in support of national energy policy.

Alternative Technology

Alternative technology is a shorthand expression combining alternative energy (AE)--alternative to hard-path sources such as nuclear, fossil and hydro--and appropriate technology (AT) or, in Schumacher's usage, intermediate technology. Because it must be defined in relation to need, appropriateness is situationally contingent and culturally variable. In a general way, however, appropriateness implies a matching of energy quality and scale to end use. For example, electric resistance for space heating would in most cases represent an inefficient, hence inappropriate, energy use. On the other hand, electrification of mass transit systems would seem appropriate, compared to widespread reliance on the internal combustion engine. Appropriateness cannot be defined in terms of source or scale of energy systems without further qualification.

It is sometimes asked, "Where has the environmental movement gone?" One clear direction the environmentalist response to the energy crisis has taken is toward appropriate technology, e.g., environmentally benign technologies such as solar. It is not too much to speak of this development as constituting a new social movement--the "AE/AT" movement. Like earlier offshoots of the environmental movement (e.g., the survival movement of the early seventies based on subsistence agriculture), the AE/AT movement is not antitechnology but rather pro-appropriate technology. Schumacher, himself a pivotal figure in the movement, best exemplified this persuasion. Although some political activism has been directed against hard-path technologies, as in the Clamshell Alliance's occupation of the Seabrook, N.H., nuclear reactor site, AE/AT groups have been overtly apolitical for the most part. Implicitly, however, their emphasis on technological decentralization has definite political implications for scaling down institutional size to what they regard as more humane and manageable proportions.

The decentralist argument implies that energy conservation can be achieved through small-scale technologies that are closer to end users, who can accurately gauge the source, social cost, and amount of energy used, and can maximize energy efficiency by modifying demand. The AE/AT movement is the chief proponent of this view and may be an effective change agent in its cause. In contrast, the federal government's research policy has been criticized for concentrating on large-scale, centralized systems, including solar--of "creating solar technologies in the image of nuclear power" (Hammond and Metz, 1977, p. 241). The problem of scale remains in conceiving and installing alternative energy systems for load centers such as the New York metropolitan region. How far the general public is prepared to go in adopting localized, hands-on energy technologies, substituting control for convenience, is likewise a matter for further research. Even where sunk costs of infrastructure investment are not prohibitive, the innovation of community total energy systems such as the Modular Integrated Utility System face serious, if not insurmountable, institutional barriers (see Shostak, 1979).

Renewable Energy Resources

With this topic and the next we return to technology-based concerns such as those supply technologies indicated in the hard-path line of Figure 1, e.g., biomass conversion. As before, our research interests focus on the social causes, conditions, and consequences of developing and deploying these alternative energy systems.

Strong preference has been expressed for shifting the energy resource base from nonrenewable to renewable sources. The latter are not without their own difficulties, however; for example, hydro is usually classified as a renewable energy resource, but record droughts of the past two years have underscored the vulnerability of this source to climatic variation, and few prime sites for new construction remain. Even were such energy resources perfectly reliable and indefinitely expansible, however, removing the limits to energy growth would still pose serious questions of potential impact--say in the induced-growth impacts of dispersed settlement patterns that on-site solar electricity would make possible. Perhaps the lesson of the energy crisis is to accept some reasonable limits and adjust to them rather than to regard curtailment as a temporary abberation in the long-term trend of exponential growth.[8]

Nonrenewable Energy Resources

Similar questions arise with regard to nonrenewable resources, particularly in the conversion of end-use products from waste to resource. Materials that were previously valueless and even noxious must be reconceived and recovered for further use. Solid waste is a prime example, stimulated not only by improving technologies and economics but also by regulatory push in the impending ban on ocean dumping and land filling. The most obvious case is recycling paper, glass, and metals. Market economics and their fluctuations have undermined recycling incentives in the past; social inefficiencies in waste collection and disposal systems have discouraged household practice; and the net energy balance of recovery has sometimes appeared unfavorable. Nevertheless, recycling

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[8] In short historical perspective, that is. Coal replaced firewood as the leading U.S. energy source only in the third quarter of the 19th century, and oil replaced coal as recently as the early 1950's.

is a symbolic act which every consumer can usefully perform. Making it personally convenient and socially commendable, as well as economically profitable, is the institutional challenge.

SUMMARY

The broad research topics briefly sketched above can be summarized in the following agenda for energy-related social research:

1. Socioenvironmental Impacts of Energy Development, Conservation, and Use.
    - Relationship of social purposes and consequences of energy development, use and conservation (needs assessment, effects research).
    - Quantification of social impact categories.
    - Compilation of impact data base (parameter estimates, indicator measurements; data quality assurance--validation studies, etc.).
    - Dynamic analysis using input-output time series data.

2. The Decoupling Question.
    - Assessment of economic (employment, inflation, etc.) impacts of energy alternatives.
    - Prediction of energy to GDP ratios under increasing energy price assumptions (institutional/behavioral aspects of elasticity).
    - Relationship of energy consumption to objective and subjective quality-of-life measures.
    - Social impacts of zero/low economic growth (equity, employment, etc.).
    - Effectiveness of institutional mechanisms for internalizing energy/environment externalities.

3. The "Two-Paths" Debate.
    - Sociopolitical impacts of hard vs. soft energy strategies (political stability, etc.).
    - Aggregate analysis as a basis for energy demand projection.
    - Philosophical vs. technical aspects of the debate.
    - Possible complementarities and convergences of the two paths.

4. Energy Conservation.
    - Rapidity with which conservation measures can be implemented.
    - Social costs and benefits of conservation measures (home insulation, car pooling, etc.).

a. Technical Efficiency.

- Institutional/behavioral aspects of technological innovation and diffusion.

b. Patterns of Energy Use.

- Value maintenance and change in relation to reduced energy consumption.
- Accurate mapping of existing energy-use patterns.
- Projected energy-use patterns under conditions of post-industrialism and post-materialism.
- Energy-use implications of demographic change.

c. Voluntary Conservation Measures.

- Conditions for motivating and mobilizing voluntary conservation.
- Emergence of a voluntarily frugal sector.
- Voluntary action as a function of technological and institutional decentralization.
- Effectiveness of conservation education.

d. Mandatory Conservation Measures.

- Public acceptance of and political support for mandatory conservation.
- Format and content of an energy impact statement.
- Social costs and benefits of governmental regulation vs. market allocation.
- Constraints vs. incentives in determining an optimal energy policy mix.

e. Market Incentives to Conservation.

- Strength of consumer preference for energy-efficient products.
- Effectiveness of price incentives in reducing energy consumption (equity impacts, institutional barriers, etc.).
- Commercialization of conservation technologies and measures.

f. Nonmarket Incentives to Conservation.

- Motivational and value bases of conserving behavior (under noncrisis conditions).
- Conditions of social consensus for national commitment.
- Linkage of individual and collective goals in national energy policy formation.

5. Alternative Technology.

- Environmental response to the energy crisis (the Alternative Energy/Appropriate Technology movement, etc.).

- Criteria for appropriate energy technologies.
- Comparative advantages of centralized and decentralized energy production and utilization.

6. Renewable Energy Resources.

    - Social limits to growth.

7. Nonrenewable Energy Resources.

    - Institutional incentives for materials recycling.

It has not been possible to develop these research ideas in great depth in this survey. Nevertheless, these ideas suggest the range of research social scientists might undertake in the common effort to formulate and implement national energy policies. Whether this exercise can acquire a real cutting edge or will remain merely academic is partly a matter of the social science community's sense of social responsibility and their resourcefulness in pursuing such research interests. Partly, too, it is a matter of the encouragement and support they receive from policymakers, administrators, and the public. In any case, the social contexts and contents of energy policy research will assume increasing importance in the years to come with the realization that, fundamentally, the energy problem is a social problem.

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SOCIAL SCIENCE RESEARCH AND THE FORMATION OF ENERGY POLICY

by

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PREFACE

This essay was published in slightly different form in Social Impact Assessment 5 (May 1976). It was prepared in January 1976 for the National Research Council's Committee on Nuclear and Alternative Energy Systems and represents an initial attempt to outline issues of social relevance in energy policy formation.

INTRODUCTION

The knowledge requirements of a rational energy policy are of course enormous, and social science knowledge is only a part of these requirements. This statement addresses itself to some topics for research that would add to our store of relevant social science knowledge. Some research has of course been carried out on many of these topics; in order to meet the stringent space restrictions, descriptions of this research and citations to its publications are not provided.[1]

Since energy use is related to every aspect of society, social research into energy problems involves the study of organized complexity. In part because of this complexity, simple answers do not exist and are explicitly not promised in this statement.

The research described in this statement is a part of what is known as technology assessment, or more specifically as social impact assessment. Its broad purpose is to enable society to anticipate the consequences of decisions concerning technology and thus to minimize their possibly harmful effects.

Research into the topics outlined below cannot be completed in a year or two. Rather, the statement should be viewed as a first attempt to outline a program of basic research, a program that would take many years of work before useful results could be expected. Should such a long-term research program be undertaken? The answer has to be "yes," assuming as we must that energy problems will be on the public agenda for many decades and that an energy policy is desired that best meets the needs of society. What other aspects of energy production and use should be studied? What are the components of the program? What are the most efficient modes of carrying out a broad research program such as this? These are questions that need extensive discussion and review.

The topics proposed for social science research are grouped below into four broad categories:

I. Institutional Studies
  - Energy decision making
  - Institutional and human error
  - Education and training
  - Centralized authority versus diffused authority
  - Legal issues

II. International Studies
  - Energy transmission across national boundaries
  - International controls

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[1] See the selected bibliography by Frankena, Buttel, and Morrison (contained elsewhere in this volume), which also lists at the outset more comprehensive bibliographies. See also the boomtown bibliography by Cortese and Jones (contained elsewhere in this volume).

III. Historical Studies
  - The search for precedents
  - The longevity of social institutions

IV. Public Acceptance Studies
  - Public attitudes
  - The environmental movement
  - The pro- and antinuclear energy movements
  - Social acceptability of new technologies
  - Attitudes toward nature
  - Quality of life
  - Public health and safety

A very large and important class of social science research--the economic aspects of energy--is not discussed directly. There is, for example, need for additional work in cost-benefit analyses of different patterns of energy production, conservation, and use. Topics such as this are not discussed here, in part because the author feels less competent to make recommendations in this area, and in part because such research is relatively better developed than is research on historical, social, and political aspects.

INSTITUTIONAL STUDIES

Energy Decision Making

The decisions on energy policy made over the next decade will be the result of interaction among an assortment of interested groups: government executives, legislators, industrial leaders, citizens' groups, and voters. CONAES, an institutionalized mechanism for bringing the findings of science and the views of individuals in industry and in universities to the attention of government officials, is of course a part of this process.

Although important policy decisions are increasingly made as the result of this kind of interaction, we know very little about how the process actually works. Accordingly, one area of needed research is the decision process itself. For example, there have been a number of attempts--most significantly in the U.S. and Sweden--to create citizen forums for the purpose of informed discussion of energy policy. Evaluations of these attempts are badly needed, in order to improve the decision-making process.

Institutional and Human Error

Since nuclear power plants are dangerous and can become hazardous if stringent safety procedures are not followed, and since the consequences of institutional or human error can be catastrophic, technical and social research into error control are needed. Two quite different types of social research are needed: (a) research into man-machine interactions and their failures, and (b) research into the level of risk that individuals and societies are willing to tolerate. That is, since all technology use involves risk, the risks of nuclear power plant accidents cannot be evaluated except in comparison to other risks and levels of risk that the public seems to accept.

Education and Training

Different energy systems require specific types of educated manpower. Accordingly, schools and universities should ideally attempt to alter their curricula to make them appropriate for manpower needs 10 to 15 years ahead. Nuclear power may require geologists and nuclear engineers trained in universities, plus large numbers of trained laborers; solar energy may require more craftsmen--glaziers, plumbers, and sheet metal workers, trained either in schools or as apprentices; and coal mining may require large numbers of semiskilled workers. There is need for studies of the educational requirements of different energy production and use patterns.

Centralized Authority Versus Diffused Authority

Technology influences the structure of social control: many believe, for example, that government bureaucracies first developed in ancient civilizations because irrigation systems required communication between strangers over long distances. Similarly, patterns of energy production have implications for the authority structure of a society. To cite two extreme cases: nuclear power, with its needs for large capital investment, highly skilled management personnel, and safeguards against thefts and accidents, appears to require a high degree of centralization, while solar energy (as far as we can predict) appears more adaptable to decentralized social control, to local autonomy, and thus to regional independence from the central government. Broad studies--historical and comparative--of the relationship of energy sources to authority patterns are needed in order to anticipate and understand changes in society that the use of new forms of energy will bring about.

Legal Issues

Since energy is often derived from or transported through private property, new sources of energy will bring the need for new property-related legislation. Examples are the land-use requirements of the nuclear parks called for in the Energy Reorganization Act of 1974 and the inevitable future disputes over the air rights required for the solar heating of houses and offices. There is need for research into these and other legal aspects of energy production and use, so that the rights and obligations of both energy producers and users can be clarified, and serious legal conflicts can be minimized.

INTERNATIONAL STUDIES

Energy Transmission across National Boundaries

Power plants that require large capitalization and a skilled labor force can be too expensive for many small countries. Accordingly, many countries obtain energy from power plants in neighboring countries. The implications for international relations of this interdependence are potentially as important as are the implications of international trade, yet little research has been done into the interdependencies that now exist and into those that might exist with different patterns of energy production and use.

International Controls

Energy policies in the United States are obviously made in a world context. It is not only the unequal distribution and use of petroleum throughout the world that determines this: every aspect of energy use involves the crossing of national boundaries--from the use of ocean thermal power to the disposal of nuclear wastes in oceans to the safeguarding of nuclear materials from careless use, theft, or blackmail. As in the case of environmental policies, purely national energy policies have limited use. Fifteen nations now have nuclear power plants that produce plutonium; by 1985, there may be as many as 50. Research is needed on the capacity of different systems of international control to regulate with appropriate safeguards the flow of energy across national boundaries. Also needed is knowledge of the capacity of international controls to guard the security of dangerous materials against exploitation for political ends.

HISTORICAL STUDIES

The nuclear debate is a debate about the future, and every possible research strategy for understanding the future must be used.

The Search for Precedents

One strategy is the use of history as a source of precedents. History reveals a number of examples of reversing the unilinear development of technology. In the Middle East, for example, wheeled vehicles were replaced by camels in post-Roman times, and roads were abandoned. In Sri Lanka, an elaborate irrigation system used in ancient times was abandoned in favor of a system dependent upon seasonal rains. Roman plumbing fell into disuse during the Middle Ages.

The Longevity of Social Institutions

Both advocates and critics of nuclear power recongize that provisions must be made for the long-term storage of radioactive wastes. They differ, however, on two major points. Critics stress the long duration of the period during which the wastes must be isolated from the biosphere--their estimates range up to 250,000 years for plutonium. Advocates, on the other hand, stress technical reasons why 700 years is the upper limit for fission products. Both agree that social institutions must be created to guard the wastes.

The second point of disagreement concerns the longevity of the social institutions that link people to physical objects such as storage vaults. Can we be sure that stored nuclear waste materials will continue to be isolated from both the biosphere and society? Advocates of nuclear power cite agriculture as an example of a long-lived social institution: since the first domestication of plants, annual care has been necessary to preserve both seeds and land. Nations, empires, and societies have risen and fallen, yet this annual care has continued without interruption.

The successful centuries-old maintenance of the dikes between the land and the sea in Holland is also cited by nuclear power advocates as an example, but critics reject this example by pointing out that the German army breached a number of dikes during World War II, without serious consequences.

Critics of nuclear power claim that there is no precedent for the long-lived social institutions that the guarding of nuclear wastes will require, pointing out that the 2,000-year-old Catholic Church is the oldest relevant social institution in the world. The Pyramids at Giza are cited by both advocates and critics. Advocates point to their durability over the centuries, while critics recall that they were pilfered by thieves within a few hundred years of their construction.

Research is needed into the determinants of longevity of social institutions, and into the applicability of different classes of historical examples to the need to safeguard the storage of radioactive wastes.

PUBLIC ACCEPTANCE STUDIES

Public Attitudes

A system that continuously monitors the formation, content, intensity, and stability of energy-related public attitudes should be established so that changes over time can be measured and policy revisions made with an awareness of public opinion.

The Environmental Movement

The formation and adoption of an energy policy will be products of the political process. This process is not limited to the electoral system; a host of interest groups will seek to achieve policies that reflect their own ideologies and goals. Prominent among these will be organizations that are loosely affiliated in the environmental movement--the Sierra Club, Friends of the Earth, the Audubon Society, the Natural Resources Defense Council, and hundreds of others. Aligned against the environmental movement are organizations representing or reflecting the views of the timber, oil, coal, and nuclear industries--what has been called the counterenvironmental movement. Important beginnings have been made toward research into these movements; much more extensive research is needed if policymakers are to understand the public constraints upon different aspects of an energy policy.

The Pro- and Antinuclear Energy Movements

The debate over nuclear energy has polarized both the scientific community and the general public. Although the debate takes a number of forms, essentially it concerns the extent to which electricity should be produced by nuclear power plants. In addition, there are related debates over the proposed massive funding of the liquid metal fast breeder reactor program and over the proposal to permit the use of plutonium fuel in existing light water reactors. Each side in the debate seeks to demonstrate that science, economics, and a concern for the future welfare of society require that its position become public policy. Quite apart from any questions of truth, this debate, and the emotions and facts it brings out, is an enormously important one--perhaps as intellectually important as the debate over evolution that raged during the 19th century. Because of the hazards of radioactivity, it is immediately relevant to millions of poeple, and certainly needs careful study.

Social Acceptability of New Technologies

Any new pattern of energy production or use requires new technologies, which in turn alter many facets of the society that uses them--the nature of work, transportation, housing, and recreation, to name a few. Existing legislation requires the preparation and acceptance of environmental impact statements before major technological innovations can be introduced. Procedures are needed for estimating the impact of new energy technologies on attitudes and behavior. Such estimates cannot be made without extensive research into technology forecasting, technology assessment, and technology acceptance.

Protagonists of nuclear power assert that public resistance is simply a continuation of a centuries-old pattern of resistance to innovations. Critics, on the other hand, assert that there is something qualitatively different about nuclear energy. They note that three decades after its introduction--and into the foreseeable future--only a tiny elite understands its fundamental principles: they compare it with public understanding of fossil, hydroelectric, and solar energy. Furthermore, say these critics, the problem of waste disposal is qualitatively different. The creation of large quantities of a nonnatural, long-lived, highly toxic substance seems to them to be an historically unique crime against nature and future generations. Certainly social research into the nature, intensity, and distribution of these views is central to our knowledge of the social acceptability of nuclear power.

Attitudes toward Nature

Nature and man's conception of it are related in complex and shifting ways. Since any pattern of energy use--whether it involves the construction of oil rigs, cooling towers, windmills, or solar reflectors--leads to a distortion of what is "natural," research into the stability and form of social attitudes toward nature is needed. Only then can charges of "crimes against nature"--whether they be the scars of open-pit coal mines or the burial or dumping of radioactive waste material--be evaluated.

Quality of Life

In general, a high level of energy consumption leads to a high quality of life--assuming of course that labor-intensive activities such as working with a pick and shovel or walking rather than driving to work are viewed with disfavor. Witness, for example, the liberation (largely of women) from household drudgery that energy-intensive households make possible. But this linear relationship has many exceptions; it is necessary to learn about them through a program of research into the relationship of energy consumption--by both level and type--to the life goals, the expectations, and the quality of life of people of different localities, ages, educational levels, and income. When are increases in energy use needed to maintain or improve the quality of life and when are they not? How do we explain the higher (than U.S.) per capita incomes of Switzerland and Sweden when their per capita energy consumption is substantially less? Why is a family's possession of energy-intensive "labor-saving" household appliances unrelated to the amount of time family members spend on housework?

Since a substantial portion of energy is used for residence heating and passenger transportation, conservation measures will have a major impact on style and quality of life.

Public Health and Safety

Industrialization has both improved public health and safety (through medicine, sanitation, skill diffusion, etc.) and introduced new risks (airplane crashes, air pollution, etc.). Different energy systems introduce different types of risks. To cite an extreme case: the certainty of a general increase in air-pollution-related diseases if coal (or synthetic fuels such as gasified coal) is burned without adequate controls, versus the small probability of many deaths from an accident at a nuclear power plant. Research is needed into the statistical probability of different kinds of threats to public health and safety, and into public perceptions of these threats, in order to plan for publicly acceptable energy systems.

This statement has outlined a number of areas in which social science research could usefully illuminate the formation of energy policy. It is of course far from exhaustive. Moreover, there has been neither sufficient space nor sufficient wisdom on the part of the writer to provide the necessary linkage between the research topics and the needs of policy makers. Many of the questions whose answers would be most helpful to policy makers can only be identified by further research. As a first step toward identifying these questions, a task force of social scientists interested in energy policy might be assembled and assigned the task of outlining a long-range program of research to be carried out by universities and research institutes. Although there are technical problems in abundance, most of the basic problems underlying the energy question are social in nature, and the nation's best social scientists should be mobilized to work on them.

V.

ENERGY/SOCIETY ANNOTATIONS

ENERGY/SOCIETY ANNOTATIONS

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INTRODUCTION

The works annotated below study the reactions--of individuals, families, firms, communities, and regions--to energy shortages, price increases, and development efforts since 1973-74. For the most part, they were selected from two larger bibliographies compiled by Denton E. Morrison:

Energy: A Bibliography of Social Science and Related Literature. 1975. New York: Garland.

Energy II: A Bibliography of 1975-1976 Social Science and Related Literature. 1977. New York: Garland.

In addition, two other bibliographies were consulted:

Lopreato, Sally C., and Marian W. Meriwether. 1976. Energy Attitudinal Surveys: Summary Annotations, Research Recommendations. Washington, D.C.: U.S. Energy Research and Development Administration.

Olsen, Marvin E., and Jill A. Goodnight. 1976. Social Aspects of Energy Conservation Implementation: Study Module I-B, Draft Final Report. Battelle Human Affairs Research Centers. Northwest Energy Policy Project, Seattle.

Two bibliographies released subsequent to the September 1977 completion of the present one will assist interested readers in obtaining more recent literature on consumer and public opinion issues related to energy:

Anderson, Dennis, and Carman Cullen. 1978. Energy Research from a Consumer Perspective: An Annotated Bibliography. Faculty of Administrative Studies, University of Manitoba. Ottawa: Consumer and Corporate Affairs Canada.

Contains an annotated bibliography and summaries of research findings classified by attitude/behavior, country, year, form of energy and choice/use situation, correlates of energy attitudes, correlates of energy behavior intentions, and correlates of energy behavior.

Farahar, Barbara. 1979. Public Opinion About Energy: A Literature Review. Golden, Colo.: Solar Energy Research Institute (SERI/TR-51-155d).

Contains an extensive bibliography.

Acknowledgment is due Sally C. Lopreato and Marian W. Meriwether for their assistance in acquiring and annotating some of these studies, and to the many authors and organizations that sent us their studies. Support for this work was provided by the National Research Council, Committee on Nuclear and Alternative Energy Systems, and by the Michigan Agricultural Experiment Station.

ANNOTATED BIBLIOGRAPHY

Albrecht, Stan L. 1976. Socio-Cultural Factors and Energy Resource Development in Rural Areas of the West. Department of Sociology, Brigham Young University, Provo, Utah.

Method: A theoretical model of the sociocultural impacts of boom growth based upon social and demographic data from several communities in Wyoming and Montana facing extensive population growth due to large scale energy resource development. Secondary data are used, mostly U.S. Bureau of Census, for the years 1960, 1970, and 1974.

Variables: The effect of energy resource development upon population growth and social change in adjacent communities.

Findings: Data from the impacted communities suggest that they will experience interpersonal, family, and community social problems; problems in the delivery of social services; and impacts on the physical environment that have social implications.

Barnaby, David J., and Richard C. Reizenstein. 1975. Profiling the Energy Consumer: A Discriminant Analysis Approach. Knoxville: University of Tennessee. Summarized in Perspectives on the Energy Crisis: Gasoline Prices and the Southeastern Consumer, 1975, Survey of Business 11(1):28-31.

Method: Multivariate discriminant analysis of behavioral and attitudinal responsiveness to the energy crisis, based on a survey conducted February 1974 and repeated October 1974. Data were gathered by mail questionnaire from a random sample (N=2,500) of Columbus, Georgia; Charlotte, North Carolina; and Chattanooga, Tennessee.

Variables: The effect of the energy crisis on consumer attitudes and behavior in connection with gasoline and home heating.

Findings: Respondents were grouped and profiled according to gasoline consumption (high, medium, or low use) and heating preference levels for the home. The major factor which seems to identify the energy-conscious consumer (for both gasoline and heat) is exposure to media and source of personal information. Income was also an effective discriminator. A negative attitude toward energy conservation and pollution abatement exists among those respondents who desire to maintain the status quo. Major changes between February and October 1974 seem to be increased awareness that energy resources are running short; greater agreement that rationing will become necessary; and increased agreement with controlling home temperature by law. Also, fewer respondents agreed that oil companies which advertise their efforts to develop new energy sources are more concerned with public relations than with resource development.

Bartell, Ted. 1974. The Effects of the Energy Crisis on Attitudes and Lifestyles of Los Angeles Residents. Presented at annual meeting of the American Sociological Association, Montreal, August. Rev. as Political Orientation and Public Response to the Energy Crisis, 1976, Social Science Quarterly 57:430-436.

Method: A multiple regression analysis of a February-March 1974 area probability sample (N=1069) survey of Los Angeles County adults to determine the behavioral and attitudinal effects of the energy crisis and the likely impacts on general political orientations and public policies.

Variables: Beliefs about severity and duration of the energy crisis, feelings about who is to blame, general perceptions of governmental institutions and actors, preferences for alternate energy policies, and expectations concerning future economic conditions and employment.

Findings: The only significant predictor of personal energy conservation appeared to be an anticipated effect on one's future employment. Although some changes in basic life-style were reported, these were generally perceived as causing minimal personal difficulties. Certain demographic characteristics and energy-related expectations were significantly related to beliefs about who was responsible for the energy crisis. Blacks, women, and persons of lower socioeconomic status tended to blame the President; men and non-blacks tended to blame the oil companies. Energy policies having a negative effect on the environment were most often supported by persons more highly integrated into the social order, and the findings of this study predicts increasing support by all respondents for environmentally detrimental activities if the crisis worsens.

Barth, Michael, Gregory Mills, and Chuck Seagrave. 1974. The Impact of Rising Residential Energy Prices on the Low-Income Population: An Analysis of the Home-Heating Problem and Policy Alternatives. U.S. Department of Health, Education, and Welfare. Bethesda, Md.: Congressional Information Service (American Statistics Index Microfiche 9308-5).

Method: A study of the effect of rapidly rising residential energy prices, specifically for home-heating fuels, on the lower income population, along with an analysis of various policy alternatives to ameliorate this impact. Home heating is discussed with respect to climate, housing characteristics, fuel type, and fuel prices. Regional variations in home-heating-cost increases and the problems faced by low-income households are given special attention.

Variables: The effect of increased energy costs on the low-income population in the U.S.

Findings: There are wide variations in heating cost increases as a result of regional differences in energy price levels and in price changes, coupled with variations in climate and type of fuel used. Low-income households spend an average of more than 11% of their income on natural gas and electricity. This compares with less than 2% for households with annual incomes over $16,000. Yet the poor consume only 56% as much electricity and 82% as much natural gas as the non-poor. Home-heating needs of the poor are lower than other income classes because low-income households are generally in warmer climates, involve smaller sized homes and are less likely to be single-unit dwellings. But they also have fewer energy-saving features. The net effect is that low-income households pay in dollar amounts about three-fourths of what is spent by other households for home heating. However, while actual dollar increases will be somewhat smaller for the poor, the increases must be covered out of considerably smaller incomes.

Battalio, Raymond C., and John H. Kagel. 1976. Household Demand Responsiveness to Peak Use Pricing: Implications Drawn from Experimental Studies of Consumer Demand Behavior of Both Humans and Animals. Presented at UMR-MEC (University of Missouri [Rolla]-Missouri Energy Council) Conference on Energy, Rolla, October. Available from Department of Economics, Texas A&M University, College Station.

Method: An experimental economics approach to the study of consumer demand behavior, in particular peak-pricing responsiveness. Both human and laboratory animal experiments are brought to bear on the problem. Data are presented from several sources, including a summer 1975 experimental study of 129 College Station, Texas, residential electricity customers.

Variables: Demand responsiveness to peak-use pricing.

Findings: Experiments involving, respectively, laboratory animals and alcoholic drinkers, demonstrate that daily behavioral patterns which are seemingly unresponsive to economic contingencies do adjust when economic variables in the environment are altered. Suggestive parallels to the study of peak use of electricity are discussed. The authors believe that where demand is deferable over small periods, peak-use differentials can significantly affect electricity-use patterns, and that information feedback can contribute to that end; where demand is not transferable, e.g., for space heating and cooling, there may be substantially less smoothing of demand on response to time-of-day pricing differentials.

Battalio, Raymond C., John H. Kagel, Robin C. Winkler, and Richard A. Winett. December 1976. Residential Electricity Demand: An Experimental Study. Department of Economics, Texas A & M University, College Station.

Method: An investigation of (1) short-run price elasticities via direct price manipulation and (2) the impact of weekly feedback and written, government-prepared energy conservation materials on electricity consumption. Both facets of the study dealt with situations where space cooling was the dominant source of electricity use. A random sample (N=496) of College Station, Texas, electricity customers was drawn and yielded 129 volunteers. Meters were read once a week in the experiment phase during June-August 1975. Five groups were subjected to a two-week pretreatment period, a four-week initial experimental period, and a second six-week experimental period in conjunction with five treatments--high price rebates, low price rebates, feedback, information, and control.

Variables: The short-term price elasticities for electrical energy use in space cooling, and the effects of four treatments, involving rebates, feedback, or information, on electricity consumption for said purpose.

Findings: Electricity use declined pursuant to price rebates accompanied by feedback and information. However, these differences were not large relative to the size of price rebates. Rebate checks seemed to spur conservation after a lull in the initial experimental period. Information alone led to increased use. No differences were found between feedback condition and control. Short-run price elasticity of demand was determined to lie in the bottom quarter of previously reported estimates--between 0 and -0.15. The authors assessed the experimental results as having no positive effect on energy conservation.

Bee Angell and Associates. 1975. A Qualitative Study of Consumer Attitudes Toward Energy Conservation. Chicago: Bee Angell and Associates.

Method: A marginal frequency analysis of public attitudes and conservation behavior, with respect to the energy situation, involving interviews with a series of 10 focus groups of 8-10 people each, from four different regions of the U.S. Participants were given a cash incentive and were selected from a heterogeneous cross-section of the population. Study is ongoing.

Variables: Attitudes and conservation behaviors.

Findings: Respondents were willing to make sacrifices in energy consumption only if the need were severe and responsibility shared by all. They generally reacted to energy shortage with frustration and a sense of helplessness, felt the general public to be exploiting the situation, and tended to blame the oil companies, public utilities, "business," and the government--not the Arabs or the OPEC countries. Based on perceived U.S. technological know-how, respondents felt optimistic about the future. Since the energy situation was not regarded as critical, they were generally skeptical of suggestions for large environmental sacrifices.

Berman, M. B., and M. J. Hammer. 1973. The Impact of Electricity Price Increases on Income Groups: A Case Study of Los Angeles. Santa Monica, Calif.: Rand (R-1102-NSF/CSA).

Method: The study basically dealt with the likely effect of electricity price increases on income groups in the residential sector of Los Angeles. A model of residential electricity consumption was fitted to data provided by the L.A. Department of Water and Power for the period 1970-71. Data on population are taken from U.S. Bureau of Census tract reports, and data on climate from the U.S. Department of Commerce.

Variables: Eight income groups in Los Angeles.

Findings: Residential consumption appears to be largely dependent on household income and number of household members when the price of fuels is constant across households. Consumption of electricity was determined to be influenced most by household income, the influence increasing exponentially with income levels. Relative to income, the burden of electricity price increases was found to fall most heavily on the lowest income groups. Low-income groups (below $5,000 per annum) constituted 31% of all L.A. households at the time of the study, but only accounted for 17% of total electricity consumption. For high-income groups (over $15,000) the respective figures are 21% and 41%. The evidence indicates that low-income groups, by contrast with high-income groups, have limited ability to reduce electricity consumption.

Berman, M. B., M. J. Hammer, and D. P. Tihansky. 1972. The Impact of Electricity Price Increases on Income Groups: Western United States and California. Santa Monica, Calif.: Rand (R-1050-NSF/CSA).

Method: The effects of increased electricity prices on residential consumers of different income classes were analyzed, with the objective of estimating how a reduction in the growth rate of electricity consumption (through increased electricity prices) might be distributed among various socioeconomic groups in the residential sector. Western U.S. data are from the Bureau of Labor Statistics and the Federal Power Commission for the years 1960-61. Data for California for the year 1970 were obtained from Los Angeles area utilities. Classes were grouped according to gross household income less taxes and classes ranged from under $1,000 to $15,000 and over.

Variables: The effect of increased prices of electricity on residential consumers of different income classes, in conjunction with stock of appliances, size of household, size and volume of the housing unit and the quality of its insulation, variance in the outside temperature, price of fuels, and amount of time spent away from the home.

Findings: Consumers in the $5,000-and-over category (60% of the population in the year studied) consumed 80% of the electricity demanded by the residential sector, whereas those earning less than $3,000 (17% of the population) consumed only 6% of the total electricity demanded. For Los Angeles, 1970, the ability of low-income groups to reduce consumption of electricity was found to be lower than had been predicted by previous research, which had used highly aggregated data to predict average reduction. This suggests that the ability to reduce consumption increases with income.

Blakely, Edward J. 1976. Energy, Public Opinion, and Public Policy: A Survey of Urban, Suburban, and Rural Communities. California Agriculture 30(8):4-5. A more detailed reporting, with H. G. Schutz, is Energy, Community, and Quality of Life in California: A Survey of Urban, Suburban, and Rural Communities, 1977, Journal of Energy and Development 2(2):224-238.

Method: Urban, suburban, and rural residents of Sacramento Valley were surveyed in the spring of 1975 to determine whether place of residence affected (1) attitudes about the causes and potential consequences of the energy crisis, (2) energy-related community behavior and life-style, and (3) preferred alternatives for public policy on energy. Questionnaires were mailed to samples of metropolitan Sacramento (N=800), the nearby small city of Winters (N=600), and rural Capay Valley (N=200). The return rate pursuant to reminders was 62.5%. Results were weighted for the marginal frequency analysis.

Variables: The effect of place of residence on attitudes, behaviors, and preferences concerning the energy crisis and public policy toward it.

Findings: Respondents across residence and location classes held similar opinions on the energy crisis and its overall consequences for themselves and the nation. The real dichotomy between urban and rural respondents was with regard to the role of government in solving the problem. Rural and suburban respondents were more opposed to direct government intervention and controls than urban residents. Rationing was disapproved by all segments of the sample with rural and suburban respondents being most antagnistic.

Blevins, Audie L., Jr. 1976. Public Response to Municipally Owned Utilities in Wyoming. Land Economics 52(2):241-245.

Method: A 1972 survey was undertaken of 215 randomly selected households in five communities with municipally owned electrical distribution systems and two communities with privately owned electrical systems.

Variables: Attitudinal perceptions of municipally owned power systems.

Findings: Residents in communities with municipally owned utilities favor public power, are satisfied with the cost of electricity, and believe that public power is an equitable way to raise revenue. Respondents in communities with private power generally favor municipally owned power and are equally divided over the issue of their community entering the power business.

Blevins, Audie L., Jr., James G. Thompson, and Carl B. Ellis. 1974. Assessing the Social Impact of Energy Related Growth in Wyoming. Presented at annual meeting of the Society for the Study of Social Problems, Montreal, August. Available from Department of Sociology, University of Wyoming, Laramie.

Method: A January 1973 random sample of 219 persons, representing a cross-section of individuals in Campbell County, Wyoming, were questioned about their attitudes toward coal development in the county.

Variables: Attitudinal perceptions of social impacts of coal development.

Findings: A large percentage of the respondents is fearful of the damage strip-mining will do to the physical environment and their life-styles. Respondents would like to see strict reclamation controls instituted.

Bloom, Martin. 1975. The Effect of Rising Energy Prices on the Low and Moderate Income Elderly. Springfield, Va.: National Technical Information Service (PB-244 200/2BA).

Method: A study of the effects of energy costs on the income and expenditures of the low- and moderate-income elderly. Expenditure data are from the 1973 Washington Center for Metropolitan Studies Nationwide Sample (N=1,455) and its subsample (N=115) of poor households where the age of the head is 65 or over. Secondary data on household consumption patterns and prices were taken from U.S. Bureau of Labor Statistics documents. The climatic data are from an atlas put out by the U.S. Department of Commerce.

Variables: The effects of increasing energy costs on the elderly in the United States, particularly as related to age, income, climate and type of fuel, at the national, regional, and SMSA levels.

Findings: Nationally, the elderly poor consume less energy than any other age-income group. Energy expenditures increase gradually as income level rises for all ages combined, but for the age-group 65 and over, the increase is dramatic from the lower middle income level to the upper middle income level. There were smaller differences in expenditures across income levels for natural gas relative to electricity and gasoline. Of the three energy sources, the energy gap was greatest for gasoline. For all U.S. regions, lower income elderly couples spent a disproportionate amount of their budget on fuel and utilities, compared to similar intermediate or higher budget households. The reverse was found regarding expenditures on transportation. Elderly households spent a much higher portion of their budget for energy in colder than in warmer regions. Energy price inflation hit hardest in the New England and Middle Atlantic States, and least in the South and Southwest. Overall, the rapid rise in energy prices imposed a severe economic strain on the elderly.

Bullard, Clark W., III, and Robert A. Herendeen. 1975. Energy Impact of Consumption Decisions. Institute of Electrical and Electronics Engineers Proceedings 63(3):484-493.

Method: An attempt to determine the energy cost of goods and services was largely based upon a 360-sector input-output analysis of the U.S. economic system. The model is applied to illustrative problems, including (1) total energy cost of an automobile and an electric mixer, (2) energy impact of urban bus and auto transportation, (3) total energy impact of a family's expenditures, (4) energy and labor impacts of government spending, (5) industrial energy dependence, (6) national import-export energy balance, and (7) an energy-conservation tax. Secondary data are used and are taken from various statistical sources for the year 1963.

Variables: The direct and indirect effects of consumption decisions in selected sectors of the economy on energy consumption.

Findings: A set of tables summarize results of the analyses of the seven problems listed above. Regarding the energy impact of a family's expenditures, for the lowest income group, energy purchases account for two-thirds of the total purchases, while for the highest income group, the fraction drops to one-third. Estimates of the impact of direct energy use only might therefore be misleading.

Bultena, Gordon L. 1976. Public Response to the Energy Crisis: A Study of Citizens' Attitudes and Adaptive Behaviors. Department of Sociology, Report No. 130. Ames: Iowa State University.

Method: A random sample interview survey of 190 persons from different socioeconomic groups in Des Moines, Iowa. Questions focused on attitudinal and behavioral responses to the 1974 energy crisis. Differences between three groups were tested for statistical significance using Chi Square.
Variables: Attitudinal perceptions of the crisis, impact of shortages on behavioral patterns, socioeconomic effects, and sociopolitical actions of respondents, all references to upper (N=56), middle (N=74), and lower (N-60) class groups.
Findings: Most respondents attributed shortages to the actions of large oil companies, not to dwindling energy reserves. Middle and lower class respondents more often blamed activities of large oil companies and concomitant government favoritism. Upper class respondents tended to perceive the energy shortage in terms of dwindling energy reserves. More upper class, than middle or lower class, persons reported taking energy conservation measures. Upper class respondents emphasized environmental quality goal, whereas lower class respondents reported a major interest in keeping energy prices down.

Burdge, Rabel J., Paul D. Warner, and Susan D. Hoffman. 1976. Public Opinion on Energy. Department of Sociology, University of Kentucky, Lexington. Available from Institute for Environmental Studies, University of Illinois, Urbana.

Method: Marginal frequency analysis of opinions on various energy conservation and utilization measures based on a statewide survey taken in Kentucky (N=3,438).
Variables: Energy use for transportation, home consumption; new energy sources; government regulation of energy use.
Findings: Respondents were willing to accept energy conservation measures in personal transportation and home use, and to support the development of new energy sources with government funding.

Buttel, Frederick H. 1978. Social Structure and Energy Efficiency: A Preliminary Cross-National Analysis. Human Ecology 6(2):145-164.

Method: Data for circa 1965 are taken from UN publications. The cross-national analysis includes 118 nation-states and employs multiple correlation and regression analysis. A ratio of gross national product in U.S. dollars to total inanimate energy consumption (in kg coal equivalents) is used as a measure of energy efficiency.
Variables: Effect of level of production (GNP per capita), division

of labor outside of agricultural sector (percentage of gross domestic product from the agricultural sector--an inverse indicator), urbanization, level of defense expenditures, territorial size, and population density on energy efficiency.

Findings: Level of production, division of labor outside of the agricultural sector, and population density exhibit substantial inverse relationships with energy efficiency. Territorial size bears little bivariate relationship to cross-national patterns of energy efficiency, but proves to have a discernible inverse relationship at the multivariate level. Level of defense expenditures and urbanization have substantial bivariate relationships wth energy efficiency; these variables, however, have only small multivariate relationships with the dependent measure.

Buttel, Frederick H. 1977. Agricultural Structure and Energy Intensity: A Comparative Analysis of the Developed Capitalist Societies. Presented at annual meeting of the Rural Sociological Society, Madison, Wis., September.

Method: A test of the hypothesis that energy use in the agricultural production sector is of great importance in shaping the overall energy intensity of developed capitalist nations. UN data is analyzed for 25 developed market economies (as defined by the United Nations) for the year 1965. Four indicators of agricultural organization are identified and their product-moment correlations established.

Variables: The percentage of the labor force in agriculture, agricultural share of GDP (Gross Domestic Product), mechanization, and average farm size.

Findings: The four indicators of agricultural structure are found to be highly intercorrelated. Agricultural composition of the labor force and economy proved to be inversely related to energy intensity, while mechanization and average farm size were positively related. Agricultural share of the GDP was the agricultural structure variable most closely associated with energy intensity, and had substantial direct effects on the dependent variable when per capita GNP and urbanization were held constant. The multivariate impacts of the other agricultural structure variables were less clear because of multicollinearity and parameter estimation problems. The author concludes that agricultural structure seems to have broad implications for energy use in the developed capitalist societies, extending far beyond resource use in the agricultural production sector itself.

Cartee, Charles. 1976. Solar Energy Installations: Trends and Lender Attitudes. Journal of Property Management 41(1):21-28.

Method: A marginal frequency analysis of representatives of lending institutions attitudes toward solar heating and cooling of residences and the feasibility of advancing funds for same, based on a questionnaire survey (N=300).

Variables: Lender attitudes toward solar heating and cooling with respect to fuel savings, reliability, insurability of home, etc., as well as toward their feasibility for making a loan.

Findings: Nearly three-fourths believed solar energy would represent a feasible alternative energy source for heating and cooling of single-family residences during the next ten years. Financiers indicated a preference for making loans on solar homes. Concern was expressed about the expected life of solar equipment and the associated maintenance costs.

Carter, Lewis F. Ongoing. Interactive Monitoring System for Evaluating Energy Policy Effects on Private Nonindustrial Consumption. Social Research Center, Washington State University, Pullman.

Method: A continuously updated interactive data retrieval system as established to monitor consumer energy conservation and the effects of energy shortages and policies. A rotating panel design with six panels is selected each year from a random area stratified sample (N=3,100) of Washington state residents. An examination is made of differences in matched time-lag changes, displacement of time series data, and perturbations within specific periods. Data are from utilities, interviews, and questionnaires.

Variables: Changes in consumer conservation attitudes and behaviors pursuant to changes in energy policy and availability.

Findings: Not yet reported.

Center for Rural Affairs. 1979. Small Farm Energy Project, the First Two Years: A Preliminary Report on the First Two Years' Experience in a Three-Year Research and Demonstration Project. Prepared for the U.S. Community Services Administration. Walthill, Nebr.: Center for Rural Affairs.

Method: A 39-month study being conducted in Cedar County, Nebr., "to demonstrate the impact of proven energy innovations and conservation technologies on the energy use, cost of production, and net incomes of small, low-income farmers." Fifty family farms that volunteered were divided into an experimental group of 25 and a control group of 25.

Variables: The effect of information and assistance on family farmers' willingness to adopt energy-saving practices and technologies.

Findings: Preliminary findings indicate that farmers will adopt innovative energy technologies if given technical assistance and, in the case of the costlier technologies, if costs can be shared.

Cohen, Reuben. 1976. Setting Equitable National Goals for Household Energy Conservation. Presented at annual meeting of the American Sociological Association, New York, August.

Method: A study of two specific conservation levels, or targets, for electricity and natural gas. These conservation targets are based on an analysis of the distribution of energy consumption by households in the U.S., using data obtained through personal interviews from a May-June 1973 national probability sample (N=1,500) of households. Low-income households were oversampled and weighting procedures were used to compensate for the disproportionate sampling. Data were also obtained from utilities for one-third of the sampled households. A multiple regression analysis determined the major factors which affect energy use by households.

Variables: The effects of household and climatic characteristics on consumption of natural gas and electricity. Also the potential for energy conservation in relation to specific targets based on the effects established.

Findings: About one-third of the variation among households was explained by factors including size of household, use of fuels for such essentials as hot water and cooking, and climatic conditions. The top income group used about 50% more natural gas and 160% more electricity per household than the lowest. Author relates these findings to target #1 (that U.S. households consume no more energy than the average reported in 1972-73 for households with their characteristics) and finds that 18% of electricity and 13% of natural gas consumption could be conserved. Overall, the biggest per-household share of the savings would have to come from upper income groups. Target #2 (that households occupy no more than the median number of rooms reported for households of the same numbers of persons, and consume no more energy than the average reported for households of that type) would entail a similar savings, requiring a disproportionate reduction by upper income groups because of the more discretionary expenditure for living space at upper income levels.

Connecticut Power and Light Co., Hartford. 1976. Experimental study reported by Associated Press in New York Times, August 21.

Method: A federally funded experiment to determine if home users of electricity would change their life-style to reduce their power bills. This year-long experiment began October 16, 1975, and entailed 239 residential customers of Connecticut Power and Light, representing a wide range in level of demand. Of these, 40 constituted the control group. Each home was outfitted with a meter to record use during 15-minute segments. Subjects were presented with a much higher price (16 cents per kilowatt-hour) during peak demand periods and a reduced rate (1 cent per kilowatt-hour) during power lulls. A 3-cent-per-kilowatt-hour levy obtained during the rest of the day, on weekends, and on designated holidays. These rates were applied January-March 1976.

Variables: The effect of pricing incentives and disincentives on peak-period use of electricity by residential customers.

Findings: Few customers in the experimental group significantly changed their power use during the warmer months, but nearly all used less electricity during peak periods in winter than did the control group or the average company customer.

Cook, Stuart W., Lou McClelland, and Laura Belsten. Ongoing. Encouraging Energy Conservation in Master-Metered Buildings. University of Colorado, Boulder.

Method: An experiment on how to encourage occupants to conserve energy when they do not directly pay their energy bills. A management and a user method, the former involving a leader and the latter, occupant participation, are contrasted in four pairs of University of Colorado office-classroom buildings and in three pairs of dormitories. In a second study, one a pair of married student apartment complexes will institute a program of rewards (lottery tickets) for residents found in random checks to have their thermostats set below a specified level. The second complex will serve as the control. Actual use after implementation will be compared through multiple regression, with predicted use.
Variables: The effect of management and user-oriented methods on energy consumption by occupants of master-metered office and residential apartment buildings.
Findings: Not yet reported.

Cook, Stuart W., Lou McClelland, Nancy Wascoe, and Laura Belsten. Ongoing. A Comparison of Three Methods of Encouraging Homeowners to Install Insulation. University of Colorado, Boulder.

Method: An experiment which seeks to determine what type, or combination of types, of persuasive communication is most effective in encouraging homeowners to install attic insulation. The subjects are firemen who own homes in the Denver metropolitan area. Either 2x2x2 analyses of variance or chi-square analyses are used to evaluate attitudes and behavioral intentions, acceptance of insulation inspection, and actual installation of insulation.
Variables: The effect of seven types of communications, e.g., an "energy crisis" appeal or an economic appeal, on subject's willingness to install insulation.
Findings: Not yet reported.

Corr, Michael, and Dan MacLeod. 1972. Getting It Together. Environment 14(9):2-10.

Method: A 1972 study of energy and life-style using a questionnaire on energy consumption habits, administered to 12 communes totaling 116 members in the Minneapolis area.
Variables: The effect of communal living on consumption of natural gas, electricity, and gasoline, and on energy use in appliances and automobiles.
Findings: Communal life-style appears to entail substantially lower personal energy consumption than the average for households nationally and in the Minneapolis area.

Cunningham, William, and Sally Cook Lopreato. 1978. Energy Use and Conservation Incentives: A Study of The Southwestern United States. New York: Praeger.

Method: Statistical analysis of a fall 1975 random sample (N=10,000) survey of five Southwest cities. The survey was accomplished by a mail questionnaire and an examination of billing records. A subsample (N=801) of all-electric users in Austin, Texas, was drawn in spring 1976. The purpose of the study was to identify attitudes and behavior across diverse groups of individuals and to relate these findings to conservation incentives.

Variables: Energy attitudes and behavior with respect to socioeconomic variables.

Findings: Respondents generally acknowledged the existence of a national energy problem; 89 percent believed that major difficulties will result during the next five years and 75 percent expressed this view when asked about the next 20 years. Although responsibility was widely assigned, blame was more frequently placed with the consumer than anywhere else. Subjects discussed the energy problem with a variety of people yet were reluctant to complain to either public or private officials. Substantial efforts to conserve were acceptable if they would not involve a great monetary investment or reduce living standards. Those generally found to be more energy conserving include low-income groups, the less-educated, minority races and ethnic groups. Middle-income consumers appear to be most responsive to economic incentives to conserve energy. This group showed a greater propensity to respond to price increases than did the lowest or highest income groups. The middle-income group seemed most amenable to guaranteed loan programs and were willing to wait longer for payback of home improvement investments. Creative measures appear necessary to get upper-income consumers to conserve.

Curtin, Richard T. 1976. Consumer Adaptation to Energy Shortages. Journal of Energy and Development 2(1):38-59.

Method: A multiple classification analysis of conservation behavior, attitudes, and motivations based upon a fall 1974 random sample (N=1,400) interview survey of family heads or spouses drawn from the 48 contiguous states of the U.S.

Variables: The effect of the energy crisis on conservation behavior with respect to the consumption of gasoline, electricity, and home heating.

Findings: Widespread conservation did occur, but there was an almost equally widespread prospect of difficulty in making future adjustments. Moreover, differences in past experience and expected difficulty were highlighted by the substantial numbers of respondents who report patterns of adaptive or maladaptive adjustments in their energy consumption: while fully one-third of all respondents said they have conserved in the past and could do so again without difficulty, one-fourth said they did not conserve and could not do so without great difficulty.

Doering, O. C., Jerry Fezi, Dave Gauker, Mike Michaud, and Steve Pell. 1974. Indiana's Views on the Energy Crisis. Cooperative Extension Service, Paper No. 6. West Lafayette, Ind.: Purdue University.

Method: Marginal frequency analysis of 670 randomly selected Indiana residents responding to a questionnaire concerning public attitudes toward the 1973-74 energy crisis.
Variables: Attitudinal perceptions; behavioral patterns.
Findings: Although the results indicate substantial adjustments in the home and some changes in personal transportation habits due to energy shortages, only 36% of the respondents indicated that the crisis had any real effect on their life-styles.

Donnermeyer, Joseph F. 1977. Social Status and Attitudinal Predictors of Intentions Toward Practicing Energy Conservation Measures and Energy Consumption Behavior. Department of Sociology. Lexington: University of Kentucky. Summarized in Social Status and Attitudinal Predictors of Residential Energy Consumption, presented at annual meeting of the Rural Sociological Society, September 1-4, 1977, Madison, Wis. Available from Department of Sociology, Purdue University, West Lafayette, Ind.

Method: An analysis of the consistency between attitudes, intention, and behavior through an examination of the social status and attitudinal predictors of willingness to practice energy conservation measures and of the actual energy consumption in the home. Data are from a statewide random sample survey (N=3,438) of Kentucky, gathered by mail questionnaire. The survey determined respondents' attitudes toward a number of issues, including environmental concerns. A subsample involving Fayette County, in conjunction with data from utilities, was used to assess energy consumption. Data are analyzed using stepwise correlation and regression.
Variables: Income, education, occupation, attitudes toward a series of environmental issues, and willingness to practice energy conservation measures.
Findings: A majority of respondents agreed that there should be conservation regulations, including a special tax on automobile manufacturers who produce low mileage vehicles. Less than one-fourth were willing to approve of a change in the school schedule. Overall the respondents tended to be in favor of conservation. Ninety percent were willing to turn down the thremostat in winter, but only 55% would cut back on the use of air conditioner, a disposition that reflects Lexington's mild winters and hot summers. Examination of the correlation coefficients between items within the attitude and behavior sets demonstrated that there are few significant associations. A positive correlation was found between residential energy consumption and income, white-collar occupation, and formal years of schooling--in other words, with social status. The strongest correlate of daily consumption was size of house. Correlations are also reported for standardized daily consumption by size of house per number of household members.

Duncan, Otis Dudley. 1976. Sociologists Should Reconsider Nuclear Energy. Rev. ed. of first annual Amos H. Hawley lecture at the University of Michigan, Ann Arbor. Also in Social Forces 57(1):1-22.

Method: A review of work by sociologists on nuclear energy, followed by an evaluation of selective historical developments. Recent work on the public acceptability of nuclear power is summarized in this context.
Variables: The performance of sociologists in research on the social aspects of nuclear power.
Findings: Sociologists' forecasts have generally been naive, and off target. Sociologists have performed badly in matching forecasts with outcomes and in diagnosing discrepancies. An illustrative analysis of one facet of public opinion on nuclear issues--public acceptability--reveals a four-way interaction: (1) response to item, (2) how controversial the item is, (3) how much confidence one has in one protagonist, and (4) how much confidence one has in the other protagonists, all in connection with an intensely argued public controversy. Author concludes that although improved social forecasts are desirable, a higher priority should be reliable findings and cogent analyses of the social costs and benefits of alternative energy futures, couched in sociological theory and modern research practice.

Dunlap, Riley E., and Kenneth R. Tremblay, Jr. 1976. Hard Times and Human Concerns: Assessing Probable Reactions to Scarcity. Presented at joint session of the Rural Sociological Society and the Society for the Study of Social Problems at their annual meetings, New York. Available from Department of Sociology, Washington State University, Pullman.

Method: Panel survey (summers of 1970 and 1974) of a sample of 3,101 Washington State residents to determine any changes in their priorities for funding government programs.
Variables: Changes from 1970 to 1974 in attitudes toward the allocation of government funds for government programs in personal security, public services, social justice, and environmental quality.
Findings: There was a trend toward increased support for personal security programs, e.g., retirement benefits, health and medical care, and social security benefits, but a decline in concern for social justice, environmental quality, and the public good.

Early, John F. 1974. Effect of the Energy Crisis on Employment. Monthly Labor Review 97(8):8-16.

Method: Marginal frequency analysis of the impact on employment of the energy shortage during November 1973, to March 1974, using data from the payroll survey of the Current Employment Statistic program, an analysis of its monthly employment estimates and labor turnover data for manufacturing, and unemployment estimates from the current population survey of households.
Variables: The effects (direct, negative indirect, positive indirect, and tertiary) of the energy crisis on employment in the U.S. economy. The four types of effects relate, respectively, to the inability of establishments to obtain the power needed for operation, to

reduction of goods and services output, to increased demand for alternative fuel sources and equipment needed for extraction, and to reductions in aggregate demand due to layoffs.

Findings: The most obvious direct effect was gasoline service station closings and reduced hours. Other direct effects were well scattered, but involved an estimated 150,000 and 225,000 jobs lost from November 1973 to March 1974. For the same period indirect effects entailed a total employment decline of 310,000, more than half of this in the manufacture of automobile parts. Increased unemployment was heaviest among adult men, especially the 20-24 age-group. The employment decline was smaller than those in major employment slowdowns and was also more concentrated in a few industries.

Eastman, Clyde, Peggy Hoffer, and Alan Randall. 1974. A Socioeconomic Analysis of Environmental Concern: Case of the Four Corners Electric Power Complex. Agricultural Experiment Station, Bulletin 626. Las Cruces: New Mexico State University. Also in Public Opinion Quarterly 38:574-584.

Method: A study to determine socioeconomic characteristics associated with concern for environmental quality, measured by willingness to pay for pollution abatement. Five bidding games were designed to obtain monetary estimates of willingness to pay for pollution abatement, and utilized in interviews of a target sample (N=760) of reservation and nonreservation residents, and out-of-region recreationists, conducted during the summer of 1972 and January 1973. The sample was drawn from the four-state air-quality control region in the southwest U.S.

Variables: Willingness to pay for pollution abatement as determined by bidding games and as related to demographic and socioeconomic factors.

Findings: A clear majority of respondents were willing to pay for pollution abatement. A large majority also preferred that companies bear responsibility for financing the costs of abatement. Few consistent relationships were found between concern for environment and socioeconomic characteristics such as age, occupation, income, ethnicity, and organizational participation. Aesthetic concern had little assocaition with social stratum.

Eichenberger, Mary Ann. 1975. A Comparison of Ownership of Selected Household Appliances and Residential Energy Use by Employed and Nonemployed Homemakers in the Lansing, Michigan, Area. M.A. thesis, Department of Family Ecology, Michigan State University, East Lansing.

Method: A 1974 self-administered questionnaire and interview survey of families in the Lansing SMSA to assess residential energy use. Data were drawn from a random sample (N=187) and analysis of covariance was the mode of analysis.

Variables: The effects of employment status and income on direct residential energy consumption, and on appliance use by function and quantity.

Findings: No significant difference was found among full-time, part-time, and nonemployed homemakers on total quantity of appliances and of major appliances owned by households. The test of a hypothesis concerning total direct residential energy revealed no significant difference among these three employment status groups of homemakers. A nonsignificant but interesting finding was that a fully employed homemaker used 8% less, and part-time 6% less, residential energy than nonemployed homemakers.

Foxx, R. M., and D. F. Hake. 1977. Gasoline Conservation: A Procedure for Measuring and Reducing the Driving of College Students. Journal of Applied Behavior Analysis 10(1):61-74.

Method: This attempt to motivate college students to reduce driving, and thus save gasoline, utilized students from two psychology classes at a commuter college. The students were divided into an experimental and a control group. The experimental group was offered prizes, a tour of a mental-health facility, car servicing, and a university parking sticker as inducements to reduce driving. The values of prizes were scaled to match appropriate reductions in driving. Data were gathered by reading odometers, and special precautions were used to detect alterations.

Variables: The effect of several inducements on college student driving behavior.

Findings: The experimental subjects reduced their average daily mileage by 20 percent over the initial baseline. No change was observed in the control group. The authors conclude that some drivers can be motivated by reinforcement to reduce their driving.

Freudenburg, William R. 1976. The Social Impact of Energy Boom Development of Rural Communities: A Review of Literature and Some Predictions. Presented at annual meeting of the American Sociological Association, New York, August. Available from Department of Sociology, Washington State University, Pullman.

Method: Summary of the largely fugitive literature on the social impacts of energy boomtown development. Several hypotheses are proposed for future research on the nature and severity of impacts.

Variables: Size of host community, size and suddenness of development, proportion of jobs going to "locals," skill requirements of new jobs, number of new (unemployed) persons entering a region, the unemployment rate outside the region, and notoriety of the project outside of the region, in relation to the amount of social disruption caused by energy development of rural communities.

Findings: No concrete findings are reported, but the following hypotheses guide the author's ongoing study of energy boomtown development: (1) Size of host community being held constant, social disruption will be directly related to both the size and the suddenness of development. (2) Given a particular development, the lower the population density of the host region, the greater the disruption. (2a) Impact will be inversely proportional to the local unemployment rate. (3) The higher the proportion of jobs going to persons already living within the area, the lower the disruption. (3a) The higher the skill requirements, the greater the disruption. (4) Impact will be directly proportional to the number of new (unemployed) persons entering a region, and will vary directly with (4a) the unemployment rate outside the region, and (4b) the general notoriety of the project outside the region.

The author is conducting a questionnaire study (N=800) of energy growth/potential growth towns of Colorado, with plans to employ a panel design (reinterview) at a later time. This questionnaire is the primary methodological device to be used to test the hypotheses given above.

Gilmore, John S. 1976. Boom Towns May Hinder Energy Resource Development. Science 191:535-540.

Method: A qualitative appraisal, based on the author's socioeconomic-impact study of coal and oil shale boomtowns, of the effects of rapid growth associated with energy resource development. A typology of the boomtown is used to assess its functions and problems.

Variables: The socioeconomic effects of the rapid growth accompanying energy resource development.

Findings: The boomtown is a major source of social tension in an area or a region. Both litigation and legislation result, with confrontation between state and federal governments a likely outcome. When communities are unable to furnish the services and facilities to accommodate rapid growth or to maintain the amenities of life, productivity declines, projects overrun time and cost schedules, and operating outputs fall behind.

Goen, Richard L., and Ronald K. White. 1976. Comparison of Energy Consumption Between West Germany and the United States. Springfield, Va.: National Technical Information Service (PB-245 652/3BA).

Method: Analysis of the differences in per capita energy consumption between the United States and West Germany. Most comparisons are for 1972, the latest year for which sufficient data were generally available. Data are presented in the form of tables.

Variables: The per capita use of energy in the sectors of transportation, industry, utilities, residential, commercial, exports and imports, and total of all sectors by the U.S. and West Germany.

Findings: West Germany uses only half as much energy per capita as the U.S., for transportation only one-fourth, for residential space heating (climate corrected) one-half, for other residential uses one-fourth, and for industrial uses 58 percent of that of the U.S. The U.S. uses at least 40 percent more energy for industry in relation to output as West Germany. Total energy use in the U.S. in relation to national income is about 50 percent greater than in West Germany. The authors of the study are disposed to conclude that continued economic growth and improvement in the standard of living in the U.S. should be possible without a proportionate increase in energy consumption.

Gollin, Albert E., Shirley J. Smith, and JoAnne S. Youtie. 1976. Energy Consumers' Awareness and Preferences in New Hampshire: A Comparative Assessment. Washington, D.C.: Bureau of Social Science Research.

Method: A marginal frequency analysis of a random sample of New Hampshire households (N=256) surveyed by telephone interview between April 30 and May 2, 1976, to determine energy consumers' awareness and preferences with an eye toward establishing the degree of comparability to the relationship between residents and energy consumption in neighboring states.

Variables: Population, housing, climatic conditions, appliance saturation, consumer concern and awareness, household routines and time-of-day pricing, and acceptance of time-of-day pricing.

Findings: Respondents were found to be concerned about energy, especially for home heating and electrical appliance use. They were usually aware of the main aspects of the pricing system now in use in the state, and a substantial number seemed prepared to consider significant changes in their household routines in order to take advantage of a favorable alternative-pricing scheme.

Gottlieb, David. 1974. Sociological Dimensions of the Energy Crisis. Austin, Tex.: Governor's Advisory Council (Project E/S-5).

Method: Statistical analysis (frequencies, crosstabs, chi square) of a random sample of housing units from urban (Houston, Amarillo) and rural (Colorado County, Deaf Smith County) areas of Texas to discern perceptions, attitudes, behavior, and expectations in response to the energy crisis. The pre-embargo (April-May 1974) sample is of South Texas and the post-embargo (June-July 1974) sample of North Texas. The urban sample is based on year-round housing units from census block data tapes. The rural sample was derived from names and addresses on county tax rolls. Data were gathered from heads of household by hand-delivered questionnaires.

Variables: The effects of the energy crisis on the communities sampled with respect to three categories of socioeconomic status, an energy-knowledge scale, and a measure of energy consumption.

Findings: The only major difference found between the two regional samples was a greater concern about anticipated escalating costs of energy expressed by the post-embargo (North Texas) sample. Both samples failed to see the energy crisis as of long-term consequence; showed distrust of energy producers, distributors, and government officials connected with energy policies and programs; felt citizens are energy wasteful; and did not blame environmentalists. Lack of knowledge about energy sources and appliance energy-consumption characteristics were found to be correlated with lack of belief in the crisis. The poorest people seem to be affected most because they have the fewest alternatives. Consensus about waste was not accompanied by voluntary-conservation sentiments. Respondents believed that the more real the perception of the crisis or emergency, the more responsible the populace would become, and that the shortage was more a political contrivance than the result of the world running out of fuel.

Gottlieb, David. 1978. Texans' Responses to President Carter's Energy Proposals. In Warkov (1978), pp. 33-44.

Method: Marginal frequency analysis of a statewide random sample of Texas adults (N=493) drawn during the weekend of 24-25 April 1977 following President Carter's national energy address. Appropriate comparative data are presented from two earlier surveys conducted by the Energy Institute at the University of Houston.
Variables: Respondents' opinions with regard to President Carter's energy proposals.
Findings: A majority (62%) heard at least one of the President's energy-related talks during the week of April 18-23, 1977. College graduates, older respondents, and those with annual incomes in the $10,000-$15,000 range more often reported hearing one of these talks.

A majority (64%) have become convinced that our nation is confronted by a long-term energy crisis (compared to 28% in the 1974 survey and 37% in the 1975 survey).

Urbanites, the more affluent, males, and college graduates were the respondents most likely to endorse the notion of a long-term energy crisis in all three surveys. When asked about the cause of the crisis, 90% agreed that "the American people waste too much energy in needless consumption." A majority also expressed the beliefs that the world is running out of fuel supplies, that the U.S. has exported too much fuel overseas, and that the crisis is caused by the scheming of oil companies. Only a minority perceived environmentalists as playing a major contributory role. Respondent reactions to specific proposals by the President are detailed, including assessments of their fairness.

The proposals were regarded as unfair to Texans and the poor, and of greatest benefit to industry and the more affluent, with an even balance as to equity for consumers.

Gottlieb, David, and Marc Matre. 1975. Conceptions of Energy Shortages and Energy Conserving Behavior. Presented at annual meeting of the American Sociological Association, San Francisco, August. Available from Energy Institute, University of Houston.

Method: Marginal frequency analysis of randomly selected heads of households (N=782) in four different geographic areas of Texas, via questionnaires administered during and shortly after the Arab oil embargo of Spring 1974.
Variables: Attitudinal conceptions toward the energy crisis; behavioral patterns concerning energy conservation.
Findings: A large percentage of the respondents expressed skepticism regarding the reality of the energy crisis as well as a high level

of distrust of energy-producing corporations and of leadership in the national government. Those of lower socioeconomic status more often reported conservation efforts, especially in response to rising utility costs, than those of higher socioeconomic status.

Gottlieb, David, and Marc Matre. 1976. Sociological Dimensions of the Energy Crisis--A Follow-up Study. Energy Institute. Houston: University of Houston.

Method: Statistical analysis of a follow-up questionnaire, administered April-June 1975 on the sample described above under Gottlieb, 1974, to determine the extent of change in energy-conservation behavior, attitudes, and values from the 1974 study.
Variables: The effects of the energy crisis on the communities sampled with respect to three categories of socioeconomic status, an energy-knowledge scale, and a measure of energy consumption.
Findings: The majority of respondents have come to accept the proposition that the world is running out of fuel and that Americans are wasteful, but there was only a slight increase in belief in a serious, long-term energy crisis. No positive relationship was found between belief and energy-consuming behavior. The main motivation of those who conserved was cost. Thus, while higher socioeconomic status persons were more likely to believe in the crisis, lower and middle status people were more likely to reduce energy usage. As in 1974, the majority was not energy and conservation knowledgeable, was only willing to endure policies which would cause the least disturbance in life-style, and largely blamed big oil companies for the crisis.

Grier, Eunice S. 1976. Changing Patterns of Energy Consumption and Costs in U.S. Households. Presented at Allied Social Science Association meeting, Atlantic City, September. Available from Washington Center for Metropolitan Studies, Washington, D.C.

Method: A report on the findings of two consecutive national surveys, conducted by the Washington Center for Metropolitan Studies, which examine the responses of U.S. households to increasing energy costs. Each was a random sample cross-section survey, the first (N=1,600) done in the spring of 1973 and the second (N=3,200) during the spring of 1975.
Variables: The effect of increased energy costs on household behavior and perceptions in conjunction with energy-related practices.
Findings: An energy-conservation ethic is beginning to take hold among U.S. households, but efforts to conserve are as yet meager. Although residential energy costs have risen rapidly, they remain a relatively small portion of the average U.S. household's budget. However, for certain categories of households--e.g., the poor and the elderly--this rising cost is a serious and growing burden.

Hannon, Bruce. 1975. Energy Conservation and the Consumer. Science 189:95-102.

Method: Data evaluation in connection with three conservation "dilemmas": (1) the substitution of energy for labor; (2) the relation between personal income and energy use; and (3) the respending of saved dollars as a function of energy use. Secondary data from U.S. Department of Commerce, Edison Electric Institute, and other sources for various years from 1925 to 1975.
Variables: The effect of economic activities on the energy intensity of dollar flows.
Findings: (1) When wages increase relative to costs, then energy use increases through the process of mechanization. (2) Energy use and income are linearly connected such that the spending of an average additional dollar of income demands nearly the same amount of energy, regardless of one's income level. (3) Saving energy usually means saving money--the respending of which reduces, if not eliminates, the energy first thought saved. Given the interactions shown for these three dilemmas, it is argued that there are probably no popularly acceptable solutions to energy conservation.

Hannon, Bruce. 1975. Energy, Employment, and Transportation. World Resources: The Forensic Quarterly 49(4):497-511.

Method: An estimate of the impact of transportation systems on energy use and on employment, using an input-output model. U.S. data for 1963 to 1967 are used in this study.
Variables: Dollar-flow values from 362 sectors of the U.S. economy transformed into energy-flow values.
Findings: In general, the slower the mode of transportation, the less energy intensive it is. Cars and airplanes are more energy intensive than buses, and trucks more so than trains.

Hass, Jane W., Gerrold S. Bagley, and Ronald W. Rogers. 1975. Coping with the Energy Crisis: Effects of Fear Appeals Upon Attitudes Toward Energy Consumption. Journal of Applied Psychology 60(6):754-756.

Method: A 2 x 2 factorial experiment conducted in 1975 which examines the persuasive effect of two communication variables--(a) the magnitude of noxiousness of a threatened event and (b) the probability of its occurrence--in connection with an energy crisis. The subjects were 60 students enrolled in undergraduate business courses. Analysis of variance was used to establish main and interaction effects.
Variables: High versus low magnitude of noxiousness of a potential energy crisis and high versus low probability of that event's occurrence.
Findings: Although increases in the perceived likelihood of an energy shortage had no effect, increments in the perceived noxiousness or severity of an energy crisis strengthened intentions to reduce energy consumption. This suggests that informational programs should stress the severity of the problem.

Hayes, Steven C., and John D. Cone. 1977. Reducing Residential Electrical Energy Use: Payments, Information, and Feedback. Journal of Applied Behavior Analysis 10:425-435.

Method: Monetary payments, energy information, and daily feedback of consumption rates were utilized in this attempt to reduce electricity consumption in four units of an 80-unit housing complex for married students at West Virginia University. The study was conducted from late January to mid-May 1975. Because the complex has a master-meter it was necessary to install separate watt-hour meters. A combined multiple-baseline and withdrawal design was used to permit comparisons both within and between units.
Variables: The effects of three techniques--payments, information, and feedback--on consumption of electricity by volunteer families in a master-metered apartment complex.
Findings: Payments produced immediate and substantial reductions in electricity consumption in all four units. This relationship held even when the amount of the payments was substantially decreased. Feedback also resulted in conservation. However, information about both ways to conserve and the typical dollars and cents cost of using various appliances did not. In general, combinations of payments, and either information or feedback, were found to produce no greater effect than payments alone.

Heberlein, Thomas A. 1975. Conservation Information: The Energy Crisis and Electricity Consumption in an Apartment Complex. Energy Systems and Policy 1(2):105-118.

Method: A study of the effect of informational material designed to either increase or decrease the amount of electricity use in an apartment complex (N=96 apartments) near Madison, Wisconsin, March and April 1973. Materials were mailed to three groups but not to a fourth, the control group, during March. A time-lapse experiment was then conducted using daily meter readings over a 30-day period.
Variables: The effects of three types of information on electricity consumption by residents of an apartment complex.
Findings: Neither the energy crisis nor the attempt to "engineer" a behavior change influenced electricity consumption in these apartments. A follow-up 1 year later, and after the Arab oil embargo, found that no significant change in consumption had occurred.

Herendeen, Robert A. 1974. Affluence and Energy Demand. Mechanical Engineering 9(6):18-22.

Method: Input-output analysis of 1960-61 Bureau of Labor Statistics Consumer Expenditure Survey data for 368 sectors of the U.S. economy (aggregated to 97) in order to evaluate direct and indirect energy needs of three income classes.
Variables: The effect of income (measured by three classes) on seven consumption categories, i.e., direct energy purchase, food and water, housing and clothing, auto purchase and maintenance, medical

and education, transportation and recreation (besides auto), and investment.

Findings: The importance of indirect energy impact increased with income. Two-thirds of energy use was indirect for the highest income classes, one-half for all consumers. Author concludes that a flat-rate energy tax would be less regressive than one only on direct uses.

Herendeen, Robert A., and Anthony Sebald. 1975. Energy, Employment, and Dollar Impacts of Certain Consumer Options. In Ford Foundation Energy Policy Project Report: The Energy Conservation Papers, ed. Robert H. Williams, pp. 131-170. Washington, D.C.: Ford Foundation.

Method: An examination of energy-conservation opportunities in switching from one transport mode to another, using input-output analysis. Energy and dollar costs are calculated, along with employment impacts, for both intercity and urban transport modes. Secondary data are taken from various statistical sources for the years 1963 and 1971.

Variables: Per-mile values for dollars, Btu, and person-years.

Findings: The more labor-intensive, less energy-intensive, and more economical transportation modes were rail for intercity travel and buses for urban travel. For intercity travel the modes in order of increasing energy intensiveness were train, car, and plane, although car and train were sometimes nearly equal. Urban bus travel costs 52% more money, used 42% less energy, and was twice as labor intensive as urban car travel on a per-passenger-mile basis when total actual user costs are compared.

Herendeen, Robert, and Jerry Tanaka. 1976. Energy Cost of Living. Energy 1(2):165-178.

Method: Evaluation of energy requirements of household expenditures for all products from the 1960-61 Consumer Expenditure Survey of the Bureau of Labor Statistics (N=13,000), using input-output analysis.

Variables: Socioeconomic variables, e.g., income, number of members, location, and age of family head, as related to household energy requirements and expenditures.

Findings: Within error bounds, one universal curve shows the dependence of energy impact of expenditures for households of two through six members. A typical poor household exerts about 65% of its energy requirements through purchases of residential energy and fuel. This fraction drops to 35% for an affluent household.

Hirst, Eric, and John C. Moyers. 1973. Efficiency of Energy Use in the United States. Science 179:1299-1304.

Method: A review of 1970 energy use in transportation, space heating, and air conditioning to ascertain possibilities for conservation. Secondary data gathered from various sources, e.g., Stanford Research Institute, Edison Electric Institute, and U.S. Bureau of the Census.

Variables: Effect of energy-consumption patterns in transportation, space heating, and air conditioning on efficiency of energy utilization.

Findings: (1) To some extent the current mix of transport modes is optimal, disregarding noninternalized social costs. (2) Electrical-resistance heating is more wasteful of primary energy than direct-combustion heating. (3) Air-conditioning units vary widely in efficiency; an improvement in average efficiency of same would result in appreciable energy savings. Various measures for potential energy savings are suggested by the data analysis.

Hogan, M. Janice. 1976. Energy Conservation: Family Values, Household Practices, and Contextual Variables. Ph.D. dissertation, Michigan State University, East Lansing.

Method: Statistical analysis of 1974 Lansing SMSA survey (N=157) to determine differences in the rate of adoption of household energy-conservation practices among families with varying husband-wife patterns of agreement and commitment to values.

Variables: The effect of attitudes such as self-esteem, social responsiveness, familism, and eco-consciousness, on energy-conservation behavior. Familism is the perception a family member has of his family unit and the level of integration of its members within the unit. Eco-consciousness is the awareness of the interrelationship of man and nature in terms of earth's capacity to sustain life-style.

Findings: Those conscious of environmental problems were most likely to report conserving energy. No systematic relationship was found between conservation behavior and contextual variables--education, occupation, employment status of wife, age, family size, income, and urban-rural residence. The same lack of association was true of self-esteem and familism in relation to conservation behavior.

Hohenemser, Christopher, Roger Kasperson, and Robert Kates. 1977. The Distrust of Nuclear Power. Science 196:24-34.

Method: A qualitative study of the safety of nuclear power, particularly to explore how the risk of rare events enters into energy policy decisions of our society.

Variables: Public perceptions of nuclear power safety as they pertain to concomitant policy decisions.

Findings: The issue of nuclear safety keeps cropping up no matter how many technical problems appear to be solved. Many times more dollars per fatality are spent on accident prevention in the nuclear industry than are spent for this purpose in the fossil-fuel power plants, even after the catastrophic nature of nuclear accidents is taken into account. The reasons nuclear issues tend to overwhelm society are shown to stem from the social history of nuclear power, genuine public uncertainty in the face of complex safety issues, underestimation of the regulatory task, and the rancorous nature of the debate. "Distrust of nuclear power, which begins as a question about technology, turns out to be as much a question about the social institutions designed to develop, regulate, and contain that technology."

Holmes, Cheryl Lynn. 1975. A Socio-Demographic Analysis of the Energy Intensiveness of Food Consumed with Implications for National Energy Conservation. M.A. thesis, Department of Family Ecology, Michigan State University, East Lansing.

Method: The relationship between food consumption and associated energy costs, based upon statistical analysis of a 1974 survey of a stratified random sample (N=190) of households in the Lansing SMSA. Family food consumption and socioeconomic characteristics were determined by interview. Data on fossil-fuel expenditure from agriculture to supermarket were obtained from a variety of sources.

Variables: The energy intensiveness of individual diets, given estimates of the energy cost per pound and per serving of specific food items. Individual diets were posited in terms of family income, occupation of the household head, education and working status of the wife, and urban or rural residence.

Findings: The data did not support any hypothesized differences between groups. The author infers that there is apparently no one group toward which to direct energy-conservation efforts in connection with food consumption.

Holmes, Cheryl L., and Peter M. Gladhart. 1976. The Energy Cost of Food: The Family Can Now Make Informed Decisions. Department of Family Ecology, Michigan State University, East Lansing.

Method: Food consumption data were collected from a 1974 subsample of 190 individuals from 85 families in the Lansing SMSA.

Variables: Food consumption choices, consumption timeframe, and energy cost of food consumed.

Findings: Energy intensiveness of individual diets was not found to vary with family income, occupation of household head, wife's education and work status, or residence location. Energy costs in BTU per serving of selected representative foods are discussed.

Honnold, Julie A., and L. D. Nelson. 1976. Voluntary Rationing of Scarce Resources: Some Implications of an Experimental Study. Presented at annual meeting of the American Sociological Association, New York, August. Available from Department of Sociology, Virginia Commonwealth University, Richmond.

Method: A typology of conservation orientations was developed to test commitment to conservation behavior in relation to reward probability and reward magnitude, and utilized on a sample (N=485) of undergraduate students surveyed by questionnaire. Six relevant hypotheses were tested with partial correlation analysis.

Variables: Scales relating conservation, necessity, and sufficiency attitudes and perceptions to conservation orientation.

Findings: Tests among the undergraduate sample supported the following predictions: conservationists regard conservation behavior as both necessary and adequate to attain collective benefit; consumerists believe such behavior to be unnecessary; and cynics view conservation behavior as necessary but insufficient. The dissemination of scarcity information was not found to increase commitment to conservation behavior.

Hummel, Carl F., Lynn Levitt, and Ross J. Loomis. 1975. Perceptions of the Energy Crisis: Who Is Blamed and How Do Citizens React to Environment-Lifestyle Tradeoffs? Department of Psychology, Working Paper in Environmental Psychology No. 2. Fort Collins: Colorado State University.

Method: Survey of two representative samples (total N=238) of residents of a Colorado community; one when gasoline was abruptly scarce and the other after the energy problem had been established. Data were analyzed by stepwise regression.

Variables: Effect of the 1973 gasoline shortage on support for (1) voluntary actions, (2) mandatory actions that had benefits for energy and air pollution problems but entailed life-style costs, and (3) actions with energy benefits but environment costs.

Findings: Relatively inconsistent predictive power was obtained across five criteria (dependent variables) of explanatory variables dealing with demographics and perceived personal effects of the energy crisis. But in both samples, blaming environmentalists was negatively related to support for mandatory actions that would attack air pollution as well as energy problems, and was a positive predictor for pro-energy actions that would damage the environment. Those blaming individual consumers supported mandatory remedies.

Hyland, Stanley E., Judith S. Liebman, Demeter B. Shimkin, Richard C. Roistacher, James J. Stukel, and John J. Desmond. 1975. The East Urbana Energy Study, 1972-1974: Instrument Development, Methodological Assessment, and Base Data. College of Engineering. Urbana: University of Illinois.

Method: Marginal frequency analysis of two surveys (Fall 1972, Spring 1973; follow-up in June 1974) of a 10% stratified random sample (N=228 for first, N=116 for second) of households in East Urbana, Illinois, to determine change in behavior and attitudes regarding energy and conservation. Data were gathered by a questionnaire administered in personal interviews.

Variables: Behavioral change over time with respect to 382 household and individual variables in the first survey, 182 household and individual variables in the second.

Findings: (Major findings have not yet been published.) Population appears to have responded to energy crisis and concomitant rising costs by using air conditioners, vacuum cleaners, and ovens less.

There has been little change in automobile use--perhaps due to respondents' high value placed on privacy, autonomy, and mobility.

J. M. Viladas Co. 1974. Impact of the Fuel Shortage on Public Attitudes Toward Environmental Protection. 2 vols. Springfield, Va.: National Technical Information Service (PB-244 933).

Method: A study of the impact of the energy crisis on attitudes toward environmental protection and how these attitudes were related to how affected respondents were by the fuel shortage. Telephone interviews were conducted with 500 of 3,012 respondents from a national sample studied in 1973. Follow-up telephone interviewing was accomplished during May 1974.

Variables: The effect of the energy crisis on attitudes toward environmental protection.

Findings: The energy crisis appeared to have little impact on attitudes about fighting pollution. The most popular prospective methods of reducing fuel consumption were improving public transportation, lowering speed limits on highways, and driving smaller cars. Rationing and price increases were among the most unpopular steps to reducing fuel consumption. In addition, five steps which represent various ways of relaxing environmental control standards so as to reduce energy shortages were generally unpopular. One of these anti-environmental strategies--letting air pollution increase in areas that now have clean air--was the least acceptable of the entire battery of 18 potential public policy options. Strategies related to increasing the supplies of energy--e.g., increasing coal production through strip mining, building more atomic power plants, and building the Alaska pipeline--were generally intermediate in public acceptability between the popular conservation measures and the unpopular anti-environmental measures. In general, people who report being affected in their life-styles and consumption patterns by the energy crisis (compared to those indicating they were not affected by the crisis) were most likely to: favor policies to conserve energy, favor policies to expand energy supplies, and believe that these conservation and expansion of energy supply policies would be effective in alleviating fuel shortage.

Johnson, Jean. 1974. Societal and Political Implications of the Energy Crisis. Forecasting International, Arlington, Va.

Method: A scenario approach to forecasting alternative life-styles with reduced energy, using baseline secondary socioeconomic data gathered from a variety of sources and empirical studies.

Variables: Effect of alternative reduced-energy life-styles (referenced to income level) on energy intensity, level of risk, environment, social cohesiveness. Four dominant forces for changing energy use: political control, technological breakthrough, economic allocation, and social adaptation.

Findings: Twenty-four scenarios are created along with a "policy capturing" technique for inferring subject (public opinion) preferences among the scenarios.

Johnson, Warren, Victor Stoltzfus, and Peter Craumer. 1977. Energy Conservation in Amish Agriculture. Science 192:373-378.

Method: Energy analysis of Amish agriculture to determine (1) how much less energy the Amish use compared to their non-Amish neighbors, and (2) what penalty they pay in reduced yields because of the low energy intensity of their agricultural methods. The technique of energy analysis compares different production processes in terms of energy that is degraded to obtain the desired product. Both Amish and non-Amish farms were sampled in central Pennsylvania, eastern Illinois, and southwestern Wisconsin.

Variables: The energy ratios and agricultural yields of farms in connection with the energy value of inputs and outputs (expressed in 1,000 kilocalories or Mcal).

Findings: Although the old order Amish of Pennsylvania had a higher yield than their non-Amish neighbors and a net energy ratio above 1, the Amish of Illinois did not produce net energy (at 0.886) and had a yield well below adjacent non-Amish farms. The respective ratios for the non-Amish farms are 0.553 and 0.650. The authors note that despite the lack of decisive results, Amish agriculture is clearly energy-conservative in the limited demands it makes on the available resources of this country.

Kasperson, Roger, Gerald Berk, David Pijawka, Alan B. Sharaf, and James Wood. 1979. Public Opposition to Nuclear Energy: Retrospect and Prospect. [Contained elsewhere in this volume.]

Method: A qualitative study of the emergence of public concern over the risks of nuclear power. Appropriate articles appearing in The New York Times and Reader's Guide between 1945 and 1975 were surveyed and categorized. Local controversy, the escalation of conflict to higher societal level, and linkages to the environmental movement are discussed in turn. A review is made of various surveys, conducted in America and abroad, of public attitudes toward nuclear power. The socioeconomic correlates of public response are noted, particularly the differences between men and women (see the Harris survey report above).

Variables: The nature of and change in public concern since 1945 with respect to nuclear power.

Findings: Prior to 1955 there was little concern over the risks entailed in the operation of what were then experimental reactors. A number of accidents were reported and media interest rose between 1955 and 1961. The context of the period 1961-68 was ripe for the growth of public concern, but instead it declined precipitously. Although public interest was low in the 1960's, local controversy increased. From isolated clashes over individual reactors, a coordinated national campaign of nuclear opposition emerged after 1968. The evidence is substantial that environmental activists have spearheaded the opposition. The prognosis of the study is that public opposition to nuclear energy at both the local and national level will not dissipate in the near future. Nevertheless, the authors expect that the nuclear industry will continue to grow.

Keck, Carol A., Nathan Erlbaum, Patricia L. Milic, and Michael F. Trentacoste. 1974. Changes in Individual Travel Behavior During the Energy Crisis, 1973-74. Planning and Research Bureau, Preliminary Research Report No. 67. Albany: New York Department of Transportation.

Method: Four articles describe and analyze changes in individual travel behavior, as affected by the 1973-74 energy crisis, from the viewpoints of individual responses, amount of gasoline used, car purchase habits, and the effectiveness of car pooling. These analyses are based on three community-wide surveys conducted by the New York State Department of Transportation during the early months of 1974. In each of the three communities (Oneonta, Gloversville/Johnstown, and Hudson) a random selection (N=300) was made from available telephone listings, and one person interviewed from each household.

Variables: The effect of the energy crisis of 1973-74 on travel behavior in terms of individual responses by amount of gasoline used, car purchase habits, and car pooling.

Findings: People did not react strongly to a prospective rationing of 8 gallons per week per licensed driver, notwithstanding average precrisis consumption of 15-20 gallons per week per driver. Publicity about the small number of miles per gallon for new large cars did not cause people to buy small cars so much as to buy used ones. Car pooling rose during the study period, but appeared to be used inconsistently by those who had already shown an awareness of the gasoline shortage by driving a small car or by those among whom many shared their work destination. Overall, the energy crisis did not induce significant changes in travel habits for most people in the communities sampled.

Kelley, Tom. 1975. The Way Some People Live. In The American Energy Consumer: A Report to the Energy Policy Project of the Ford Foundation, eds. Dorothy K. Newman and Dawn Day, pp. 11-31. Cambridge, Mass.: Ballinger.

Method: A qualitative study of energy and life-style utilizing six family vignettes to provide a living frame for the facts and figures discussed in other chapters of the volume. Data were gathered from selected interviews.

Variables: Life-style by income and location, e.g., "David and Gloria M--Income $11,000 a year-plus--Near Alexandria, Va." and "Edward and Mabel A--Income $3,000 or Less--Mid-City, Baltimore, Md."

Findings: Compared with prior generations nearly all the six families interviewed were materially better off. The rise of affluence based on cheap energy is evident in the automobile, in both its symbolic and practical value. Nearly all owned or had owned a car. The poorest family was content to walk or take a bus. Mobility was a major secondary effect imputed to cheap energy and the automobile.

Keyfitz, Nathan. 1976. World Resources and the World Middle Class. Scientific American 235(1):28-35.

Method: A largely qualitative study of the feasibility of entry by the less developed countries into the resource-intensive world of the middle class. UN figures are the points of departure.
Variables: Economic development for less developed countries as a function of world population growth in relation to dwindling world resources.
Findings: Constraints on both production and environmental quality will limit the growth of the world middle class.

Kilkeary, Rovena. 1975. The Energy Crisis and Decision-Making in the Family. Springfield, Va.: National Technical Information Service (NSF-SOS GY-11543).

Method: A statistical analysis of a random sample (N=602) of Bronx and Queens, New York, households to determine whether family characteristics and energy-related experiences affect household energy knowledge and conservation practices. Data were collected by interview during July and August 1974.
Variables: The effect of the energy crisis on household member characteristics, energy knowledge, and actual practices in terms of exposure to extended blackouts, direct payment of utility bills, car ownership, belief that families in the U.S. pulling together can influence the energy crisis, family income, educational attainment, family composition, age, sex, and recent major appliance purchase.
Findings: Car ownership, education, and family composition (number, ages, and sex) were found to be positively related to energy knowledge scores. Exposure to extended blackouts, direct payment of utility bills, car ownership, the belief U.S. families can together affect the energy crisis, and family composition were positively related to changed practice scores, i.e., a measure of the practice of energy savings. The strongest influence on knowledge and conservation was income, with middle income having the highest scores. Families composed of couples with children also demonstrated high levels of energy knowledge and conservation practices. This study found the strongest influence on energy use to be the pocketbook. Those families who could afford to pay energy price rises did, while moderate-income families tended to strive to save energy.

King, Jill A. 1975. The Impact of Energy Price Increases on Low Income Families. Washington, D.C.: U.S. Federal Energy Administration, Office of Economic Impact. Springfield, Va.: National Technical Information Service (PB 262 098).

Method: Econometric analysis of energy price increases on low-income families, using an energy data file for a national representative sample of 50,000 households in the continental U.S. Energy expenditures for each of six energy types were imputed for each household from this data file. The primary data source was the Public Use Sample of the 1970 Census of Population, supplemented by travel information from the Nationwide Personal Transportation Study. Energy expenditures in 1974 were estimated using figures from a microsimulation which related energy consumption and disposable income for 1973 data.

Variables: The effect of increasing energy expenditures for electricity, piped natural gas, bottled gas, fuel oil, coal, and gasoline on low-income families.

Findings: A substantial rise in household energy expenditures occurred as a result of 1973-74 energy price increases. Households in New England and the Middle Atlantic regions were hardest hit. Although low-income households spent less on energy and experienced smaller absolute increases in expenditures, these expenditures and increases represented a much larger proportion of disposable income than for high-income households, by a factor of 10. Single-family homes, larger families, and rural location were associated with larger impact because families with these characteristics use more energy. Impact of higher energy prices for home fuel expenditures did not vary by household characteristics, e.g., race, age, or occupation of head of household. Gasoline expenditures, and their impact, did not exhibit as wide a regional variation.

Klausner, Samuel Z. 1978. Household Organization and Use of Electricity. In Warkov (1978), pp. 49-59.

Method: A microsocial, microcultural analysis of energy consumption as related to social structure. A sample of households (the unit of analysis) was selected from a list of those receiving Aid to Families with Dependent Children in Camden, New Jersey, for June and July of 1969, 1970, and 1973. Respectively, 438, 373, and 291 heads of welfare households were interviewed. Income and expenditure budgets, including purchases of energy lumped into a single figure, were asked of respondents for the month prior to the interview. Information was also gathered on demographic, psychological, and household interaction attributes.

Variables: The effects of household social organization on energy consumption.

Findings: Three conditions predispose to increased household energy consumption: a base of familial relations supporting interaction focused around the home, a tendency toward a high tempo of social activity, and a tendency on the part of the head of household toward expressiveness and achievement. It was determined that the presence of a male (or male disposition) increased order and decreased energy consumption. The author concludes that this refutes the macrosocial proposition that increased social complexity causes greater energy consumption.

Kohlenberg, Robert, Thomas Phillips, and William Proctor. 1976. A Behavioral Analysis of Peaking in Residential Electrical-Energy Consumers. Journal of Applied Behavior Analysis 9(1):13-18.

Method: Peaking--the tendency for electrical-energy users to consume at high rates for brief periods during the day--was examined through a continuous data collection system for monitoring consumption of electrical energy in the homes of three volunteer families. Information, feedback, and incentives were evaluated for their effects on peaking behavior. The experiment was conducted over a three-month period from early January through March in the Seattle area on three middle-class families. Data were automatically recorded on a device, and data records were not visible to the subjects. Three baselines and conditions were administered to each family.

Variables: The effects of information, feedback, and incentives on the peaking behavior of middle-class families.

Findings: A combination of feedback plus incentives proved to be most effective, reducing peaking by about 50 percent. When experimental treatments were removed, subjects returned to pretreatment patterns of consumption.

Kostyniuk, Lidia P., and Wilfred Recker. 1976. Effect of a Gasoline Shortage on Acceptability of Modes for the Urban Grocery Shopping Trip. Journal of Environmental Systems 6(9):1-30.

Method: A study of the differences in perceived acceptabilities, in relation to the gasoline shortage, of modes for the urban grocery shopping trip. Data were gathered using a psychological continuum scale, from a mail survey sent to a random sample of 1,500 households in six representative subareas of Buffalo, New York, during December 1973-March 1974.

Variables: The effect of the gasoline shortage on place of shopping, mode choice, and socioeconomic description of households.

Findings: Over the time studied, a general increase in acceptability of walking for the middle of the scale and a decrease in the acceptability of the driver mode across the subsamples. Taxi, bus, and bicycle were rated near the bottom of the scale of all subsamples. An increase in the acceptability of the bus was most pronounced among lower income subsamples; but this was not sufficient to place this mode in the acceptable category.

Kruvant, William J. 1975. People, Energy, and Pollution. In The American Energy Consumer: A Report to the Energy Policy Project of the Ford Foundation, eds. Dorothy K. Newman and Dawn Day, pp. 125-167. Cambridge, Mass.: Ballinger.

Method: Air pollution estimates for five metropolitan areas were examined. A detailed study was then done of the relationship between air pollution and socioeconomic characteristics of the Washington, D.C., metropolitan area. These studies yielded a profile of the most likely victims of pollution. Pollution data were obtained from the D.C. Department of Environmental Services; other data came largely from 1968-70 U.S. Bureau of Census reports. Data from both sources were analyzed by the Washington Center for Metropolitan Studies.

Variables: The differential effects of air pollution by socioeconomic class in Washington, D.C.

Findings: The Washington data show that socioeconomic characteristics associated with disadvantage--poverty, occupations below management and professional levels, low rent, and high concentrations of black residents--go hand in hand with poor air quality. It is noted that these groups produce little of the air pollution that affects them. The findings show that antipollution policies have already helped disadvantaged groups, proving that well-enforced policies can be effective.

Leholm, Arlen, F. Larry Leistritz, and James S. Wieland. 1975. Profile of North Dakota's Coal Mine and Electric Power Plant Operating Work Force. Department of Agricultural Economics, Report No. 100. Fargo: North Dakota State University.

Method: Marginal frequency analysis of a questionnaire mailed or handed out to all (N=416) employees of the four largest coal mines and four largest electric power plants in North Dakota, to determine the socioeconomic characteristics of the operating work force in these mines and plants. Survey was taken during June 1974.

Variables: Years lived in present community, years worked for the given company, rates of pay, job satisfaction, commuting distance, education, in-migration from out-of-state to work at the plants or mines.

Findings: The work force proved to be very stable, members having lived an average of 22 years in their present community and having worked an average of 8.6 years with their present employing company. Coal industry workers proved to have higher average annual incomes than coal workers average in the state as a whole (median incomes average between $12,000 to $13,000 per year), despite their low levels of formal education (72 percent of employees had 12 years or less of education). More than half the work force resided within the county before they were hired. Workers reported generally high satisfaction with their jobs. Length of employment is negatively associated with commuting distance. Income is positively associated with in-migration from another state.

Levy, Paul F. 1973. The Residential Demand for Electricity in New England. Cambridge: Massachusetts Institute of Technology (MIT-EL-73-017).

Method: An econometric model based on 1970 cross-section data for 67 New England electric utilities and their service areas. A two-stage least squares design was used to obtain consistent coefficients in terms of estimated supply price and demand equations. Elasticities of demand were also calculated. Data are from the utilities and a number of statistical reports.

Variables: The effect of price on residential electricity demand in conjunction with various socioeconomic characteristics.

Findings: Residential demand for electricity was found to be significantly correlated with its average price, family income, family size, heating degree days, and the ownership (private or public) of the electric utility--price and income being the most important determinants. The supply price is correlated with the quantity of electricity consumed, utility operation and maintenance costs, total number of customers, degree of urbanization, and ownership of the utility. A significant elasticity of demand with respect to price as well as income was established.

Little, Ronald L. 1976. Rural Industrialization: The Four Corners Region. In Social Implications of Energy Scarcity: Social and Technological Priorities in Steady State and Constricting Systems, eds. Lewis Carter and Louis Gray, pp. 108-131. Washington, D.C.: National Science Foundation.

Method: The study team utilized a random sample survey of 407 residents of five communities (Blanding, Monticello, Kanab, and Escalante, Utah; and Page, Arizona) in the Four Corners area of the Southwest during the summer of 1974. Each of the five communities was in the proximity of or had experienced energy resource development. Over 92% of all sampled respondents completed interviews, and the interview schedules were largely composed of open-ended questions. All persons interviewed were household heads. Marginal frequency analysis of the survey results is combined with presentation of relevant U.S. Census data.

Variables: Attitudes toward energy development in the Four Corners region.

Findings: Over 80% of the respondents were favorably disposed toward extant energy developments (e.g., the Four Corners Power Plant, Glen Canyon Dam, Black Mesa Coal Mine), and the proposed Kaiparowits project (a coal strip-mining and electrical-power-generation venture). Two major reasons were given by respondents for favoring extant and proposed energy development projects: the societal need for energy, and the expected employment and economic benefits of energy-development projects for the region. Expected environmental damage and the belief that there was no overwhelming need for more energy were the two major reasons for disapproving of energy development projects. The author speculates that attitudes that are highly supportive of energy resource development can be attributed to prevailing economic and religious patterns in the communities. For example, Mormon religious beliefs are dominant in the region, and the author suggests that "Mormon doctrine and practice provide both stimulus and justification for engaging in economic activities," and Mormonism "stresses the active development of resources." See also Lovejoy (1976).

Little, Ronald L. 1976. Some Social Consequences of Boom Towns. Department of Sociology, Utah State University, Logan. Available from Department of Sociology, Arizona State University, Tempe.

Method: Summary of research on boomtowns and an analysis of the boomtown experiences of Page, Arizona. The analysis of Page employs both census-type data and the survey data gathered in connection with the Little and Lovejoy paper detailed below.

Variables: The social consequences of boom and bust cycles of community development.

Findings: The primary result of boomtown development is rapid population growth, and rapid population growth typically leads to a breakdown in municipal services and other institutional facets of the community. Because population growth is the major initial facet of the boomtown phenomenon, boomtowns are seldom manifest in urban areas (since a new industry that adds 10,000 or 20,000 persons will be only a negligible proportion of the population of a large city). Energy resource development in the western states appears destined to foster boomtown problems in a number of small rural communities, and these problems are apparent in the case study of Page (increased crime rate and high community conflict).

While the obvious solution to boomtown problems is to slow down and stretch out the construction process, industries find this solution unacceptable because construction compressed into a short time period is most economical. "The present national mania over energy self-sufficiency would also conflict with this (stretching out the construction process) solution," in the opinion of the author. The author also argues that the boomtown consequences of energy and other natural resource developments are seldom considered in political decisionmaking, and the environmental impact statement process only exacerbates these problems. Boomtown phenomena are complex, and EISs are structured to direct attention away from questions that *need* to be answered and to redirect it toward questions that *can* be answered in a short time and with little research effort.

Little, Ronald L., and Stephen B. Lovejoy. 1976. Employment Benefits from Rural Industrialization. Department of Sociology, Utah State University, Logan. Available from Department of Sociology, Arizona State University, Tempe.

Method: Data are taken from 248 household interviews obtained from residents of one northern Arizona and two southern Utah communities situated in the Four Corners area near the proposed Kaiparowits power project. The Kaiparowits power project is a combined coal strip-mining and electrical-power-generation project sponsored by a consortium of utilities. The respondents were selected by simple random sampling and were given open-ended interviews. All respondents are household heads.

Variables: The extent to which employment benefits of the Kaiparowits project might accrue to local residents, based on respondents' characteristics.

Findings: Similar to other rural industrialization projects in the U.S., relatively few jobs deriving from the power-generation project will go to local residents, and the jobs that local residents will get are largely in the unskilled categories. These projected benefits are substantially lower than the respondents anticipate. Four factors are seen to account for the meager employment gains resulting from the Kaiparowits project: (1) there is a mismatch between project employment requirements--generally, skilled jobs--and the low level of job skills available in the local population, (2) there is an apparent unwillingness on the part of local residents to be trained or retrained for employment, (3) there is a lack of desire on the part of local residents to apply for employment with the project, and (4) the communities are a long commuting distance from the project.

Lockeretz, William. 1975. Growth of Residential Consumption of Electricity: Distribution among Households at Various Consumption Levels. Land Economics 51(2):149-157.

Method: Econometric analysis of Missouri service area (about 580,000 households) of the Union Electric Company to determine how the monthly frequency distributions of residential consumption had changed from 1968 to 1973 for both base-load and peak-load months.

Variables: Changes in the distribution of residential electricity consumption.

Findings: Only a small fraction of the overall increase in consumption went to those in the lowest consumption levels.

Lopreato, Sally C. 1978. Some Issues Concerning Citizen Participation and Planning for Resource Development Near Small Communities. In Warkov (1978), pp. 204-219.

Method: A description and marginal frequency analysis of a mail survey of citizens in a potential geopressured geothermal test-well locality--Brazoria County and six communities in Galveston County which lie within a 20-mile radius of the test-well site. A systematic probability sample (N=2,364) was drawn from telephone books. The 612 usable returns (response rate of 26 percent) appear to be biased toward individuals at higher education and income levels.

Variables: Awareness of the resource, favorability toward the impending development, levels of community satisfaction, and perceived future problems due to community growth.

Findings: More than half of respondents were unaware of the resource. The large majority from all sections of the study area were favorable towards test drilling and leasing of the land for geothermal development. The wealthier and better educated were in general more favorable to such development. Sixty percent of respondents proved sympathetic to the precedence of the nationwide need for energy (perhaps due to altruistic wording in the question). Recommendations are made for resource development compatible with the interests and concerns of local citizens.

Louis Harris and Associates. 1975. A Survey of Public and Leadership Attitudes Toward Nuclear Power Development in the United States. New York: Ebasco Services.

Method: A study designed to measure attitudes of the public and their leaders toward the development of nuclear energy in the United

States, based on a nationwide random sample (N=1,537) of households conducted by in-person interviews between March 21 and April 3, 1975. In addition, 301 interviews were conducted with neighbors of three nuclear power plants: 195 in San Onofre, California; 93 in Morris, Illinois; and 103 in Indian Point, New York. Finally, between March 31 and April 12, 1975, in-person interviews were conducted with 201 leaders nationwide: 51 political, 51 business, 47 regulatory, and 52 environmental.

Variables: Public and leadership attitudes toward nuclear power development in the U.S., with reference to respondents' socioeconomic background, political interests, and concerns over environmental and health issues.

Findings: The public sample believed strongly in the prospect of a serious energy shortage that will not disappear overnight. Four in five hoped the U.S. would become independent of foreign energy sources. Nuclear energy was viewed as a viable alternative to fossil fuels as a source of electric power. The biggest drawback (registered by 63%) in the public's mind was the disposal of radioactive waste materials, followed by escape of radioactivity into the atmosphere (49%), chance of an explosion in the case of an accident (47%), thermal pollution (47%), the threat of sabotage (39%), giving off polluting fumes (36%), and the possibility of theft of plutonium (34%). However, 26% regarded nuclear power plants as "very safe" and 38% as "somewhat safe," with only 13% believing they are "not so safe" and 5% believing that they are "dangerous"; 18% were undecided on this issue. Neighbors of nuclear power plants indicated that they had learned to live with them. The public identified some apparent advantages of nuclear energy over coal and oil, and were prepared to live with the risks involved if proper safeguards and precautions are taken. Leaders, especially those in politics, seriously underestimated public concern about environmental quality and public support for building more nuclear plants. Both the public and leaders regarded scientists as more credible than any other group (e.g., government leaders, the media, environmentalists). Although the public expected government to regulate nuclear energy development, it harbored deep distrust of government control of private industry or intrusion into the private sector as the agent of development.

Lovejoy, Stephen B. 1976. Future Energy Development in the Western United States and Inmigration. Department of Sociology, Utah State University, Logan. Available from Department of Rural Sociology, University of Wisconsin, Madison.

Method: A random sample survey of four rural communities (ranging in population size from 638 to 2,250) in Utah was made during the summer of 1974. An open-ended interview was conducted with 337 household heads. All four communities are in the Four Corners region of the Southwest.

Variables: The effects of the religious composition of in-migration streams on local atittudes toward future energy development in southern Utah--particularly with respect to the Kaiparowits project (a combined coal strip-mining and electrical-power-generation project sponsored by a consortium of utilities).

Findings: In-migrants are less likely to practice the Mormon religion and less likely to favor energy resource development than locals. Non-Mormon in-migrants were less in favor of the development of energy resources than either Mormon in-migrants or long-term residents, regardless of long-term residents' religious beliefs. The author concludes by suggesting that in-migration may have a greater impact on local attitudes in other rural areas of the western United States where religion is not such a primary influence on attitudes toward natural resources.

Lovejoy, Stephen B. 1976. Local Preceptions of Energy Development: The Case of Kaiparowits Plateau. Department of Sociology, Utah State University, Logan. Available from Department of Rural Sociology, University of Wisconsin, Madison.

Method: A random sample survey of 407 household heads in five communities (Blanding, Monticello, Kanab, and Escalante, Utah; and Page, Arizona) in the Four Corners area of the Southwest was conducted during the summer of 1974. Each of the five communities was in the proximity of or had experienced energy resource development. The response rate was in excess of 92%, and the interview schedules were composed of open-ended questions.

Variables: Opinions on the Kaiparowits project (a combined coal-mining and electrical-power-generation project sponsored by a consortium of utility companies) in relation to perceived effects of the project.

Findings: The solid majority of residents of the five rural communities in the Four Corners region favor the Kaiparowits project. The author argues that local residents tend to overemphasize the positive effects of the project while deemphasizing or ignoring the negative consequences. He suggests further that these attitudes reflect a high level of misinformation on the part of the respondents--primarily because local residents received most of their information about the proposed project from the utilities and the news media, who strongly favor the energy development project.

Mazur, Allan. 1977. The Effect of the Energy Crisis of 1973 on Public Attitudes toward Nuclear Power. Presented at Social and Behavioral Implications of the Energy Crisis: A Symposium, Woodlands, Tex., June. Available from Department of Sociology, Syracuse University, Syracuse, N.Y.

Method: An evaluation of the author's erroneous early 1976 prediction that there would be a marked decline in public opposition to atomic power plants. The analysis is largely qualitative and exploratory. The proposition is tested which holds levels of opposition within movements, as well as fluctuations in the particular issues of concern, to be tied to the rise and fall of topics of national concern in the U.S. This pattern appears to hold for other controversies as well, e.g., fluoridation, ABM, and legalized abortion.

Variables: The continuing interaction between topics of national concern and the intensity of popular movements opposed to nuclear power plants.

Findings: Although the Mazur-Leahy "wave" model did predict the rise of antinuclear sentiment pursuant to the Arab oil embargo, it failed to anticipate the recent opposition manifested by, for example, the Clamshell Alliance. The author interprets this failure to be a misapprehension of a new crest in the energy crisis wave. The new upsurge in public concern, as reported in Gallup Polls, is considered to reflect President Carter's attempt to publicize his energy program.

Mazur, Allan, and Beverlie Conant. 1976. Controversy Over a Local Nuclear Waste Repository. Social Science Program, Syracuse University, Syracuse, N.Y. Also in Social Studies of Science, 1979, 8(2):235-244.

Method: Case study of the short-lived controversy surrounding the proposal to site a nuclear waste repository near Syracuse, New York. A random sample of local residents (selected from residential phone listings in the 1976 Syracuse directory) was interviewed near the height of the publicity (N=124) and then nearly four months later, after the publicity had died away (N=106).

Variables: The effects on attitudes of amount of exposure to the controversy, by gender.

Findings: Men were three times more likely than women to be aware of the controversy. Yet exposure to the controversy had a greater effect on women than men, shifting female attitudes against the repository. The attitude formed at the peak of publicity tended to persist over time, particularly for men. The authors speculate that observed sex differences derive from our cultural expectation that men should know politics and technology, and women need not.

Mazur, Allan, and Peter J. Leahy. 1977. A Comparative Analysis of Movements that Arise in Opposition to Technological Innovations. In Research in Social Movements, Conflicts and Change, ed. Louis Kriesberg, pp. 143-154. Greenwich, Conn.: JAI Press.

Method: A qualitative, comparative study of citizen movements against three technical innovations: fluoridation, the antiballistic missile system (ABM), and nuclear power plants. Some consideration is also given to the movement against legalized abortion inasmuch as abortion is a social innovation with technical overtones. Included are graphs of the number of articles appearing in the Reader's Guide indexed under various controversial topics over appropriate time spans.

Variables: The similarities and differences between three movements against technical innovations, with an eye toward finding the general principles of such movements.

Findings: There are similar patterns of leadership and growth in the four movements analyzed. Leaders appear to be knowledgeable, reputable, well-integrated members of society. They oppose technology on grounds of ideology as well as risk. Such leaders are usually recruited by personal associates of a like political philosophy who are already in the movement. Mass media play a crucial role in a regular sequence of rise and fall of controversy. As media coverage increases, so does opposition to the technology among the wider public. Coverage rises and falls with the activity of leaders. The authors suggest, based on this comparative study, that without resurgence of opposition leadership the nuclear-power controversy will diminish.

Mazur, Allan, and Eugene Rosa. 1974. Energy and Life-Style. Science 186:607-610.

Method: Correlation analysis of the 1971 energy-consumption patterns in 55 countries in order to estimate some of the long-term effects of reduced energy consumption on life-style. UN data.
Variables: Energy consumption (total and electricity) in relation to life-style indicators for health, education, culture, general satisfaction, and economic well-being, among all nations and developed market economies.
Findings: Nearly all the life-style indicators for all nations sampled correlate highly with the measures of energy consumption. Among nations with developed market economies the majority of correlations drop to insignificance. However, economic indicators generally retain high correlations with the measures of energy consumption.

Miernyk, William H., Frank Giarratani, and Charles Socher. 1977. Regional Impacts of Rising Energy Prices. Cambridge, Mass.: Ballinger.

Method: A study of the economic consequences for regions of rising energy prices. The focus is especially on coal. Data are summarized for production and consumption of basic energy resources by census region, for the distribution of incremental value added for coal, oil, and natural gas by states, and for 78 sectors of the economy by rank of price effects. A regionally disaggregated U.S. input-output model was used to analyze data for the years 1967 and 1973.
Variables: The effect of rising real energy prices on the pattern of regional economic activity in the United States.
Findings: Throughout much of the nation's history, energy-producing regions have "subsidized" the growth of urban areas through an abundant supply of energy at low and stable prices. Pursuant to the energy crisis of 1973-74, the energy-producing states have gained an economic advantage relative to the energy-consuming states. The former are growing in population and economic activity and have experienced less adversity as a result of high energy prices. Based on these assumptions and trends, the author projects that there will be a regional shift of real income from the energy consumers to the

energy producers. Thus, "the coal-producing regions of Appalachia and the Far West could be transformed into relatively prosperous areas. Meanwhile, parts of some of the nation's most prosperous states--such as Michigan and Connecticut--could become chronically depressed areas." The authors conclude that "there is no reason to believe that the differential impacts on energy-producing and energy-consuming regions are less significant--or less permanent--than those that have recently altered the relationships among energy-producing and energy-consuming nations."

Milstein, Jeffrey S. 1977. Attitudes, Knowledge and Behavior of American Consumers Regarding Energy Conservation with Some Implication for Governmental Action. Office of Conservation and Solar Applications, U.S. Department of Energy, Washington, D.C.

Method: Empirical data and analyses of psychological, cultural, economic, and political reasons that U.S. consumers (who are responsible for one-third of U.S. energy consumption) favor energy conservation but generally do not practice it. Possible effective incentives and motivations for conservation are proposed, along with implications for governmental policy and action. Data are of two types: Opinion Research Corporation national probability sample surveys, and focused group discussions. The surveys entailed telephone interviews of 1,000 to 1,200 people each and were accomplished monthly from August 1974 to April 1976 (see Rappaport and Labaw, below). A total of 18 focused group discussions, led by trained leaders and lasting 1 to 1½ hours, were held in Denver; Trenton, Hartford, Seattle, Chicago, and Nashville.
Variables: Attitudes and behavior in relation to energy conservation.
Findings: Virtually everyone seems to be for conservation in the abstract, but evidence marshalled here suggests a gap between attitudes and energy-conservation behavior. Reasons for this seem to be lack of knowledge, cultural norms of comfort and convenience, and skepticism and cynicism regarding the nature of the energy problem. In speculating on prospective incentives the author notes that a conservation ethic, patriotism, or concern for one's progeny are not likely to induce energy conservation, but that the chance to save money may be the most effective incentive. Experimental analyses reinforce the view that financial reward is most effective in this regard, followed by feedback, exhortation, and information. All four methods are considered acceptable to the public and the author suggests that all of them be used despite variations in effectiveness.

Milstein, Jeffrey S. 1977. How Consumers Feel About Energy: Attitudes and Behavior During the Winter and Spring of 1976-77. Office of Conservation and Solar Applications, U.S. Department of Energy, Washington, D.C.

Method: A description and marginal frequency analysis of the results of several surveys of the American public done from February through May 1977. These surveys were intended to establish the effects on American consumers of the cold winters, natural gas crisis, and the remedies to the energy crisis proposed by the Carter Administration. The analysis relies on a series of tables that summarizes the surveys.

Variables: U.S. public opinions in connection with the winter 1977 shortage of natural gas and energy policy messages of the Carter Administration.

Findings: Three-fifths of respondents in the February survey thought the solution to the fuel shortage to be in their own hands, yet energy-conservation behavior was minimal. A March survey also directly measured home temperatures, a tactic which yielded at least a 10 percent overall difference in fuel consumption between the temperatures people said they had maintained and what they were directly measured to have maintained. Turning off lights not in use and reduced driving were other frequently reported conservation efforts. However, the conservers in all instances were in the minority. Lack of knowledge about energy appeared to be a problem--about half the people in the U.S. did not accept the shortage as real. Less-informed people tended to be less receptive to calls for energy conservation and sacrifices. Two-thirds of respondents rejected the idea of a right to use as much energy as they want to or can afford to. Moreover, three-fourths felt that what individuals do counts, yet nine-tenths believe the government should help solve the crisis. With regard to the energy policy debate, people tended to prefer voluntary measures to compulsory ones, those that are fair to them to those that are not, and laws that provide incentives to those that penalize consumers. The President's address seemed to produce significant changes in awareness of and attitudes toward the energy crisis. Policy proposals which hit closest to home are the least preferred.

Morrison, Bonnie Maas. 1975. Socio-Physical Factors Affecting Energy Consumption in Single Family Dwellings: An Empirical Test of a Human Ecosystems Model. Ph.D. dissertation, Michigan State University, East Lansing.

Method: Multiple step-wise regression and recursive path analysis were used to test hypotheses relating selected sociophysical determinants with (1) belief in the reality of the energy problem and (2) total direct energy consumption in single-family detached dwellings. Data were gathered by interview, based upon a cross-sectional field survey, and drawn from a May-June 1974 multistage probability sample (N=97) of the Lansing SMSA.

Variables: The effect of the energy crisis of 1973-74 in terms of energy-consumption characteristics and the beliefs of household members residing in single-family dwellings.

Findings: Belief in the reality of the energy problem is positively related to mean (husband-wife) educational attainment, agreement (husband-wife) on the availability of electrical energy, and reported total costs of all energy forms used in the dwelling unit (June 1974-May 1974). The number of persons, the number of major appliances, and the number of rooms in a dwelling unit contributed most to the variance explained with respect to energy consumption as a function of life-style and behavior. Belief in the reality of the energy problem was not found to change energy consumption patterns.

Morrison, Bonnie Maas, and Peter Gladhart. 1976. Energy and Families: The Crisis and Response. Journal of Home Economics 68(1):15-18.

Method: Overview of a five-year longitudinal study of the Lansing SMSA households to determine how family decisions are made about energy use. A multistage area probability sample survey was used for urban (N=160) and rural (N=57) areas.
Variables: Energy use as related to attitudes, food consumption, transportation, housing conditions, financial expenditures and resources, and the character and quality of the family's interaction patterns within the family, and with friends, relatives, and the larger community.
Findings: Family income proved to be the single best indirect predictor of residential energy consumption. In general, families in child-rearing stages use more residential energy than families without children, or at the early or later family life-cycle stages. Larger families use more than smaller ones. Single-family homes use more energy than multifamily dwellings or mobile homes. Half the respondents believed in the reality of the 1973-74 energy crisis, but this belief did not diminish in any meaningful way the energy consumed in a household. However, concern about the environment was associated with energy conservation, and tended to be found in higher categories of educational level and occupational attainment. Urban and rural respondents differed on energy policies.

Morrison, Bonnie M., Joanne G. Keith, Peter M. Gladhart. 1977. Family Energy Project Update: Response to the Increased Costs of Energy, A 1974 and 1976 Comparison. Presented at annual meeting of the American Home Economics Association, Boston, June. Available from Institute for Family and Child Studies, Michigan State University, East Lansing.

Method: An analysis of how households have responded to increased energy cost and its concomitant effects in the period between 1974 and 1976. An area probability sample of Lansing, Michigan, SMSA households was used at each date (respectively, N=216 and N=264). Fifty-nine percent of the households interviewed in 1974 were repeated in 1976. Questionnaires were both self- and interviewer-administered. Data on direct energy consumption for each household was collected from utility and fuel oil companies.
Variables: Changes in attitudes and behaviors of families (households) at two points in time pursuant to the energy crisis.
Findings: Percent of respondents believing in the energy problem declined slightly from 1974 to 1976, with about half in each case so reporting. The declines were substantial for less educated,

older, and rural resident respondents. Behaviors reflecting energy awareness and conservation increased since 1974. Almost all households reported some effort to conserve. Specific measures are discussed within the rubric of a hierarchy of household practices. A 6.3% overall reduction in energy consumption was observed between 1974 and 1976, likely a low figure since an adjustment was not made for the seasonal differences in energy use. The reduction came in heating fuels, whereas electricity use increased slightly.

Morrison, Denton E. 1978. Equity Impacts of Some Major Energy Alternatives. In Warkov (1978), pp. 164-193.

Method: An assessment of the probable distributional impacts of increases in the relative real price of energy (both direct, i.e., coal, oil, gasoline, electricity, and natural gas, and indirect, as a factor in the provision of other goods and services). Data are arrayed for 10 income classes by flows (monetary and energy) in 26 consumption categories. These data were recalculated from an input-output analysis of the 1960-61 U.S. Bureau of Labor Statistics "Survey of Consumer Expenditures." The input-output analysis (see Herendeen [1974], above) is unique in showing the energy impact of consumer expenditures, thus opening the way for a determination of the relative distribution of energy by class. The analysis is brought to bear on social equity considerations related to price increases, energy conservation, coal development, and nuclear development on persons, and to a lesser extent firms and communities, but especially on the poor.

Variables: The effect of some major energy alternatives on the distribution of energy flows, both direct and indirect, to social classes, firms, and communities.

Findings: Higher energy prices are regressive, particularly because the poor derive a larger proportion of their energy from direct forms. Energy conservation would entail transfer payments if high first-cost conserving technologies are to be made available to the poor. Moreover, the affluent would have to reduce their consumption disproportionately, especially in connection with indirect and nonbasic energy inputs. Nuclear and coal development could carry the seeds of inequitable risks and benefits. Inequity claims are briefly sketched in terms of quality of life. It is shown that the causal relationship of energy to quality of life is more essential for the absolute levels of the poor than for those of the affluent. A section is appended treating the equity impacts of six specific conservation strategies.

Muchinsky, P. M. 1976. Attitudes of Petroleum Company Executives and College Students toward Various Aspects of the Energy Crisis. Journal of Social Psychology 98(2):293-294.

Method: Spring 1974 survey and statistical analysis of the attitudes of 26 members of the Independent Connecticut Petroleum Association and 328 undergraduates at Iowa State University toward various aspects of the energy crisis.

Variables: Responses on causes, solutions, personal involvement, and present and future status--all regarding the energy crisis.
Findings: Students generally found companies responsible while companies faulted government for the 1974 energy crisis.

Murray, James R., Michael J. Minor, Norman M. Bradburn, Robert F. Cotterman, Martin Frankel, and Alan E. Pisarski. 1974. Evolution of Public Response to the Energy Crisis. Science 184:257-263. A more detailed report is The Impact of the 1973-74 Oil Embargo on the American Household, 1974, National Opinion Research Center, Report 126, Chicago: University of Chicago.

Method: An assessment and evaluation of changes in behavior and attitudes of the public as they encountered energy shortages in 1973, based on the continuous national panel survey conducted by National Opinion Research Center. For fuel oil (N=331), electricity and gasoline (N=1,946). The sampling was done from November 1973 to February 1974.
Variables: Attitudinal and behavioral responses related to fuel oil, electricity, and gasoline consumption.
Findings: The importance respondents attached to the energy problem was determined to be stable through the period under study. Respondents generally regarded the government to be responsible for the energy crisis. Two-thirds of a sample taken during the gasoline shortage believed it could be solved if individual consumers cut down on gasoline consumption. Opinions were not found to be significantly related to region, education, income, or area of residence.

Nelkin, Dorothy. 1974. The Role of Experts in a Nuclear Siting Controversy. Bulletin of the Atomic Scientists 30(9):29-36.

Method: A qualitative study of the role of academic experts in the 1973 case of organized community opposition to the construction of a nuclear power plant on the shore of Cayuga Lake, N.Y.
Variables: The influence of academic experts on the controversy over construction of a nuclear power plant.
Findings: (1) In a controversial situation political values can permeate technical material itself, whether or not the experts intended it. (2) Public sentiment tends to reflect nontechnical considerations. (3) Technical advocacy is likely to encourage participation in technical decisions, and to increase the probability of controversy.

Newman, Dorothy K., and Dawn Day. 1974. Energy, the Environment, and the Poor. Presented at annual meeting of the Society for the Study of Social Problems, August. Available from Washington Center for Metropolitan Studies, Washington, D.C.

Method: A study of the interrelationships between energy, environmental quality, and poverty, using 1972-73 figures from the Washington Center for Metropolitan Studies Lifestyles and Energy Surveys.

The survey used is based on a stratified national sample (N=1,455) of households. A second survey (N=142) asked utility companies serving the sample households how much electricity and natural gas the households used and how much they paid for it in the most recent 12 months.

Variables: The effect of changing patterns of energy consumption on the poor and their environment.

Findings: At the time of the study, currently accepted fuel pricing bore heavily on respondents who were least able to afford it. The unit price of fuel was found to be higher for those who use it as a necessity, and cheaper for those whose demand is more a matter of life-style. Authors conclude from their data analysis that the question of which households use energy and for what purposes is intimately related to the question of how our rapid growth in household energy consumption can be slowed. Further, slowing the growth of energy consumption is extremely important in slowing the spread of pollution.

Newman, Dorothy K., and Dawn Day. 1975a. The Energy Gap: Poor to Well Off. In The American Energy Consumer: A Report to the Energy Policy Project of the Ford Foundation, eds. Dorothy K. Newman and Dawn Day, pp. 87-124. Cambridge, Mass.: Ballinger.

Method: A description of how poor, middle income, and well-off families use energy, based on data from the Washington Center for Metropolitan Studies Lifestyles and Energy Surveys, conducted May-June 1973 (household interviews) and June-September 1973 (acquisition of billing data from utilities) on a nationwide multistage area probability sample (N=1,455) of heads of households.

Variables: Energy consumption characteristics relative to income class characteristics.

Findings: The poor use less energy, pay relatively more for the energy they must have, and, more than any other American group, suffer from exposure to the residuals of energy production and consumption. The energy gaps were found to be greatest in gasoline use.

Newman, Dorothy K., and Dawn Day. 1975b. Energy in the Home. In The American Energy Consumer: A Report to the Energy Policy Project of the Ford Foundation, eds. Dorothy K. Newman and Dawn Day, pp. 33-65. Cambridge, Mass.: Ballinger.

Method: A marginal frequency study of the role of consumer choice in home energy use (the domain for over half of all personal energy consumption) based on secondary data from a variety of sources and on the Washington Center for Metropolitan Studies Lifestyles and Energy Surveys (sample described in Newman and Day, above).

Variables: Consumer choice in relation to: personal energy use distribution; type of structure and heating fuel; mean annual total cooling degree days; size of home, presence of insulation, and other physical housing characteristics; changes in energy use by appliances, water heating, and air conditioning; and regions and specific characteristics, e.g., heating-fuel use and square feet of floor space.

Findings: On the average, space heating uses the most energy in the home, accounting for almost a third of all household energy use. Water heating uses about one-tenth. Cooking and refrigeration each use about 3 percent, with other appliances and lighting composing the remaining 9 percent. With regard to consumer choice this study is more oriented toward the prescriptive than the descriptive, although numerous data are reported on actual consumer and housing-market behavior.

Odum, Howard T., C. Kylstra, J. Alexander, N. Sipe, P. Lem, M. Brown, S. Brown, M. Kemp, M. Sell, W. Mitsch, E. De Bellevue, T. Ballantine, T. Fontaine, S. Bayley, J. Zucchetto, R. Costanza, G. Gardner, T. Dolan, A. March, W. Boynton, M. Gilliland, and P. Young. 1976. Net Energy Analysis of Alternatives for the United States. In Middle- and Long-Term Energy Policies and Alternatives: Part 1. Hearings before the Subcommittee on Energy and Power of the Committee on Interstate and Foreign Commerce, U.S. House of Representatives, 94th Cong., 2d sess. Washington, D.C.: U.S. Government Printing Office.

Method: Given that energy flows are the basis for organization of matter, information, money, and value, this study uses systems-level models to analyze the U.S. economic system in terms of flows of energy from domestic sources, from the environment, and from international exchanges. Termed "energy analysis," this technique produces estimates of net energy, i.e., energy yield minus that needed to collect and process the original energy. Intrinsic to energy analysis is a system of symbols for describing energy flow and storage. The secondary data used were transformed into fossil-fuel equivalents and are derived from a variety of statistical sources.

Variables: The net energy values of present and proposed types of energy sources and their current and likely future effects on the U.S. economy.

Findings: In view of the net energy constraints pursuant to declining stocks of fossil energy resources, it was determined that the present leveling trends in the U.S. economic system will not be reversed. Moreover, energy analysis diagrams suggest that when energy sources decline, the very high quality sectors of the economy on the end of the energy chain decrease most. Steady-state regimes (leveled economies) are projected for the U.S. and suggest sharp changes in public viewpoint and public policy if a smooth transition is to take place. Net energy analyses are discussed for the following cases: cooling towers, tertiary treatment, interface ecosystems, environmental technology generally, the harvest of environmental products, industrialized agriculture, and housing density. Public policy predictions based upon net energy analysis are provided for domestic energy sources, imported petroleum and project independence, deficit financing, unemployment, military defense, environmental protection, and energy pricing.

Olsen, Marvin E. 1978. Public Acceptance of Energy Conservation. In Warkov (1978), pp. 91-109.

Method: A review and synthesis of survey research studies on energy conducted since the 1973-74 oil embargo. This provides the basis for evaluating the relative effectiveness of persuasion, pricing, and pressuring as strategies for increasing public acceptance of energy conservation.

Variables: The state of knowledge about public acceptance of energy conservation.

Findings: A rather rapid and extensive shift has recently occurred in American public opinion toward awareness and acceptance of the energy problem. But the practice of serious energy conservation is not yet a significant feature of American life. The public appears to be ready to accept energy conservation policies that are rigorous by present standards, should they become necessary.

Pallak, Michael S., and William Cummings. 1976. Commitment and Voluntary Energy Conservation. Personality and Social Psychology Bulletin 2(1): 27-30.

Method: Two experiments, one focusing on use of natural gas (N=65) and the other on electricity (N-142), were conducted respectively in October 1973, just prior to the Arab oil embargo, and in June 1974, in Iowa City, Iowa. Above figures represent total participants including control groups. Subjects were interviewed to establish personal identification (public commitment) or no identification (private commitment) in agreeing to attempt energy conservation. The response measure of energy usage was provided by utility-meter readings for the month after the interview.

Variables: The effect of commitment, public or private, on energy-conserving behavior.

Findings: Homeowners under public commitment showed a lower rate of increase in the use levels for both experiments than under private commitment or in the control (no interview) group. Results from a set of self-monitoring conditions suggest increased attention to energy-use levels as a possible cause of conservation behavior.

Palmer, Michael H., Margaret E. Lloyd, and Kenneth E. Lloyd. 1977. An Experimental Analysis of Electricity Conservation Procedures. Journal of Applied Behavior Analysis 10(4):665-671.

Method: Two feedback conditions--daily knowledge of electricity cost and daily knowledge of electricity consumption--and two prompt conditions--daily requests for conservation and a letter from a government official requesting a decrease in consumption--were examined in connection with the consumption behavior of four Des Moines, Iowa, families. The daily electricity consumption of the families was recorded from meter checks over a 106-day period (2 February-19 May 1974). A baseline was established for, and all four conditions were administered to, each of the families.

Variables: The effects of two feedback and two prompt conditions on family electricity consumption.

Findings: Electricity consumption was reduced in three of the four families. Despite the evaluation of both prompting and feedback procedures, no clear differences emerged in their effectiveness. The savings in both electrical power and money was considerable for the subject families. The authors recommend consequence control over stimulus control in government programs to encourage energy conservation.

Passino, Emily M., and John W. Lounsbury. 1976. Sex Differences in Opposition to and Support for Construction of a Proposed Nuclear Power Plant. In The Behavioral Basis of Design: Selected Papers, eds. Lawrence M. Ward, Peter Sudfeld, and James A. Russell, pp. 180-184. Shroudsburg, Pa.: Dowden, Hutchinson and Ross.

Method: Statistical analysis of a 1975 survey of adults (171 males and 179 females) to determine sex differences in views toward the social impacts of a proposed nuclear power plant for a rural Tennessee county.
Variables: The effect of gender on perceptions of hazards, economic growth, social disruption, lower costs, and community visibility.
Findings: Seventy-three percent of males versus 57% of females answered either "definitely yes" or "probably yes" to the question of permitting construction. Results show that females were more opposed than males regardless of whether respondents were above or below the median age (46 years) and education level (12 years), or above the median level for number of years lived in the county (30).

Patterson, Arthur H. 1975. The Effect of the Winter 1973-74 Energy Shortage upon Attitudes about Preserving the Environment. Department of Man-Environment Relations, Pennsylvania State University, University Park.

Method: A two-wave telephone questionnaire (December 1973 and February 1974) of a random sample of 60 homeowners in the Philadelphia and Centre County areas of Pennsylvania.
Variables: The effect of the energy crisis on attitudes about preservation of the environment, based on a ten-mile attitude scale containing 9-point Likert-type items on, e.g., importance to the person of clean air and pure water. Data were also collected on self-reported energy consumption patterns.
Findings: A significant difference on post-crisis attitudes between those who heated their homes with fuel oil and those who used natural gas or electricity, the former rating environmental quality less important than the latter. This suggests that attitudes toward preserving the environment will become more negative as the costs to those holding the attitudes increase.

Peck, A. E., and O. C. Doering III. 1976. Voluntarism and Price Response: Consumer Reaction to the Energy Shortage. Bell Journal of Economics 7(1):287-292.

Method: An econometric study of changes in efficiency of household use of two heating fuels, natural gas (N=174) and liquefied petroleum (LP) gas (N=279) over the period 1971 to 1974. The study tested the effectiveness of the national conservation policy proposing creating voluntary alterations in consumption habits. Price data were obtained from two private gas companies (converted to an index with April 1971 as the base period) for the towns of Romney and Battle Ground, Indiana. A correction was made for temperature differences between winters.

Variables: The effect of national conservation policy (and the energy crisis) on fuel-use efficiency of LP gas and natural gas.

Findings: For LP gas customers, fuel-use efficiency increased 14.4%, while efficiency for natural gas customers increased only 5.8%. The latter increase was not significant at the 0.05 level. Authors suggest that among rural users of the types sampled, voluntarism evidently cannot be relied upon to reduce consumption substantially. They interpret the results as reinforcing the need for higher prices to induce fuel-use efficiency.

Perlman, Robert, and Roland Warren. 1977. Families in the Energy Crisis: Impacts and Implications for Theory and Policy. Cambridge, Mass.: Ballinger.

Method: A multistage area probability sample (N=1,440) was conducted in November 1974 in Hartford, Connecticut (N=658), Mobile, Alabama (N=483), and Salem, Oregon (N=243), to determine the impact of energy problems on households which differ by income level, social characteristics, geographic region, and access to energy supply. A follow-up questionnaire was mailed in November 1975 to ascertain changes in both behavior and attitudes since November 1974.

Variables: The effects of the energy crisis on families in terms of perceptions, attitudes, behaviors, and equity.

Findings: Self-serving economic and political motives were blamed by a majority of respondents for artificially generating the crisis. Some perceived it as a noncrisis, other saw it as potentially threatening. Adjustments were made by very sizable numbers of families in their use of the car. Considerable proportions of households cut back on the conveniences of home heating, air conditioning, and the use of electricity. Vital areas like health, well-being, and the basic financial condition of families, taken as a whole, did not seem affected. Most adversely impacted by the crisis were families whose wage-earners were forced to leave their jobs. The viability and life-styles of families other than these did not appear to be seriously affected. Aggregate energy savings was found to be 12 percent before attrition set in. With regard to equity impacts, "qualitatively and quantitatively different resources had the effect of setting differential constraints and opportunities within which families had to adjust to the energy crisis and had to absorb its costs and burdens." Higher income families demonstrated greater flexibility in absorbing cost increases. Poor families cut back more as a percentage of their pre-crisis consumption and endured a heavier burden of unemployment. Also discussed are the 1977 energy crisis and public policy on energy conservation.

Phillips, Peter. 1976. Household Energy Consumption. New Zealand Energy Research and Development Committee, Report No. 10. Auckland: University of Auckland.

Method: A summary of the results of a study of household attitudes toward energy use. During 1975 seven batches of a mail questionnaire were sent out to a random sample (N=17,500) of New Zealanders drawn from the 1974 Local Body Electoral Rolls. The response rate was just under 60%.

Variables: Attitudes of New Zealanders to the energy situation and to the need for conservation.

Findings: Considerable sympathy existed among respondents for the idea of energy conservation. The need for it was perceived to be high. The behavioral intention to conserve appeared to be well developed. Respondents particularly favored legislation to require insulation of new homes, to restrict car access to central cities in order to encourage public transport use, and to institute a progressive electricity tariff. Rationing was rejected by a 60-40 margin. Respondents felt first priority for oil, if the supply should become restricted, ought to be given to farm vehicles--not a surprising outcome in a nation heavily dependent on foreign earnings from agricultural exports. Railways and busses were ranked ahead of airlines in this regard, with private care ranked last. No relationship was found between knowledge of the energy sector and attitude toward energy conservation. Respondents demonstrated a reluctance to cut down on high-consuming uses in the home, and failed to consider that a very small proportionate reduction in one of the high-consuming uses would have at least an equal impact as a drastic reduction of a small-consuming use. Policy suggestions for turning behavioral intentions into behavior are included.

Pilati, David A. 1976. Energy Savings via Behavioral Changes. Industrialization Forum 7(2-3):102-106.

Method: Computer simulation to determine potential energy savings from several behavioral changes, based on data for a home typical of early 1960's construction.

Variables: The effect of behavioral change on energy savings with respect to temperature control settings. Hourly weather for cities also was a variable.

Findings: Theoretically, behavioral changes in the use of home space-conditioning systems could reduce U.S. energy consumption by about 4.5% with little discomfort.

Rappeport, Michael, and Patricia Labaw. Energy Polls. Opinion Research (Princeton, N.J.). 1974-76. Springfield, Va.: National Technical Information Service.

Method: Public opinion polls on energy were taken to determine public attitudes and behaviors toward the costs and availability of energy. Surveys were conducted monthly for 20 months, beginning September 1974, using telephone interviews. The samples (usually N=600-1,200 per month) were randomly drawn on a nationwide basis from selected adults in households having telephones. Analysis techniques used include frequencies and crosstabs in the study on reasons for using mass transit (multiple regression).

Variables: See individual listings below.

Findings: Mostly in the form of detailed tables without discussion; see individual listings below.

General Public Attitudes and Behavior Toward Energy Saving: Highlight Report Vol. 1. 1974. NTIS No. PB-244 979/1BA.

Based on 1,213 interviews conducted over a four-week period ending September 6, 1974. Respondents had come to believe that energy shortages are both serious and long-term; the degree to which respondents think the energy shortage is serious correlated strongly with whom they hold responsible; consumer groups were seen as the most trustworthy source of information. Additional results are presented on energy-related knowledge, solutions to the energy crisis, car pools, and packaging.

General Public Attitudes and Behavior Toward Energy Saving: Highlight Report Vol. 2. 1974. NTIS No. PB-244 980/9BA.

Based on 1,210 interviews conducted September 15-October 15, 1974. There was a small decline in trust in the federal government as an information source between the end of August and the beginning of October; perceptions of reasons for the energy shortage are reported; the majority of respondents thought Congress should legislate a minimum-miles-per-gallon standard for autos; the majority indicated that public transportation for shopping is available. Gasoline tax policy, foreign trade policy, natural resource availability, home lighting, and home heating were explored for policy implications. Most respondents are strongly opposed to any rise in taxes in order to cut down gasoline usage, and they appear to hold themselves responsible for doing a poor job of conserving natural resources.

Attitudes and Behavior of Residents in All-Electric Homes: Highlight Report Vol. 3. 1974. NTIS No. PB-244 981/7BA.

Concentrates on residents of all-electric homes and is based upon 100 personal interviews conducted among residents in two all-electric communities in Westchester County, New York. The purpose of the study is to determine in what way higher electric rates have affected behavior and whether residents are responding to higher rates through organized political action. Results are reported for the following variables: construction of the home, cost of heating, amount of yearly heating bill, total electric cost during the past 12 months, incidence of TV sets, and political action of residents outraged over increased electrical rates.

Energy Consumption and Attitudes of the Poor and Elderly: Highlight Report Vol. 4. 1974. NTIS No. PB-244 982/5BA.

Deals with energy consumption and attitudes of families with income under $7,000, and those 50 years or more in age. Results are reported for the following variables: seriousness, length, and severity of the energy shortage; the energy shortage as real vs. contrived; personal conservation efforts and their impact on total consumption of energy; attitudes toward specific government policies; changes in shopping habits as a result of inflation; cash payment vs. charging; means of transportation; and personal effects of the energy shortage.

Trends in Energy Consumption and Attitudes Toward the Energy Shortage: Highlight Report Vol. 5. 1974. NITS No. PB-244 983/3BA.

Concentrates on energy consumption and attitudes toward the energy shortage. Issues include: seriousness, length, and severity of the energy shortage; the energy shortage as real vs. contrived; effect of shortages on the public; satisfaction with President Ford's energy measures; effort made to save energy; results of the price increases on people's behavior, including use of cars influenced by shortages, use of cars influenced by price, leisure activities, and hobbies at home.

Consumer Attitudes Toward Gasoline Prices, Shortages, and Their Relationships to Inflation. Highlight Report Vol. 6. 1975. NTIS No. PB-244 984/1BA.

Focuses on consumer attitudes toward gasoline prices, shortages, and the relationship to inflation.

Respondents were categorized according to their cars' efficiency of gasoline use: under 15 miles per gallon, 15-19 miles per gallon, or 20 miles per gallon or more; and by average miles driven per week: under 30 miles, 30-99 miles, 100 miles or more.

Data are reported on the following variables: reasonableness of gasoline prices; efforts made to save fuel; concern for gas mileage; attitudes towards rationing vs. higher prices; higher prices for low-mileage car; higher taxes on gas vs. taxes on cars; the environmental costs of producing more energy; environmental threats of energy self-sufficiency; power plants and pollution; water and air pollution; the impact of lowered car usage on rate of inflation; and sponsoring of ads on gasoline mileage.

Consumer Attitudes and Behavior Resulting from Issues Surrounding the Energy Shortage: Highlight Report Vol. 7. 1975. NTIS No. PB-244 985/8BA.

Deals with consumer attitudes and behavior resulting from issues surrounding the energy shortage and is divided into highlights from Opinion Research Corporation's energy impact program (Waves 20-21), analysis of the role of education on attitudes and behavior; data on type of fuel used for home heating and its effects on consumer behavior attitudes, and synthesis of available data dealing with the public's willingness to pay for pollution controls and environmental cleanup.

In addition, the report includes data on the rising cost of electricity, rationing, the role of education in attitudes toward strip-mining, energy self-sufficiency, power plants and oil refineries as causes of air pollution, and oil-heat users.

Consumer Behavior and Attitudes Toward Energy-Related Issues: Highlight Report Vol. 8. 1975. NTIS No. PB-244 986/6BA.

Concerned with such national issues as unemployment, inflation, energy shortage, rationing vs. increased prices, increased oil import taxes, pollution control requirements, and sensitivity to rising gasoline prices. Also explored were public awareness of FEA and specific FEA advertisements; certain energy-saving efforts among the general public, and lack of public motivation and belief in the existence of an energy crisis; and public attitudes toward nuclear power plants, including thermal pollution, radiation discharge, nuclear accident, or disposal of radioactive wastes.

General Public Attitudes and Behavior Regarding Energy Saving: Highlight Report Vol. 9. 1975. NTIS No. PB-244 989/0BA.

Focuses on: seriousness of the energy shortage; methods for solving the energy problem; inflation and increased prices, unemployment, and the rebate plan; the role of rebates to encourage installation of storm windows and insulation; attitudes toward gasoline use and gas taxes, including concern with automobile gas mileage; appliance purchases, including the price of appliances and the electricity they consume; and public attitudes toward returnable bottles and cans.

General Public Attitudes and Behavior Regarding Energy Saving: Highlight Report Vol. 10. 1975. NTIS No. PB-244 988/2BA.

A study of energy saving divided in five parts: responsibility for natural resource conservation; public awareness of the Federal Energy Administration; attitudes and behavior related to daylight savings time; automobile usage and attitudes toward alternatives; and home insulation.

The Public's Attitudes Toward and Knowledge of Energy-Related Issues: Highlight Report Vol. 11. 1975. NTIS No. PB-244 987/4BA.

Attitudes toward nuclear power plants, the impact of school programs on home energy consumption, factors affecting use of mass transit, and company efforts at energy conservation are surveyed.

In connection with these categories the following variables are considered: role of the school in emphasizing energy conservation; efforts of children to conserve at home; efforts of children to recycle; car pooling in relationship to long-distance mass transit; availability of public transportation; interest in public transit for shopping; drawbacks to using public transportation; likelihood of using buses if special lanes were provided for them; impact of increased travel time; type of mass transit most needed; and money for mass transit vs. highways.

General Public Behavior and Attitudes Regarding Vacation and Business Travel, Beverage Containers, Reasons for Using Mass Transit: Highlight Report Vol. 12. 1975. NTIS No. PB-244 969/2BA.

Concerning travel, the following variables were involved: travel miles anticipated; kinds of trips taken; duration of trips; types of transportation; places visited; number of miles traveled; and effect of energy situation on trips. Questions about beverage containers included: regional differences in availability of containers; type of container preferred and type purchased; reasons for container selection; public reaction to deposit containers. A regression analysis was used for responses on attitudes towards mass transit, and mass transit available as a means of going to work.

Energy-Related Attitudes and Behavior of the Poor and the Elderly. Highlight Report Vol. 13. 1975. NTIS No. PB-244 990/8BA.

A study of the energy-related attitudes and behavior of the poor and elderly, divided into three parts: major problems in the U.S. and how they affect the poor and the elderly; plans for 1974 income tax rebates; and tradeoffs in pollution vs. price. Respondents had family incomes of under $10,000 or were 50 years of age and older. Interview items for which results are reported include: problems facing the U.S. today, such as rising unemployment, inflation, energy shortage; looking ahead at the problem of unemployment; impact of inflation; the federal government: spend or economize; trend in perceived impact of inflation; anticipated consumser price fluctuation; potential of income to keep pace with prices; fuels used in households; perceived and projected increases in prices of fuels; attitudes toward selling food to other nations; and ways to spend tax rebates.

Automobile Usage Patterns: Highlight Report Vol. 14. 1975. NTIS No. PB-246 076/4BA.

Concentrates on patterns of automobile usage and is based on 1,007 telephone interviews. Variables include car usage as affected by life-style; car-usage patterns; planned trips compared with spontaneous trips; times per week trip is usually made; analysis of trips; the extent to which shopping trips are done by phone instead of by car; willingness to cut out trips; and factors deterring car use. Findings suggest that the primary way that people could cut down automobile use without eliminating leisure-time use would be in more careful planning of trips for shopping and errands. Another important finding is a lack of sensitivity to gasoline price increases.

How the Public Views the Nation's Dependence on Oil Imports; A Possible Natural Gas Shortage This Winter; The Overall Need to Save Energy: Highlight Report Vol. 15. 1975. NTIS No. PB-245 828/9BA.

A study of opinions on these three issues. One general result is that respondents recognized the era of cheap energy to be over, but also believed consumption of foreign oil ought to be reduced and domestic resources developed. Variables involved perceptions and attitudes related to increased dependence on foreign oil; the fear of a natural gas shortage this winter; and the concern over the need to save energy.

A Public Opinion Survey on Energy and Economic Considerations and Air Pollution Controls: Highlight Report Vol. 16. 1976. NTIS No. PB-249 544/8BA.

Summarizes findings of questions on air pollution controls. It contains two parts: an executive summary and detailed tabulations of the questions. Sixty-two percent of the people do not regard air pollution as a serious problem where they live. Motor vehicle exhausts (55%) and factories and plants (52%) are seen as the most important causes of air pollution. Many people are willing to back up their commitment to less air pollution with money. In some cases, people are willing to change to more energy-conserving behavior rather than pay additional money to lower air pollution. People show a desire to prevent the significant deterioration of air quality. Ninety-four percent think areas that now have clean air should be kept as clean as they are now.

Conservation of Energy in the Home: Highlight Report Vol. 17. 1975. NTIS No. PB-254 628/1BA.

Surveys public behavior and attitudes toward conserving home heating fuel, gasoline, electricity, and hot water.

Note: The following, although not attributed to Rappeport and Labaw, are listed here in continuation of Opinion Research Corporation's energy survey series.

Consumption and Conservation of Natural Gas: Highlight Report Vol. 18. 1975. NTIS No. PB-254 629/9BA.

Gives the results of a survey of attitudes towards natural gas.

Private Individuals' Willingness to Make Energy-Saving Efforts and their Perception of the Likelihood of Others Doing the Same: Highlight Report Vol. 19. 1976. NTIS No. PB-255 946/6BA.

This report addresses: individual predispositions toward energy-saving behavior, the importance of energy saving, and the likelihood of other people conserving energy. It was found that past behavior is generally regarded as the most accurate predictor of future behavior patterns.

Public Knowledge, Attitudes and Behavior Relating to Natural Gas Issues: Highlight Report Vol. 20. 1976. NTIS No. PB-261 161/4BA.

A nationwide probability sample survey of 1,004 respondents was conducted by telephone from October 24 through November 9, 1975. Most respondents believed that a serious need to save natural gas exists in the United States, and they expressed a willingness to personally make efforts to conserve it. They understood that heating homes consumes a great deal of natural gas, and had taken steps to conserve home heat. Many respondents did not realize that it takes a great deal of energy to heat water, nor did they understand how natural gas supplies are allocated. They believed that natural gas should be conserved in order to save natural resources for the future. Because of this, respondents seemed receptive to reliable, credible information on how to conserve effectively.

Driving and Energy Conservation: Highlight Report Vol. 21. 1976. NTIS No. PB-261 162/2BA.

A nationwide probability sample survey of 1,207 respondents was conducted by telephone from November 26 through December 21, 1975. These data indicate that most drivers drive in ways that save gasoline. Ninety-six percent stop pressing the gas pedal when they see a red light; 84% plan several errands for one trip; 84% have their car engine tuned at least once a year; and 84% drive 55 mph on major highways. The major exception is that 69% drive themselves to work, whereas only 10% carpool or take passengers, 8% take public transit, and 5% walk to work.

Energy Saving Behavior Around the Home. Highlight Report Vol. 22. 1976. NTIS No. PB-261 163/0BA.

A nationwide probability sample survey of 1,016 respondents was conducted by telephone from December 30, 1975, through January 15, 1976. The survey showed most people's home use of energy to be tied to their beliefs regarding what constitutes energy saving, especially with respect to home heating, insulation, electric lights, water heaters, and washers, dryers, and dishwashers. Forty-nine percent reported setting their thermostats below 69°F during the day and 15% at or below 60°F at night; 79% said their homes are insulated; 55% turned lights off when leaving the room for a short time; 42% did not know to what temperature their water is being heated.

Results show that beliefs about energy consumption affect the way people behave; therefore, the report concludes, people should be informed through public education of more energy-efficient ways to behave.

Parents' Perceptions of Their Children's Sources of Energy Information and Energy-Related Activities: Highlight Report Vol. 23. 1976. NTIS No. PB-261 162/8BA.

A nationwide probability sample survey of 1,002 respondents (606 of whom were living in households with children under 18 years who were attending school) was conducted by telephone from January 27 through February 25, 1976. The results indicate that a substantial amount of energy information had been transmitted to American homes by children who obtained such information in school. Information about energy conservation was welcomed. Parents seemed particularly interested in home heating and lighting information. They expressed the desire for more information on saving gasoline. Parental behavior and attitudes were reflected in children's behavior and attitudes, and vice versa. Most respondents felt sponsorship of energy-saving school programs by utility companies and government to be appropriate. Children's TV programs, publications, and organizations were perceived as good means of communicating energy information to children.

Understanding the Energy Situation and Evaluation of Alternative Actions: Highlight Report Vol. 24. 1976. NTIS No. PB-261 165/5BA.

A nationwide probability sample survey of 1,203 respondents was conducted by telephone during the period March 22 through April 19, 1976. Despite two years of energy shortage, nearly one respondent in eight (13%) did not believe it to be a real problem, and only 5% saw the energy problem as U.S. dependence on foreign oil supplies. They preferred saving energy around the home in ways that would not entail physical discomfort, e.g., weatherproofing the home rather than raising the setting of air conditioners or lowering thermostats. Respondents appeared to favor life-cycle pricing information in terms of purchasing choice. Income tax credits were regarded as more potent incentives than guaranteed bank loans for getting homeowners to make energy-conserving home improvements. Respondents wanted the government to provide them with information on how to save energy.

Riegel, K. W., and S. E. Salomon. 1974. Getting Individual Customers Involved in Energy Consumption. Public Utilities Fortnightly 94(10):29-32.

Method: Atlantic City Electric Company of New Jersey innovated a statement (March 8, 1974) on each residential monthly bill, telling how much more or less electricity was used in the current month as compared to the same month the previous year.

The new billing was sent to 180,000 residential customers without direct prior notification. Eight hundred inquiries, mostly by telephone, were received during the first billing cycle (about 5% of the bills sent out and more than double the normal number of inquiries). Any design in this crude experiment is probably accidental.

Variables: The reduction of residential electricity consumption pursuant to information feedback via billing, and in conjunction with other company conservation measures.

Findings: Atlantic City experienced a 2.6% gain in April, less than the national average of 3.4%, and in May, with the program fully implemented, residential sales dropped 4.6% below the previous year's level (the national figure rising over 3%). The reduction is in part attributed to price increases. About two-thirds of the customers were surveyed in March 1974 by the company's Marketing Research Department. Respondents stated they were either conserving as much as possible (by reducing heating, cooling, or use of lights) or were concerned and intended to conserve energy.

Schipper, Lee, and A. J. Lichtenberg. 1976. Efficient Energy Use and Well-Being: The Swedish Example. Lawrence Berkeley Laboratory Report 4430. Berkeley: University of California. Reported in Science 194:1001-1013.

Method: A detailed comparison between per capita energy consumption in the U.S. and Sweden, based largely on 1970-72 data from statistical abstracts and various other sources.

Variables: Basic economic and social indicators; energy use related to transportation, residences and commerce, industry, and imports and exports.

Findings: Sweden used 55-65% of the per capita energy (with the counting of hydroelectric being problematic) at essentially the same per capita income as the U.S. This difference was shown to arise both from differences in the mix of economic activities and in the energy consumption per unit output in these activities. Sweden had higher efficiencies in transportation, materials processing, and space heating. Heavy use of automobiles in the U.S. was a major factor. The study suggests that institutional and social factors determine how close individual consumers, firms, and society as a whole come to the most economic use of energy; e.g., in contrast to Sweden, U.S. mortgage policies and market considerations constrain developers to minimize first costs, rather than life-cycle costs.

Schnaiberg, Allan. 1975. Social Syntheses of the Societal-Environmental Dialectic: The Role of Distributional Impacts. Social Science Quarterly 56(1)5-20.

Method: Summarizes existing empirical research on the distributional consequences of the energy crisis.

Variables: Effects of the energy crisis on consumption, employment, income, and profits.

Findings: Energy crisis (as a simulation of "planned scarcity") had net regressive distributional impacts, e.g., the poor suffered more than the well-to-do in terms of income loss, unemployment, impacts on life-styles; small businesses were hurt more than large corporations; and the Nixon Administration was able to use the energy crisis to justify curtailing "nonessential" federal governmental expenditures in such areas as health, education, and welfare.

Schneider, Alan M. 1975. Elasticity of Demand for Gasoline. Energy Systems and Policy 1(3):277-286.

Method: A study of gasoline sales in California to measure elasticity of demand. A time-series analysis was used in conjunction with data from 13-plus years (1960-72). Data for sales were taken from the State Board of Equalization and from reported sales for regular grade from 4,000 major brand retail stations in Los Angeles. An average figure for price was arrived at using the latter.

Variables: Price per gallon and monthly sales of gasoline in the Los Angeles area.

Findings: A 17% increase in the price of gasoline in the Los Angeles area produced no observable change in gasoline consumption for the time period analyzed. Demand was thus found to be price-inelastic.

Schnidman, Frank. 1977. Awareness and Perception of the States to Local and Regional Needs Created by Energy Production or Extraction Facilities. Prepared by the Urban Land Institute. Washington, D.C.: U.S. Department of Housing and Urban Development.

Method: A survey of state and territorial planning and energy agencies and departments of community affairs to determine their awareness and perception of the problems created by boom developments of energy production or extraction facilities. Forty-three states and the Virgin Islands responded to the survey. Three important energy-producing states--Kentucky, New Jersey, and Ohio--did not.

Variables: State awareness and perception of boom energy developments.

Findings: Responses revealed a variety of both existing and planned facilities. Community impacts existing in or forecast for a region appeared to be greatest for the Atlanta, Dallas, and Denver federal regions. The most commonly cited problems were inadequate capacity to plan, water pollution, and local government management ability. The most commonly cited severe problems were housing, local government management ability, and sewage treatment. Items reported to be little problem most often included insufficient warning of boom, parking areas, and adequacy of local government legal authority. Siting legislation, mine location, mineral severance tax, and an energy policy were the most often cited as relevant existing, pending, or proposed government actions. The study finds a lack of adequate support for programs already existing, rather than a dearth of state or federal programs which could be used to respond to certain impact created needs.

Schuller, C. Richard, James R. Fowler, Thomas J. Mattingly, Jr., Eric Sundstrom, John Lounsbury, Emily M. Passino, David A. Dowell, and Barbara J. Hutton. 1975. Citizens' Views About the Proposed Hartsville Nuclear Power Plant: A Preliminary Report of Potential Social Impacts. Oak Ridge, Tenn.: Oak Ridge National Laboratory (ORNL-RUS-3). [See also, Sundstrom *et al.* (1975, 1977), below.]

Method: A marginal frequency analysis of a random sample (N=350) of Trousdale County, Tenn., surveyed by interview during February 1975, to determine the potential impact of a large nuclear power plant complex on a rural community.

Variables: Socioeconomic background, demographic characteristics, attitudinal perceptions of the community, the changes respondents anticipate would accompany construction and operation of the plant, and respondents' evaluation of these changes.

Findings: People were apparently residing in the community because they liked it. Sixty-five percent of respondents favored the plant, 29% opposed, and 10% were undecided. The strongest supporters tended to be involved in business and labor occupations. A small majority of farmers opposed the facility. The most adamant opponents were generally women. No differences between supporters or opponents emerged from other background indicators such as formal education, age, and length of residence in the area. Support was most closely associated with the expectation of positive economic benefits. Opposition stemmed from concern over radiation and the potential for accidents at the facility, even though opponents tended to regard economic growth and development as desirable for the community.

Schwartz, Timothy P. 1975. Societal Energy Consumption: An Evolutionary Theory and a Preliminary Empirical Analysis. Ph.D. dissertation, University of North Carolina, Chapel Hill.

Method: A correlation and regression/path analysis of cross-national time-series data (largely collected from UN sources) on 120 societies, in order to test an evolutionary theory of energy consumption. The data are for the years 1929 and 1969.

Variables: The author provides 34 operationalizations of nine theoretical constructs, e.g., urbanization, division of labor, and energy consumption--all of which are macrosocial structural characteristics of nations. The research views societal energy consumption as both a major cause and effect in a complex matrix of social, demographic, and economic forces.

Findings: Societal energy consumption is found to be a major causal element in determining aspects of social structure, e.g., intrasocietal contact and economic productivity. These variables appear to have important causal ramifications for urbanization, division of labor, and intersocietal contact, which, in turn, influence energy consumption. The results, while suggestive, are tempered by the limitations of the data base.

Schwartz, T. P., and Donna Schwartz. 1974. The Short End of the Shortage: On the Self-Reported Impact of the Energy Shortage on the Socially Disadvantaged. Presented at the meeting of the Society for the Study of Social Problems, Montreal. Available from T. P. Schwartz, Coventry, R.I.

Method: A study of the self-reported effects of energy shortage, based on a panel survey conducted in July and November 1973 and March 1974. A systematic sample (N=200), proportionate to city size, of heads of households was drawn from the city directories of Chapel Hill, Durham, and Raleigh, North Carolina. Data were cross-tabulated using a significance level of 0.05.
Variables: The differential impact of energy shortage as reported by heads of households.
Findings: The energy shortage did not discriminate against socially disadvantaged groups; it did not discriminate more against groups that have multiple social disadvantages; and such discrimination did not emerge or increase as the shortage endured and worsened.

Sears, David O., Tom R. Tyler, Jack Citrin, and Donald R. Kinder. 1976. Political System Support and Public Response to the 1974 Energy Crisis. Presented at the Conference on Political Alienation and Political Support, Stanford, Calif., May. Available from Department of Political Science, University of California, Los Angeles.

Method: An examination of the role of support for the political system in determining compliance to attitudes and actions that government defines as in the public interest, specifically in connection with the case of responses by Los Angeles County residents to the energy crisis of 1974. A multistage probability sample (N=1,069) of Los Angeles residents aged 18 and over was used and interviews were conducted February-March of 1974. Data on household electricity and natural gas usage were obtained from utility companies. Four major hypotheses were tested.
Variables: Support for the political system as indicated by diffuse system support, partisanship, the individual's long-standing symbolic loyalties, and personal impact, all as related to the 1974 energy crisis in Los Angeles.
Findings: Diffuse system support was found to be significantly related to the official government energy line. Partisanship was also, as well as being strongly correlated with system support. The personal impact of the crisis had virtually no effect at all in terms of citizen's attitudinal response, i.e., it did not inspire general conformity to or rebellion against the official government interpretation of the energy crisis. Neither system support nor partisanship contributed significantly to behavioral reductions in energy consumption; however, the personal impact of the crisis did. Overall, attitudinal predictors (system support, partisanship, and perceptions of the crisis) are the most important predictors of attitudinal

response (policy support). Personal impact rather than long-standing political attitudes was the major factor in behavioral compliance.

Seaver, W. Burleigh, and Arthur H. Patterson. 1976. Decreasing Fuel Oil Consumption through Feedback and Social Commendation. Journal of Applied Behavior Analysis 9(2):147-152.

Method: A sample of 180 households was drawn randomly from the list of continuing accounts in the area of a university community in central Pennsylvania, and divided into two test groups and a control group to assess two methods of facilitating fuel-oil conservation--informational feedback and informational feedback plus commendation. The study was conducted from February through May 1974, during an acute oil shortage.

Variables: The effect of two manipulations on consumer behavioral patterns of fuel-oil consumption.

Findings: The consumption rate of the feedback-plus-commendation group was significantly lower than that of either the group receiving only information on rate of oil use or the control group.

Seligman, Clive, and John M. Darley. 1976. Feedback as a Means of Decreasing Energy Consumption. Presented at annual meeting of the American Sociological Association, August. Available from Center for Environmental Studies, Princeton University, Princeton, N.J.

Method: July-September 1975 experimental study of 40 homeowners in a planned unit development of identical dwellings in central New Jersey, to determine the effect of consumption feedback on energy consumption in residential housing. Participants were randomly divided into control and feedback groups. A baseline relationship between daily average temperature and daily consumption was established, using regression analysis, from readings of electric meters for five weeks. Both groups were told air conditioing is the biggest energy user and should be reduced. The feedback group was given daily (Tuesday-Friday) percentage scores indicating the degree to which participants' actual consumption corresponded to predicted consumption. Experimental data were subjected to analysis of variance.

Variables: The effect of information feedback on the energy conservation behavior of families in connection with the use of home air conditioning.

Findings: Both groups used significantly less electricity during the treatment period compared to the baseline, partly due to cooler weather in the treatment phase. During treatment, the feedback group consumed 10.3% less than the control group. Within the feedback group, the lower the initial level of consumption, the greater the amount of conservation during treatment. This suggests that feedback is more successful with moderate users than with high users of electricity.

Seligman, Clive, John M. Darley, and Lawrence J. Becker. 1978. Behavioral Approaches to Encouraging Residential Energy Consumption. In Saving Energy in the Home: Princeton's Experiments at Twin Rivers, ed. Robert H. Socolow, pp. 231-254. Cambridge, Mass.: Ballinger.

Method: Review of ongoing research designed to produce and test psychological strategies for helping people significantly reduce their residential energy consumption. Work to date was done on a recently completed planned unit development (PUD) of 3,000 homes at Twin Rivers, New Jersey. Each home has identical dimensions and appliance packages, thus facilitating comparisons. Descriptions and results are given for four feedback experiments, involving summer electricity usage, setting specific goals, and alternative types of feedback under summer and winter conditions. Also detailed are progress on thermostat research to achieve automatic dial-down, and results of an attitudinal survey in the Twin Rivers project. The four experiments were conducted respectively on 40 three-bedroom townhouses, 100 three-bedroom townhouses, 325 residents who had not participated in earlier studies (148 responded favorably to the request), and 125 subjects from experiment 3 who were asked to continue (54 declined).

Variables: The effects of four feedback techniques on energy consumption by residents in a PUD.

Findings: Experiments 1 and 2 yielded significant reductions in consumption of electricity, particularly when a difficult goal was adopted by subjects. The results of experiments 3 and 4 were equivocal but encouraging. All groups in experiment 3 exhibited reduced gas consumption while the two feedback groups in experiment 4 achieved moderate reduction, compared with the control group in each experiment. The researchers conclude that taken together the studies indicate feedback can be an effective strategy for energy conservation.

Smith, B. W., and G. R. Frey. 1975. Factors Influencing Spatial Consumption of Energy in the United States. Tijdschrift Voor Economische En Sociale Geographie 66(4):246-250.

Method: Correlation and regression of 1971 aggregate U.S. energy consumption by state, using secondary data from the U.S. Bureau of the Census, the Department of Interior, the Federal Highway Administration, and the National Oceanic and Atmospheric Administration.

Variables: The effect of per capita scores for value added by manufacturing, value added by minerals production, and value of agricultural output, income, total miles traveled, and climate, on the spatial consumption of energy in the U.S.

Findings: The major factors influencing the spatial pattern of energy use of states are the localization of manufacturing and minerals production. Income, climatic conditions, and volume of traffic appear to bear little, if any, relationship to the pattern of aggregate energy use.

Sparrow, Tom, Seymour Warkov, and Robert C. Cass. 1978. Socioeconomic Factors Affecting the Adoption of Household Solar Technology: First Findings. In Warkov (1978), pp. 194-203.

Method: A study of the diffusion of household solar-heating technologies, based upon household telephone interviews (N=45) conducted throughout the United States. Respondents were all owner-users of solar custom homes.
Variables: The factors contributing to the diffusion of household solar heating technologies.
Findings: The average income of respondents was high but appeared to be beginning to drop. Solar purchasers with incomes below the sample median reported difficulty with financing, but felt fixed costs to be less of a problem than did higher income respondents. Developer-contractors seem to be replacing financiers as advisers about solar homes. When local utilities were consulted they proved less likely to encourage or facilitate the decision to go solar, undoubtedly a significant barrier to future public acceptance of this technology.

Stearns, Mary D. 1975. The Behavioral Impacts of the Energy Shortage: Shifts in Trip-Making Characteristics. Transportation Systems Center. Cambridge, Mass.: U.S. Department of Transportation.

Method: National random sample surveys (N=700), December 1973 and February 1974, gathered by home interview and statistically analyzed to contrast aggregate and disaggregate shifts in trip characteristics. Data are from National Opinion Research Center's Continuous National Survey.
Variables: The effect of the 1973-74 energy shortage on trip frequency, modes, and purpose for households of different income level.
Findings: In the aggregate, the energy shortage seems to have mildly decreased trip frequency, not changed modal use, and decreased shopping trip incidence. Disaggregation by income level revealed that sub-poverty-level respondents apparently did not decrease trip frequency, but significantly reduced their use of the automobile, and reported no significant shifts in their incidence of trip purposes, all by contrast with above-poverty-level respondents.

Stearns, Mary D. 1975. Social Impacts of the Energy Shortage: Behavioral and Attitude Shifts. U.S. Department of Transportation. Bethesda, Md.: Congressional Information Service (American Statistics Index Microfiche 7308-53).

Method: A study of selected household responses to the energy shortage, specifically with respect to shifts in behavior or trip characteristics, and in attitudes towards the energy shortage and conservation alternatives. Data were drawn from National Opinion Research Center national random sample survey (N=700) collected at the onset and peak of the national energy shortage of winter 1973-74.
Variables: The effect of the 1973-74 energy shortage on trip frequency, mode, and purpose for households of different income level, and

on household attitudes towards the energy shortage and conservation alternatives.

Findings: Subpoverty level household members report significant modal shifts away from auto trips, compared with no change for above-poverty household members. Trip frequency remained the same for the former but decreased for the latter. Analyses of attitudes showed that social status is positively correlated with shortage perception; household evaluation of its financial status is negatively correlated with expected duration of the energy shortage; and negative evaluations of household energy shortage impacts are positively correlated with dissatisfaction with regard to enacted energy conservation policies. It was also found that households became less tolerant of conservation policies as they experienced the energy shortage.

Stern, Paul C. 1976. Effect of Incentives and Education on Resource Conservation Decisions in a Simulated Commons Dilemma. Journal of Personality and Social Psychology 34(6):1285-1292.

Method: An experimental study of two strategies for escaping the double dilemma of conflicts between individual and collective good due to uncontrolled growth in a finite world and between short-term and long-term good. The strategies are: (1) making group-oriented behavior pay off for individuals through incentives or strengthened group ties and (2) inducing people to act from long-term perspective by educating them about the probable consequences of their acts. The subjects were 48 undergraduate students drawn from classes in freshman Arts and Sciences and Introductory Psychology. Each was informed he would be paid for participating. A 2 x 3 x 2 design was used in a four-person commons game modeled on a car pool in which forms of incentive and education were manipulated.

Variables: The effect of rationing, pricing, and influence attempts on resource conservation decisions.

Findings: Price-increase incentives produced a conservation effect which increased with their magnitude. Direct payoffs and a rationing system proved ineffective. Education by spot messages was not effective; however, detailed information about long-term consequences substantially extended the life of resources. The latter effect appeared early, even before that of incentives. The author cites reasons that the laboratory results are less likely to work in the world-at-large.

Stewart, Charles T., Jr., and James T. Bennett. 1975. Urban Size and Structure and Private Expenditures for Gasoline. Land Economics 51(4):365-373.

Method: Correlation and regression analysis of 134 SMSA's with 1970 populations of 200,000 or greater. Data for retail sales of gasoline and lubricants were obtained from the 1967 Census of Business; population data are from the U.S. Bureau of the Census.

Variables: Effect of urban size, proportion of the population in central cities, population per square mile in the central city and outside the central city, rate of growth, etc., on per capita retail gasoline sales.

Findings: The predictive power of the regression was generally low. SMSA size and rate of growth were found to be negatively related to per capita gasoline consumption, proportion of nonwhite population to be positively related. Per capita gasoline consumption was much higher in the West and North Central regions and much lower in the Northeast and South.

Sundstrom, Eric, John W. Lounsbury, C. Richard Schuller, James R. Fowler, and Thomas J. Mattingly, Jr. 1975. Community Attitudes Toward a Proposed Nuclear Power Generating Facility as a Function of Expected Outcomes. University of Tennessee, Knoxville.

Method: A January 1975 sample survey of 350 residents of a rural Tennessee county. A factor analysis and simple multiple regression equation using factors as predictors were used to analyze variation in attitudes.

Variables: Attitudes about hazards, economic growth, power costs, social disruption, and community visibility, etc., as related to a proposed nuclear power plant.

Findings: Approximately two-thirds of the respondents expressed favorable attitudes toward the proposed nuclear plant. The five main variables listed above accounted for 54% of the variation in attitudes toward the plant. The strongest predictor--perceived likelihood of hazards--was inversely related to favoring the proposed nuclear power plant.

Sundstrom, E. P., E. J. Costomiris, R. C. DeVault, D. A. Powell, J. W. Lounsbury, T. J. Mattingly, Jr., E. M. Passino, and E. Peelle. 1977. Citizens' Views About the Proposed Hartsville Nuclear Power Plant: A Survey of Residents' Perceptions in August 1975. Oak Ridge, Tenn.: Oak Ridge National Laboratory (ORNL/TM-5801).

Method: A panel (N=288) of residents of Hartsville and Trousdale County, Tenn., were interviewed January 1975 and reinterviewed in August 1975 to determine their views about the nuclear power plant being constructed nearby by the TVA. Trained local residents conducted the interviews; respondents received $5 for participating. Two questions were addressed: (1) What factors are related to favorable attitudes toward the nuclear plant? (2) How do residents of Hartsville perceive their quality of life, and how have their perceptions changed since the earlier survey?

Variables: Correlates of attitudes toward the Hartsville nuclear power plant, residents' perceptions of quality of life, and changes in those perceptions during the process of facility planning and prelicensing.

Findings: Sixty-nine percent of the panel (the supporters) said that, if they could decide, they would permit the facility to be built.

The remainder were opponents. Attitudes toward the plant were consistent from January to August, even when measured through different questions. Most supporters would favor a coal-burning plant, while most opponents would also oppose a coal-burning facility. Perceived effects on the community are detailed. Supporters were much more likely than opponents to rely on TVA for information about the facility. Only among farmers and farm workers were opponents a majority. Opposition was also relatively prevalent among women and unemployed persons. Quality of life received high ratings which showed no appreciable decline from January to August, and no substantial differences between supporters and opponents.

Svalastoga, Kaare. 1976. Space, Population, Energy, and Information in Seven Nations: 1820-1970. International Journal of Comparative Sociology 17(1-2):30-47.

Method: An examination of four factors related to the survival chances of a nation--the space controlled by the nation, its home population, and the amounts of energy and information it produces. The nations studied are U.K., France, Germany, USSR, U.S., China, and Japan. The historical data used came from a variety of sources. Data are plotted and analyzed by correlation and regression.
Variables: The effect of space, homeland population, energy sources (in coal equivalents per year), and information revealed by science and technology, on the historical power relationships between the nations selected.
Findings: A potential power index is adduced which shows for 1960 the U.S. to be the most powerful and the U.K. the least powerful of the nations analyzed. For 1820 China was found to have the highest potential power, followed by the USSR and the U.K. By 1840, the U.K. was on top, a position it maintained through the century. The USSR had arrived in third place by 1880, with Germany in fourth place. By 1900 the order was the U.K. (by a wide margin), the U.S., and Germany. The U.K. remained ahead for 1920, the U.S. held second, and the USSR moved to third.

Talarzyk, W. Wayne, and Glenn S. Omura. 1975. Consumer Attitudes toward and Perceptions of the Energy Crisis. In Combined Proceedings of the American Marketing Association: 1974 Conference, ed. Ronald C. Curhan, pp. 316-322. Chicago: American Marketing Association.

Method: Initial findings from a national survey on consumer attitudes toward the energy crisis (N=1,000 households), administered a few days after the oil embargo officially lifted (March 1, 1974). Factor analysis was performed on the survey data. A varimax rotated factor analysis is used to determine the effect of differences in age, income, geographic area, and other socioeconomic variables on consumer activities, interests, and opinions.
Variables: The effect of the energy crisis on consumers activities, interests, and opinions (AIO).

Findings: Greatest accord among respondents was found in the areas of attitudinal response to the energy shortage, the energy shortage's effect on activities, blame and responsibility for the energy shortage, rationing of energy resources, and the economic repercussions of energy resources. Cross-classifications between socioeconomic variables and the AIO statements, as related to the above issues, revealed associations primarily between age versus attitudinal response (older people reported less resistance to energy conservation) and between age and income versus the energy shortage's effect on activities. The $15,000-plus income classes were more likely to report a change in activities; middle-range age groups had less tendency to report a change in miles expended for shopping.

Thompson, Phyllis T., and John MacTavish. 1976. Energy Problems: Public Beliefs, Attitudes and Behaviors. Urban and Environmental Studies Institute, Grand Valley State College, Allendale, Mich.

Method: A February 1976 random sample (N=600) survey of the Grand Rapids metropolitan area drawn to determine the perceptions and beliefs that might underlie energy-related behaviors. The data were collected by interview and subjected to marginal frequency analysis.

Variables: Beliefs, attitudes, and behaviors in relation to energy use.

Findings: The respondents were distinctly divided on energy questions. The larger group (over 50%) was cynical and did not trust the information they had received, did not believe oil and gas resources could be exhausted, and regarded gasoline shortages of 1974 as manipulation by industry and government. This group adopted few or no conservation measures. They tended to be at lower occupational levels, less educated, and older than the smaller distinct group (approximately 20%) which believed we have a real and persistent energy problem. The latter believed in future exhaustion of oil and gas, and expected energy shortages, higher development costs and large price increases. They reported adoption of a variety of conservation measures. This group tended to be skilled, college-educated, and under 45.

Tuso, Margaret A., and E. Scott Geller. 1976. Behavior Analysis Applied to Environmental/Ecological Problems: A Review. Virginia Polytechnic Institute, Blacksburg. Summarized in Journal of Applied Behavior Analysis 9(4):256.

Method: A topical set of summaries of the research designs, procedures, results, and conclusions of recent behavioral interventions for ecological rebalance. The topic most germane to the present purpose is "Energy Consumption" (pp. 42-49) where a number of studies dealing with behavioral manipulations to achieve energy conservation are described.

Variables: Effectiveness of behavioral measures, as reported by various studies, to achieve energy and materials conservation.

Findings: Reinforcement procedures for litter control, recycling, and energy conservation show that cash payments or incentives of monetary value have proven effective, as have contingencies administered in the form of large-scale programs of lotteries, group contests, token economies, and individual rewards based on specific levels of performance. Difficulties enumerated include transiency of effects and the number of personnel and amount of time necessary to conduct the projects.

Walker, Nolan E., and E. Linn Draper. 1975. The Effects of Electricity Price Increases on Residential Usage of Three Economic Groups: A Case Study. In Texas Nuclear Power Policies, vol. 5: Social-Demographic and Economic Effects, pp. 102-126. Center for Energy Studies, Policy Study No. 1. Austin: University of Texas.

Method: Marginal frequency analysis based on a July 1974 survey of a random sample (N=60) of households in Austin, Texas, to determine the impact of price increases on income groups, behavior and attitudes, and electricity consumption changes. Data were gathered by personal interview and electricity consumption records (from a utility company) for the previous two years.

Variables: The effect of electricity price increases on three economic groups (lower, middle, and upper income) over a two-year period.

Findings: The number of lower income households increasing their energy use equalled the number decreasing their energy use. For middle income households, the number decreasing was greater than the number increasing their energy use. For upper income households, the number increasing ran well ahead of the number decreasing electricity consumption--suggesting that upper income groups are the least influenced by price rises. Middle income groups seem to show the greatest price elasticity.

Warkov, Seymour. 1976. Energy Conservation in the Houston-Galveston Area Complex: 1976. Energy Institute. Houston: University of Houston.

Method: A marginal frequency analysis of Houston-area residents' energy conservation and usage practices as related to income level and home ownership, based on a spring/summer 1976 random sample telephone survey (N=3,019) of Houston-Galveston metropolitan residents. The survey had the larger purpose of monitoring changes in life-styles, attitudes, and other behaviors of the population.

Variables: Energy conservation related attitudes and behaviors by household income level.

Findings: During the 12 months preceding the interviews: 75% of the respondents reported curtailment in the use of electric lights in their homes, with 65% also reporting curtailment in the use of air conditioners; 54% said they or other household members had reduced family or personal driving; 29% reported that they "bought a car that consumes less gas"; 26% indicated that they or other household members reduced the amount of driving to and from work by car pooling; 14% had insulated their home or apartment. Virtually no difference was found between the 12 income groups selected with respect to the use of electric lights, but the higher income levels curtailed air conditioning less. Both the highest and the lowest income level households were less likely to report energy-conserving behavior in driving habits. This was also true for car pooling. The likelihood of insulating proved to be directly related to income level, the poor being least and the upper income groups most likely to do so. The very lowest income households were least likely to report car pooling. In general, the higher the income level, the greater the likelihood of reporting purchase of a more energy-efficient car.

Warkov, Seymour, ed. 1978. Energy Policy in the United States: Social and Behavioral Dimensions. New York: Praeger.

Warren, Donald I. 1974. Individual and Community Effects. In Response to the Energy Crisis of Winter 1974: An Analysis of Survey Findings From Eight Detroit Area Communities. Available from Department of Sociology and Anthropology, Oakland University, Rochester, Mich.

Method: An April-June 1974 random sample survey of 766 households in eight Detroit area communities, using interviews to determine responses to and attitudes toward the "energy crisis" in the previous months. Data were statistically analyzed for individual and socioeconomic correlates.

Variables: Effects of income level, individual conservation behavior, employment status, household characteristics, and community setting on attitudes toward the Winter 1973-74 energy crisis.

Findings: The energy crisis of 1973-74 was perceived by respondents as a failure of U.S. institutions rather than a result of the actions of foreign countries. The crisis was experienced most prominently by the middle class ($10,000+ incomes). Those with incomes below $10,000 were less likely to report that they had experienced shortages or had cut back in the use of energy. The vast majority of respondents indicated some energy-conserving behavior. Social setting was determined to play a major role in the individual's perceptions and attitudes.

Warren, Donald I., and David L. Clifford. 1974. Local Neighborhood Social Structure and Response to the Energy Crisis of 1973-74. Available from Department of Sociology and Anthropology, Oakland University, Rochester, Mich.

Method: Statistical analysis of an April-June 1974 random sample interview survey (N=766) of households in eight Detroit area communities to determine the role of local neighborhood social structure in the energy crisis of 1973-74.

Variables: The effect of neighborhood typology (six varieties of local contexts) on individual attitudes and responses to the energy crisis.

Findings: The typology provided an important source of explained variance in perceptions, reported behaviors, and helpful sources of information. These differential patterns tended to follow closely those postulated for each neighborhood type. "Integral" and "stepping-stone" neighborhoods were highest in perceiving the energy crisis as real, while the "anomic" type was lowest.

Wascoe, Nancy E., Stuart W. Cook, and Richard Beatty. 1976. The Effects of Fear Appeals Upon Behavioral Intentions Toward Energy Consumption: A Replication. Institute of Behavioral Science. Boulder: University of Colorado. (See Hass *et al.* [1975]).

Method: During February through May 1976 students in the University of Colorado School of Business read one of eight communications, then completed an attitude and behavioral questionnaire. The communications were the orthogonal combinations of three two-level factors--probability, severity, and efficacy (to responding individual) in connection with energy shortage. A behavioral measure was also included: whether or not students responded to an invitation to join an energy conservation project. Data were evaluated via a 2 x 2 x 2 analysis of variance.

Variables: The effect of fear appeals upon behavioral intentions toward energy consumption.

Findings: Students who read the "severe negative effects" communication expressed stronger intentions to conserve energy, as did those who read the high efficacy communication (but only with regard to group conservation activities). The probability factor had no effect. None of the three factors was found to affect actual behavior.

W. B. Doner, and Market Opinion Research. 1975. Consumer Study: Energy Crisis Attitudes and Awareness. Detroit: W. B. Doner.

Method: A marginal frequency study of awareness, attitudes, behavioral changes, and perceived future effects of the energy crisis, based on a stratified area sample (N=525) of the state of Michigan. Data were collected between February 27, 1975, and March 10, 1975, by telephone interview.

Variables: Perceptions of and attitudes toward the energy crisis, behavioral changes due to shortages, and socioeconomic impacts.

Findings: Half of the sample perceived that there was an energy crisis, up 9% since a similar survey one year earlier (50%, February 1975, versus 41%, February 1974). Media attention appeared to be the major reason for the increase. Three-fourths claimed to have changed their behavior in response to the energy crisis, even though only half really believed it exists. Sixty-one percent reported conservation, the principal behavioral changes being reducing the use of gasoline, lowering home temperatures, and using less electricity, mainly by reducing use of lights. One motive for conservation measures was clearly because "conserving energy saves money."

Williams, Robin M., Jr. 1976. Testimony Before the Public Service Commission of New York, Case No. 26806: Report on Recent Developments in the Design of Rates for Low-Volume Residential Electric Utility Customers. Elmira, N.Y.: Chemung County Neighborhood Legal Services.

Method: A reporting of selected data and findings from the 1975 national household energy use survey carried out for the Washington Center for Metropolitan Studies by the Response Analysis Corporation. The survey basically updates and expands a survey carried out in 1973 as part of the Ford Foundation Energy Policy Project (see Newman and Day [1975a,b]). The 1975 random sample (N=2,952) survey involved personal interviews of households nationwide, with a subsample (N=221) of New York households and a subsample (N=569) of northeastern U.S. households. Meter data were collected for the households surveyed.
Variables: The relationship between income (and other socioeconomic characteristics), and the consumption of electricity.
Findings: The correlation between income and electricity usage was determined to be generally the same for all U.S. households, for those in the Northeast, and for New York State. The poor use much smaller amounts of electricity than the average household, and about half or less of the amount used by the well-off. For New York State the range in average monthly kilowatt hours consumed is 335 for the poor to 761 for the well-off. According to the survey, by contrast with the well-off the poor tend to live in smaller quarters, to use electricity less for air conditioning, and to have a smaller number of electric appliances. The poor also spend proportionately more of their income for the electricity they use. The results of the 1975 survey corroborate those of the 1973 survey.

Winett, Richard A., and Michael T. Nietzel. 1975. Behavioral Ecology: Contingency Management of Consumer Energy Use. American Journal of Community Psychology 3(2):123-133.

Method: A January 31-March 28, 1974, study of two volunteer groups in Lexington, Kentucky, to determine their relative reductions in the use of natural gas and electricity (monitored by meter). One group (N=16) received monetary incentives and the other (N=15) information on how to conserve electricity. A one-way analysis of variance technique was used to analyze the data.
Variables: The relative effects of monetary incentives and of information alone on energy-conservation behavior.
Findings: The incentive group averaged approximately 15 percent more electricity reduction than the information group. This statistically significant difference was maintained in follow-ups.

Woodson, Herbert H., Martin Baughman, Hal B. H. Cooper, Charles G. Groat, Jerold W. Jones, Michael Kennedy, Sally Cook Lopreato, Cliff Drummond, and William Lesso. 1976. Direct and Indirect Economic, Social, and Environmental Impacts of the Passage of the California Nuclear Power Plants Initiative. Center for Energy Studies, University of Texas.

Springfield, Va.: National Technical Information Service (PB-253 658/9BA).

Method: A set of scenarios projecting low, medium, and high electric energy demand growth rates, in conjunction with different electric energy supply alternatives, is used to evaluate the likely impacts of the California nuclear power plants initiative. Analytical models were used to study the interaction of the following components: conservation assessment, electrical energy demand, supply, projection, and cost analysis, long-run economic growth assessment, California input-output assessment, energy resource assessment, sociocultural assessment, and environmental and health impacts assessments. Results are reported for years 1977, 1985, and 1995.

Variables: Projections of the direct and indirect economic, social, and environmental impacts of enactment of the California nuclear power plants initiative.

Findings: California apparently will need additional electricity. Large-scale supplies may be required in addition to hydro, geothermal, and solar energy resources. Elimination of nuclear as an alternative would force increased reliance on other energy sources which possess their own impacts, risks, and uncertainties. Nuclear energy is assumed to provide the lowest cost electricity compared to coal and oil, leading the authors to conclude that elimination of nuclear energy will cause the price of electricity to rise in California. The scenarios show that there may be few overall economic or social effects should nuclear power be phased out, provided that alternatives are available. Increased use of coal could have significant social and environmental effects in nearby states, especially in terms of air and water quality. Increased use of oil could have adverse impacts on California's air quality, and would be contrary to the goals of Project Independence. Uncertainties related to nuclear waste and the fuel cycle are noted.

Wright, Susan. 1975. Public Responses to the Energy Shortage: An Examination of Social Class Variables. Ph.D. dissertation, Iowa State University, Ames.

Method: Interviews from a random sample (N=190) of Des Moines, Iowa, residents, stratified by social class criteria, were used to investigate relationships between social class and perceptions of energy shortages.

Variables: Social status measures in relation to energy shortage response variables.

Findings: Correlational analysis revealed significant relationships between each of the energy shortage response variables--e.g., attribution of responsibility for the energy crisis--and at least one of the social status indices (education, income, occupation, and so forth). The strengths of these relationships, however, were not sufficiently large to indicate a general social class polarization of interests over the energy crisis issue.

Young, Jeffrey W., John L. Mitchiner, Kenneth E. F. Watt, and John W. Brewer. 1975. Land Use and Energy Flow at the National Level. Simulation 24(1):113-116.

Method: Simulation model of the interaction between agricultural and energy sectors at the national level. The model, SPECULATER, simulates certain hypothetical interactions between national level import versus agricultural export policies and the population density versus transportation characteristics of U.S. urban areas. Runs are reported for 1970, 1975, 1985, and 2000. The secondary data used are from various sources.

Variables: Per capita gasoline demand, population size and age structure, price of agricultural land, acreage harvested, wheat exports, etc.

Findings: Preliminary simulations demonstrate inherent homeostatic mechanisms. Results of three runs with differing assumptions are given. Although the quadrupling of petroleum prices by OPEC has had a major impact on the U.S. economy, it can be inferred from the model that the overall impact may have certain positive effects, e.g., the boosting of U.S. agricultural production and exports.

Zucchetto, James. 1975. Energy-Economic Theory and Mathematical Models for Combining the Systems of Man and Nature--Case Study: The Urban Region of Miami, Florida. Ecological Modeling 1:241-268.

Method: A study of the Miami, Florida, urban region with respect to energy flow and the relationship between energy theory and economics. Economic, natural system, and energy data were compiled for this region for the period 1950-72. These data were analyzed by cross-correlation, i.e., a technique for determining how well two functions track each other in time, and used for a simulation model on an analog computer.

Variables: The systematic interactions of socioeconomic (e.g., retail sales, food, population, building structure, and taxes) and natural (e.g., rainfall, wind, and pollution assimilated by the environment) energy flows and storages.

Findings: Cross-correlations showed significant levels of correlation between the rate of change of fossil fuel use and the rates of change of population, budget, sales tax, income, building structure, and number of telephones. It was determined from the simulation that the ratio of natural to fossil fuel energy changed from 1.77 in 1950 to 0.25 in 1972.

Zuiches, James J. 1975. Energy and the Family. Department of Agricultural Economics, Cooperative Extension Service, Report No. 390. East Lansing: Michigan State University.

Method: Overview of and initial findings from a five-year longitudinal study of energy and the family. Benchmark cross-section was established May-June 1974 when a multistage area probability sample (N=217, 160 urban and 57 rural) of Lansing SMSA families was surveyed by self-administered questionnaires and personal interviews.

Variables: Energy use as related to attitudes, food consumption, transportation, housing conditions, financial expenditures and resources, and the character and quality of the family functions within the family, with friends, relatives, and the larger community.

Findings: Respondents were evenly divided about the reality of the 1973-74 energy crisis, 30% believing energy shortage will be crucial within 5 to 10 years. Acceptability of specific energy policies varied by sex and location, from most to least: urban females, urban males, rural females, and rural males. Least acceptable policies involved severe restrictions, regulation, or rationing. A positive association was found between education, energy awareness, and policy acceptance. Preliminary results are also reported for changes in family nutritional status, household energy use, and the effect of homemaker employment on household energy consumption.

Zuiches, James J. 1976. Acceptability of Energy Policies to Mid-Michigan Families. Agricultural Experiment Station, Research Report No. 1976. East Lansing: Michigan State University.

Method: Marginal frequency analysis of the attitudes of a 1974 survey of Lansing SMSA (N=217) families toward the energy crisis.

Variables: Respondent attitudes with respect to energy policies.

Findings: A bare majority of respondents believed the crisis to be real. There was wide divergence in the acceptability of specific energy-saving policies. In general, urban females were most favorable to each policy. Policies that would restrict electrical use, ration meat, increase taxes for large families, and manipulate school seasons were in the category of limited acceptability (less than 20%). Most respondents were supportive of policies re-establishing local grocery stores, providing tax deductions for home insulation and home improvements, and fostering increased home gardening and home food preparation.

Zuiches, James J. 1976. Coercion and Public Acceptance: The Case of Energy Policies. Presented at annual meeting of the Society for the Study of Social Problems, New York, August. Available from Department of Sociology, Michigan State University, East Lansing.

Method: An evaluation model based on Theodore J. Lowi's typology of public policies is used to determine the acceptability of various energy policies that would directly or indirectly affect energy conservation by consumers. Data are from two surveys of the Lansing SMSA, taken during Spring 1974 (N=217) and Spring 1976 (N=259). The model of policy acceptance employs path analysis. Results are compared with a partial regression model of energy policy as affected by sex, urban/rural residence, energy awareness, belief in the energy crisis, and education.

Variables: The effect of socioeconomic characteristics on attitudes toward four policy types: (1) distributive--policies without negative sanction; (2) constituent-voluntaristic--policies affecting the individual's environment, but entailing no coercion; (3) regulative--policies with explicit negative sanctions; and (4) redistributive--policies affecting the individual's environment, and entailing some coercion.

Findings: Regulative and redistributive policies had the lowest levels of support, on the average being acceptable to about one-fourth of the respondents in 1974 and one-third in 1976. Voluntaristic policies with no value-laden implications scored highest (75% in 1974). Distributive policies were acceptable to 43% of the respondents in 1974 and 54% in 1976. In general, urban females were most favorable to each policy. Urban males, rural females, and rural males, in descending order, found policies less acceptable. The partial regression model was found to do a better job in explaining levels of acceptance of energy policies than the model of coercion.

Zuiches, James. Ongoing. Changing Family Energy Behavior through Infra-Red Heat Loss Evaluation: An Experimental Approach. Institute for Child and Family Studies, Michigan State University, East Lansing.

Method: Experimental extension of an ongoing five-year longitudinal survey of Lansing SMSA households, which seeks to assess changes in energy conservation attitudes, behaviors, and actual consumption from utility company records, pursuant to feedback (an array of alternative actions presented to families). Hypotheses tested derive from the pretreatment survey findings. Thermographic photography and a computer analysis of individual residential energy efficiency together are used to determine heat loss and recommended changes; this information is conveyed to the experimental subject. The experimental design entails three kinds of feedback treatments, two types of delivery treatments and a control group. Households were stratified by income levels and residential location, then randomly assigned to control and treatment groups (N=40 for each) from the different strata. Analysis of variance is to be used to evaluate the data.

Variables: The effects of three kinds of feedback through two types of delivery on family attitudes and behaviors toward household heat loss.

Findings: Not yet reported.

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