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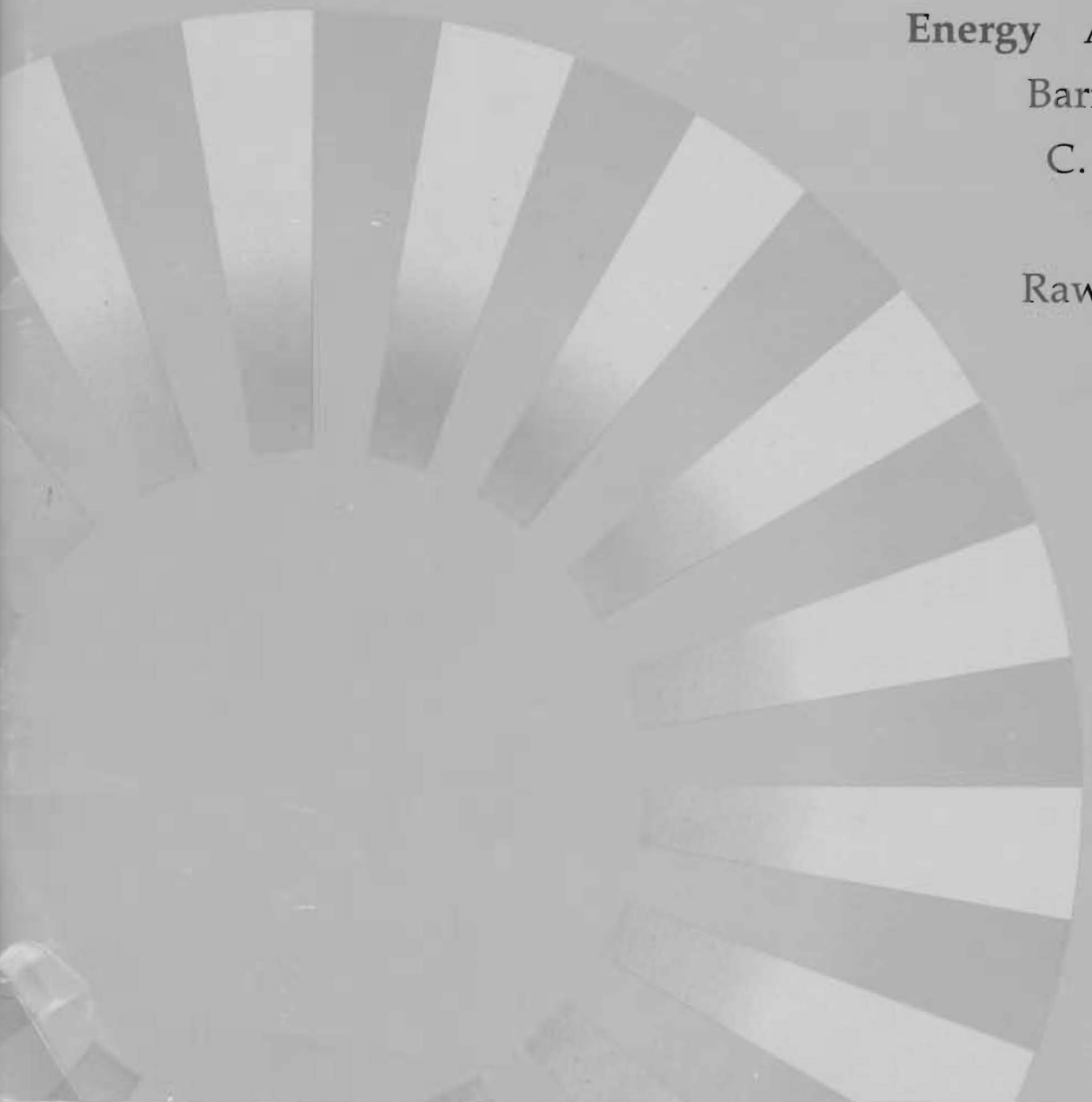
EXECUTIVE

Cornell University Spring 1976 Graduate School of Business and Public Administration



Energy A Symposium

Barry Commoner

C. C. Garvin, Jr.

Arnold Miller

Rawleigh Warner

Ralph Nader

Al Ullman

Frank Zarb

and others

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EXECUTIVE

Cornell University

Graduate School of Business and Public Administration
Volume 2 Number 3
Spring 1976

OPINION

Letters

Your issue on careers was the most interesting you have published to date. It has contributed more to my thinking on a topic of real concern than anything I have recently found in the publications to which I subscribe.

I would like to comment on Congresswoman Abzug's article which succinctly describes the role of women on the Hill. In noting the difference between male and female career paths to elected office, she implies that, in the future, women who tend to seek office in response to pressing issues should chart careers in elected office as men do. But surely we already have too many career politicians. Do we not want both men and women to enter office because of a concern for the problems facing our country rather than for purely personal enhancement? And is it not wise for all of our representatives to have some experience as private citizens so that they share some of the concerns of the people whom they represent?

Albert D. Evans
Garden City, New York

It is poignantly amusing that most of the attributes which, according to your distinguished writers, bring an individual to "power, leadership or success" are not emphasized in schools of management.

Frederic West notes the importance of integrity, a concept clearly not understood by many of the young future managers whom I meet. Henry Ford says that successful individuals make the most of their strengths; yet most young students of management cannot evaluate their strong and weak points, let alone make the most of their assets. Energy, mentioned by Robert S. Morison, does not seem to be a characteristic of students who, I believe, try to get by with as little work as possible on their way to that all-important degree.

I hope the members of your faculty will take heed and pay closer attention in their classes not only to marketing and finance but also to values and attributes which are important to success.

Leon Kearl
Scranton, Pennsylvania

Congratulations on the *Executive*. It is truly an outstanding addition to contemporary business journalism. Your recent issue on "Careers" was especially appealing. If possible, I would appreciate receiving two additional copies of that particular issue.

Keep up the good work.

David A. Heenan
Dean
University of Hawaii at Manoa

I was particularly impressed with the scope of "The Career Labyrinth" in the last issue of the *Executive*. Too often Americans think of the idea of career simply within the context of the business world. By soliciting views from a painter, an astronomer, and a composer, the magazine included the diversity that the word "career" actually embraces.

Jacob Barnes
Boston, Mass.

I want to add my congratulations for the outstanding job being done on the *Executive*.

"The Career Labyrinth" was timely and thought-provoking. I refer particularly to the piece by Tom Lodahl, who made an outstanding contribution to my education at Cornell, and who obviously has lost none of his insight and perspective.

Thomas F. Tyson
Product Manager
Foremost Foods Co.

Two Classes of Common Stock

Stockholders should be allowed to "vote" on whether or not a corporation retains earnings. To accomplish this objective and to protect the rights of minority stockholders, we suggest that two classes of common stock be created.

One class of common stock would receive cash dividends equal to earnings per share. The second class would be granted a stock dividend (the number of shares being a function of the share price). Shares could be converted from one class to the other through a small transaction cost.

Such a system would certainly give stockholders more maneuverability. If, for example, stockholders did not like the earning possibilities arising from corporate reinvestment, they could individually convert their investment into dividend-paying shares. On the other hand, if stockholders wanted the firm to reinvest, they could convert to stock dividend paying shares.

This proposal faces a major difficulty. Since the IRS would probably consider the stock dividend to be taxable income because it changes the percentage of ownership, tax laws would have to be changed before the plan would be feasible.

Currently the decision to reinvest is completely in the hands of the board of directors. The individual investor can only express dissatisfaction by selling shares. This proposed change makes corporate capitalism more democratic and inserts the "market" back into the decision process.

Harold Bierman, Jr., B&PA Professor of Business Administration.
Seymour Smidt, B&PA Professor of Managerial Economics.

Against Interest Ceilings

Under Regulation Q, the Board of Governors of the Federal Reserve System imposes interest rate ceilings limiting the amount that banks can pay on time deposits, demand deposits, and certificates of deposit.

It is, I believe, difficult to define the justifications for interest ceilings on this portion of the capital market. Although it can be argued that this ceiling on payment of interest keeps interest costs on loans lower than they would otherwise be, I question whether this is desirable.

Some investors are harmed by these ceilings. Time deposit investors have, for example, been paid interest below that of alternative money market securities for many years. Thus, sophisticated investors reduce their time deposits to minimum levels.

For short periods of time, governmental interference with market forces may make sense, but there is no reason to build this interference into the banking system over the long-run. It is, in fact, questionable whether the Government should be allowed to shape the allocation of resources and the redistribution of income.

The situation deserves study.

Harold Bierman, Jr., B&PA Professor of Business Administration.

The "Heavy Half"

Marketers have successfully used segmentation strategies in selling consumer goods for many years. These strategies target selling efforts at that segment of consumers who are most apt to respond to the marketer's efforts. In essence, then, segmentation strategies identify a group or groups of consumers sufficiently large to warrant a separate marketing effort.

The "heavy half" strategy — one segmentation approach — is a particularly useful perspective for devising energy conservation programs. This strategy takes its name from the fact that a small percentage of the total population consumes a disproportionate amount of a given product. Once this segment is identified, marketers concentrate their efforts on this group and consequently, sell more of the product.

We must take a similar approach to energy conservation. Researchers are, in fact, now examining the potential effectiveness of this strategy with consumers of electrical energy. Studying one large utility, they have learned that 18 percent of residential consumers use 54 percent of the electricity. What must now be determined is whether this 18 percent (the "heavy half") differs significantly from the other 82 percent. If the "heavy half" does differ in such areas as motives for consumption, ability to conserve, psychographics, and media consumption, then energy conservation efforts should be aimed primarily at this group.

C. Samuel Craig, B&PA Assistant Professor of Marketing.
John M. McCann, B&PA Assistant Professor of Marketing.

Load Management

Reliable and sufficient supplies of electricity are a *sine qua non* of our national energy policy. These supplies can be assured by taking two steps: first, the U.S. must develop, in an orderly fashion, its coal, oil and uranium; secondly, this Country has to institute a strong energy conservation program. If we hesitate in achieving these ends, we will bear the burden of higher costs, increased dependence on insecure sources of supply, and intolerable environmental abuses.

Load management is a major means of improving efficiency and, consequently, of conserving energy. The deterioration of load factors — both average load and peak load — has aggravated the financial condition of the electric utility industry already hurt by inflation. Yet the initial Federal Energy Administration analysis in support of the updated Project Independence "Nation's Energy Outlook" offers a way to beat higher costs. It suggests that electric plant capacity costs can be reduced by $60 billion through 1985 by load management practices which would, in turn, cost $12-15 billion. By shifting demands to baseload coal and nuclear plants, 1.3 million barrels of oil per day would be saved; electric bills would decrease by $7 billion per year, and the retail price of electricity would typically be reduced by 8 percent under what it would be without load management.

Load management is built upon differential time rates and cost-saving devices that spread energy usage more evenly through the day and the year. These devices include such things as hot water heaters that operate off-peak, radio or ripple load control systems for selectively shedding industrial or residential loads, and customer heating storage systems that permit home heating electrical inputs to be accomplished at night.

The FEA is sponsoring rate and load management demonstrations in approximately twenty states, soliciting voluntary commitments from the hundred largest gas and electric utilities, and presenting testimony in local regulatory proceedings to accelerate the adoption of these practices.

Douglas C. Bauer
Associate Assistant Administrator
Utilities Programs
Federal Energy Administration

Worldwide Oil Reserves

Percentages represent shares of the world's known, extractable oil reserves in each area.

ENERGY

A Symposium

Since the fall of 1973 the world has faced escalating oil prices and a fearful uncertainty over the future availability of petroleum. The experience of the past few years has forced us to recognize that an economy heavily dependent upon a finite resource will inevitably falter if alternative resources are not developed. Given current rates of consumption, the U.S. will, most experts agree, exhaust accessible domestic supplies of oil and natural gas by 2000.

Within Congress, the business community and the universities, debate has raged over two broad questions. What are the appropriate Government policies to shape foreign and domestic energy markets? And what are the alternative sources that may supply future energy needs?

During the past two years, the U.S. has hesitated over two basically contradictory directions in foreign policy. Heeding the voice of Secretary of State Kissinger, many have urged the creation of an "Organization of Petroleum Importing Countries" which would bargain with OPEC, trading food and other consumer goods for petroleum. Others have argued for a more conciliatory position. They have insisted that the U.S. must reevaluate its pro-Israel policy and contrive a more even-handed approach to the Middle East.

On the domestic scene, policy debate has focused on the petroleum industry. When oil companies reported unusually high profits in 1973 and 1974, some critics asserted the industry itself was responsible for high prices, that the big firms should be broken into smaller companies to increase competition. A public opinion poll conducted in December 1975 by the Roper Organization indicated that 37 percent of all Americans favored the break-up of big oil firms. Last year, two bills advocating divestiture of big oil firms were narrowly defeated in the Senate. This year similar bills are also being considered by Congress. Other public officials have argued for expanded price controls on oil and gas.

The industry has not been without its advocates. Congressmen, scholars and business leaders have warned that regulated prices would discourage further oil and gas exploration. Some have insisted that any form of divestiture would lead to inefficiency and higher prices. Industry spokesmen have maintained that the current attack on the industry is really an attack on bigness itself, which could well lead to the restructuring of the entire economy.

The search for alternative sources of energy is no less important than questions about Government policy. Although discoveries of new supplies of domestic oil and gas could decrease dependence on imported petroleum, these new finds would be no more than a short-run solution. While the U.S. has the technical know-how to extract oil from oil shale and gas from coal, mining oil shale often ravages the land, and gas produced from coal is about four times as expensive as the gasoline now used.

Some believe that the solution to our future energy problems lies in the development of technologies that will harness wind, tidal, solar, or nuclear energy. Yet the prospects for both wind and solar energy are limited to certain geographical areas; neither can be expected to supply more than a small percentage of the fuel we will require. Since little research has been done on tidal energy, this is, at best, only a possibility for the future. Though nuclear energy — in the form of either fission or fusion — has its proponents, the jury is still out. As a result of unforeseen reactor breakdowns throughout the Country, a number of experts question whether fission is economically practical or ecologically safe. While there have been several substantial breakthroughs in fusion research, few will predict just when fusion will be a practical alternative.

The terrain is fogged with uncertainty. Yet recognizing that the magnitude of our energy problems and the uncertainty surrounding possible solutions have combined into a highly complex situation, we hope this issue of the *Executive* clarifies some of the choices before us. Admittedly only a beginning, it will, we believe, lay the foundation for intelligent, informed discussion.

The Editors

OPEC: The Limits of U.S. Power

Frederick Bent

We can no longer put off a full-scale debate on U.S. policy toward the Middle East. More precisely, we must ask whether current U. S. policy should be modified to ensure that we — and to a greater extent Europe — will not again be threatened by uncontrolled fuel prices and an embargo. Without a more even-handed approach to all the countries of the Middle East, neither stability nor peace can be achieved.

I know that simply raising the question of a U.S. policy change arouses the fear and anger of many people, and understandably so. Yet we cannot continue to ignore the fundamental fact that our economy and well-being depend upon a Middle East at peace. Turbulence and unrest inevitably threaten our oil supplies. The facts speak for themselves:

Table 1

World Petroleum Reserves
560.1 billion barrels

Middle East	60.3%
Asia	4.8
Africa	9.1
Europe	12.3
S. America	4.7
N. America	8.8

No discussion of U. S. policy can be understood, however, without a firm grasp of the history of U. S.-Arab relations from 1945 to the present. In the pages that follow, then, I will point to the dominant shifts in U.S.-Arab relations during the past 30 years, and — once the events of this period are clearly in mind — suggest the foundations for a new Middle East policy.

Let me begin with some broad brush strokes. From 1945 until the early 1970's, U.S. interest in the Middle East had been both sporadic and inconsistent. It was sporadic in the sense that we became involved only when Israeli interests were at stake. For reasons which are well-known and understandable, the United States supported the establishment and survival of Israel in 1947 and in 1948, yet this stance reversed what had been a cordial — if distant — friendship with the Arab nations. Thereafter, we assisted Israel politically, financially, and (indirectly) militarily, whenever it was threatened by the neighboring Arab states. In the 1967 war and again in 1973, we airlifted *vast amounts* of munitions to this beleaguered country. Yet in the intervening years of uneasy peace, America largely ignored political developments in the Arab states.

We can no longer put off a full-scale debate on U. S. policy toward the Middle East.

Our foreign policy has, then, been inconsistent. On the one hand, we have been unabashedly pro-Israel, looking upon the so-called confrontation states of Irak, Syria, and Egypt with suspicion and distrust. But on the other hand, we have attempted to be, if not pro-Arab, at least neutral toward the oil-producing states in the south: Saudi Arabia, Kuwait, Bahrain, Qatar, the United Arab Emirates, and Oman. In short, we knew our needs. We did not have to be reminded that the continued extraction of oil was possible only if the United States maintained friendly rather than hostile relations with the oil-producing countries.

Still, it was only a question of time before the Arab nations would use oil as a political weapon to force the adoption of a foreign policy which recognized the legitimate rights of both Arab and Jew. It is, in fact, rather surprising that it took the Arab states so long to recognize the power they had. Three reasons probably account for this late coming-of-age in international politics. First, the Arab states were divided politically and economically from each other. Second, the Gulf states were almost totally dependent upon the oil companies for revenue and upon the British, with the exception of Saudi Arabia, for the conduct of their foreign policy. Third, the traditional tribal leaders in the Gulf states were opposed to the radical, secular regimes in Egypt, Irak, and Syria, and many of the leading rulers also harbored long-standing resentments against the Hashemite Kingdom of Jordan. Saudi Arabia and the smaller sheikhdoms in the Gulf were on the wings of Middle Eastern politics.

The gradual emergence of these oil-producing countries to stage center falls into 3 major phases. The first is the period between 1945 and 1968. This span can be characterized as the era of oil company domination. Huge concessions were granted by these nations to one or several of the "Seven Sisters". Saudi Arabia's oil was extracted and refined by Aramco, a consortium of four American companies — Exxon, Standard of California (Socal), Mobil, and Texaco. In Kuwait, Gulf and British Petroleum were the sole partners. In Iran, the "Seven Sisters," plus the French national oil company, totally dominated oil production. In Bahrain, Texaco and Socal controlled production. And so on. Almost all Middle East oil was extracted by these 7 large companies. In 1973 the 5 American oil companies alone controlled over 50 percent of the world's total petroleum reserves. In collaboration, they set the price of oil (in 1960 it was $1.60 per barrel) and established production schedules. Acting virtually as sovereign powers, they made decisions on prices and production that influenced economic and industrial policies throughout the world.

It was a period in which the Gulf states were politically quiescent. Saudi Arabia was just starting an ambitious economic development program, though within the context of its own Moslem orthodoxy and traditional rulership system. The smaller states of Kuwait, the Trucial states (now the United Arab Emirates), Qatar, and Oman were still under British protection, and oil production had barely started. The number of university graduates was small, jobs were scarce unless with the oil companies, and the level of political consciousness was low indeed.

But there were murmurings of change: the major development was the formation of the Organization of Petroleum Exporting Countries (OPEC) in 1960, brought about, incidentally, by the unilateral lowering by Exxon of the posted price of crude oil the year before. Initially confined to a few states including Venezuela, Saudi Arabia, and Iran, OPEC gradually grew in size to its present thirteen members. Less well-known was the establishment of OAPEC, The Organization of Arab Petroleum Exporting Countries, shortly after the debacle of the 1967 war. By and large, however, neither organization posed any threat to the oil companies. But they were both, it now seems obvious, an impressive beginning:

Table II

Members of OPEC and their Oil Revenues
($ Billions)

Country	*1973*	*1975*
Saudi Arabia	$5.2	$26.8
Kuwait	2.0	7.8
Iran	4.1	19.2
Libya	2.3	5.8
Ecuador	.2	.6
Venezuela	3.3	8.2
Irak	1.5	8.3
Algeria	1.3	3.4
Indonesia	.9	4.3
Gabon (Assoc.)	.1	.8
Nigeria	2.0	6.4
U.A.E.	.9	6.4
Qatar	.4	1.6
Oman	—	1.0

Members of OAPEC (formed in 1969)

Saudi Arabia	Libya
Kuwait	Algeria
Irak	Bahrain
U.A.E.	Egypt
Qatar	Syria

The second phase was from 1968 to 1973. During this short span of five years, the balance of power gradually shifted away from the oil companies to the producing states. Four major political events triggered this unexpected transition. In 1970, Muammer Qadaffi came to power in Libya and soon made clear his intentions of treating the oil companies in ways quite different from those of the complacent and aged King Idriss. A political radical and a religious conservative, Qadaffi was determined that the oil companies would march to his tune. About the same time, the Shah of Iran, having redistributed the non-crown lands to peasants, now looked to the oil companies for the revenue he needed to initiate his ambitious industrialization projects. Derided for his weakness in 1953 when he was temporarily forced to leave the country, he was determined, though few recognized this, to make Iran a regional power to contend with. During this period, the Palestine Liberation Organization also came into prominence; regardless how one may condemn its acts of terrorism and violence, more than any other factor it captured the imagination of the Arabs humiliated by their defeat in the 1967 war.

The final event (and this, too, was noticed by only a few) was a 1968 OPEC policy decision which stated that sovereignty over oil should be exercised by the national states, that equity participation in the oil companies should be shared with the producing states, and that the posted price of oil was a national responsibility.

These warning signs were largely ignored. In 1970, President Nixon asked George Schultz to report to him on the possibility of an oil boycott should war break out in the Middle East. The reply was reassuring: the Arabs, Schultz noted, could never get together. More aware of the changing political climate than the American Government, the oil companies agreed in 1972 to allow the producing states a 25 percent equity participation with the promise that this would increase to 51 percent in 1983. They hoped this gesture would still the radical voices demanding immediate nationalization. Yet this concession to Arab nationalism was not matched by our Government. When Sheikh Yamani and King Faisal warned, in the spring and fall of 1973, that U.S. pro-Israeli policy would poison the investment climate in Saudi Arabia and the Gulf states, the State Department refused to listen.

The third phase of Arab maturity began shortly after the beginning of the October 1973 Yom Kippur war. It can accurately be called the period of producer sovereignty. With the

imposition of an oil embargo, the war was quickly brought home to the American public, Europe, and Japan. Although some petroleum slipped through the net despite the efforts of the oil companies, who were obliged to enforce the embargo, its political effect was far more important than the temporary economic inconvenience it caused. European countries and Japan, threatened with reduced supplies, sent their diplomats with hat and checkbook in hand to assure the Arab states of their good faith. U.S. Government officials argued feverishly over what should be done if the embargo were continued indefinitely. Encouraged by Secretary of State Kissinger's efforts, the embargo was eventually called off. But the point had been made: the Gulf states could no longer be taken for granted.

More important in the long run was the precipitous increase in the price of oil. In 1960 the company-set price was $1.60 a barrel. Thirteen years later it had risen to about $2.60. In the space of 6 months it had quadrupled to over $10.00 a barrel. The embargo was a selective penalty. But the oil price increase affected all countries: industrialized and agrarian, developed and underdeveloped, rich and poor.

The war also guaranteed that the takeover of the oil companies, euphemistically called participation, would be sooner than originally perceived. The 1972 agreement stating that 51 percent majority Arab ownership would not take place until 1983 was cancelled, and an immediate 60 percent was granted; it was expected that the takeover would be complete by 1976. The oil companies would of course remain, but as contractors, not owners.

Of the 3 consequences, only the embargo can be directly attributed to the war. Oil price escalation and 100 percent participation would have taken place even had the conflict not broken out. But these decisions would not have been taken so quickly. The industrialized world would have had time to adjust to the short and long-run implications of higher-priced energy.

The first reaction of the American public to these events — particularly the embargo and the price increase — was one of astonishment. What right did these countries have to disrupt the American economy, inconvenience the American motorist, and

force thermostats down? How could these weak, backward, tribal societies "take on" the industrialized world *and* seven of the world's most powerful private companies? Why had the Shah of Iran, whom the C.I.A. had restored to his throne twenty years before, turned on us? We were indignant at the effrontery and gall of these rulers and sheikhs. It was difficult to accept the fact that the oil came from their soil and not from ours.

Secondly, many foolishly believed that somehow OPEC would fall apart. On the surface, the argument seemed reasonable enough. After all, OPEC members are scattered across four continents and have little in common with each other. Venezuela and Indonesia are alike only because they have the same natural resource. Even within the Middle East there are dynastic and political differences between "radical" Libya and Algeria and the conservative regimes of the Gulf states and Saudi Arabia. And, while the Gulf Sheikhdoms would have trouble spending more than a fraction of what they receive in royalties, Iran, Nigeria, Venezuela, and Bahrain spend all they can get. Consequently, some people hoped that they would compete for sales, that they would begin to shave prices, and thereby weaken the cartel. This hope was sustained last September when Saudi Arabia and Iran engaged in a well-publicized dispute over new price increases. The eventual compromise on 10 percent may have satisfied neither country (Saudi Arabia wanted less, Iran more), but it never seriously threatened the unity of the OPEC nations.

The third reaction to the events of 1973 and 1974 was Project Independence. Announced with great fanfare, Project Independence offered the hope that intense development of alternative energy sources coupled with a conscientious conservation policy would reduce and soon free us from dependence on outside oil by 1980. Hundreds of plans and proposals, serious and frivolous, were trumpeted. Solar, wind, and tidal projects were advocated; construction of nuclear plants was to be hastened; shale oil extraction was to be intensified; and more coal was to be mined from the western states.

The final reaction to the tumultuous events was the fear that enormous amounts of petrodollars would flood the United States and Western Europe. Two well-known economists stated that if the OPEC nations annually invested $15 billion in the next 10 years, they would have a majority interest in 20 of America's largest private companies. The normally cautious World Bank estimated that the OPEC nations would have, by 1980, a disposable investment surplus of $650 billion, growing to $1.2 trillion 5 years later.

These predictions, of course, now seem far-fetched. Last year slightly more than $6 billion was invested in the United States, and of this, only about 40 percent was in corporate stocks. In March of 1976, the Treasury Department drastically reduced earlier government figures: it has now predicted that the investable OPEC surplus will reach $200 billion by 1980.

Let me return to the question asked at the beginning of this discussion: what form should our foreign policy take toward the Middle East? I think it should be based on four dominant facts.

First, OPEC will remain for the foreseeable future as an alliance able to agree upon price increases and production schedules. These oil-producing states, heterogeneous though they may be, know that if they do not hang together they will hang separately. The OPEC cartel has limited, albeit important objectives, and provided it concentrates on oil, the possibilities of rupture are slight.

Second, it is foolhardy to organize a consumer's cartel Organization of Petroleum Importing Countries (OPIC). The European governments are not only heavily dependent upon imported oil, but most of this oil comes from the Middle East. They cannot risk alienating any of these nations. From a tactical point of view, confrontation by the industrialized nations would simply stiffen the resolve of OPEC. As the facts indicate, we are not in a position to threaten.

Table III

Estimated Imports of Petroleum
1974

	Arab	*Non-Arab**
Japan	53.7	46.3
U. K.	64.3	35.7
West Germany	65.2	34.8
Italy	82.9	17.1
France	79.2	20.8
Netherlands	7.1	92.9
Spain	86.7	13.3
United States	20.5	79.5

**Includes Iran, Venezuela, Indonesia, Canada, Nigeria, and Ecuador*

Third, we must accept the fact that there is no alternative to oil as a source of energy. Mission independence is mission impossible. This has been recognized by the most recent Government publication which has substituted the words "A National Energy Outlook" for the title "Project Independence." There is little immediate hope that alternative sources of energy are technically feasible or economically possible, even if the price of oil should increase to $13.00 a barrel. It has been estimated that by 1980 only 20 percent of our energy needs will be met by coal, 2 percent by nuclear energy, and 4 percent by hydroelectric power. Ten years later these figures will be approximately the same, although nuclear power may increase to about 15 percent. We will still need oil, and in increasing amounts, as our industrial recovery continues. In 1975, in fact, we imported 6.3 million barrels a day, which is about one-third of our total consumption.

Alternative, safe sources of oil may, moreover, be declining. Canada has announced that it will drastically reduce the amount of oil it is currently exporting to the United States, and Venezuela is planning a large cutback in its production in the coming years. The North Slope in Alaska will do little more than offset declining continental production. Along with continuing dependence will come higher prices. The 10 percent increase approved last September will undoubtedly be followed by others in the coming months.

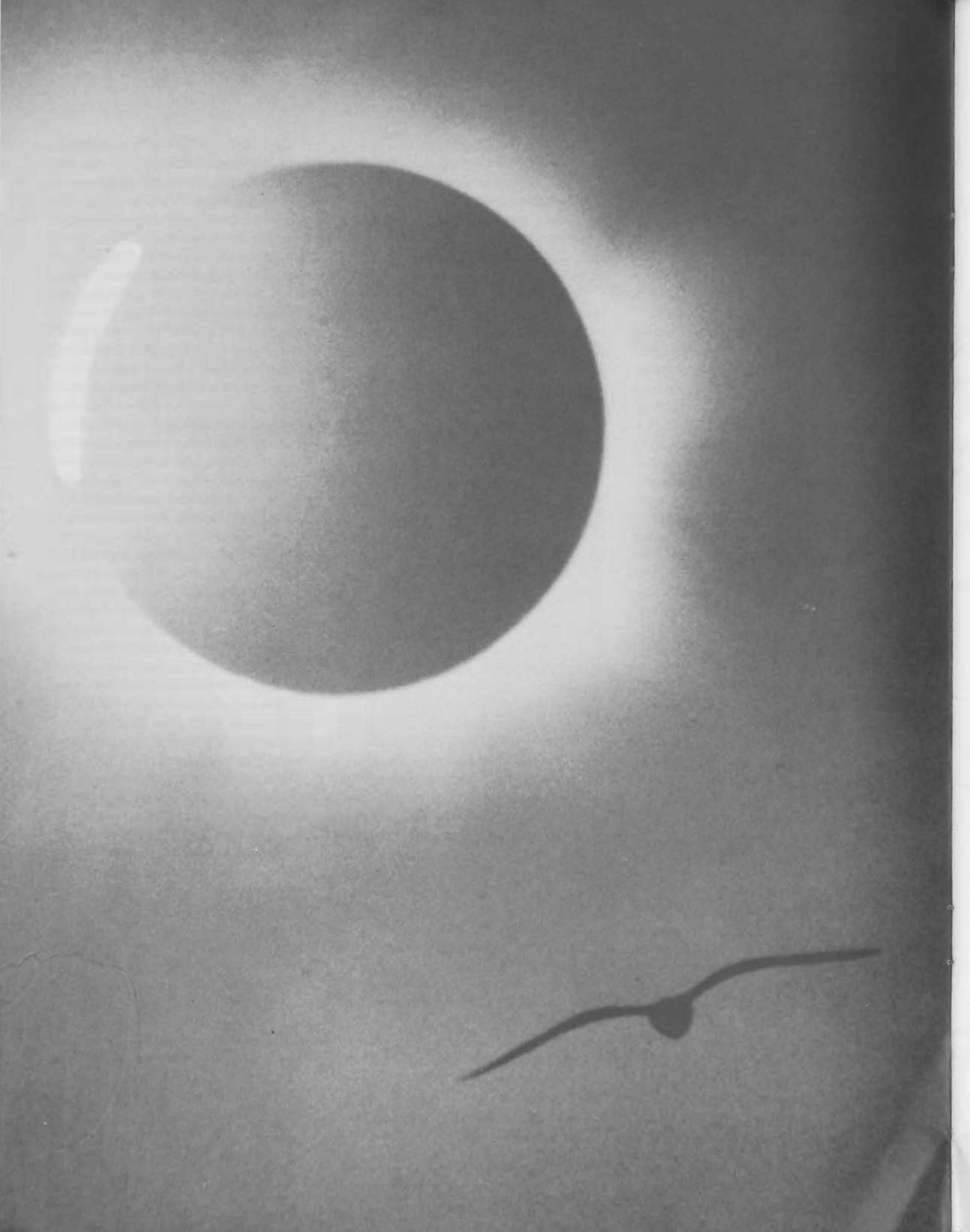
The fourth point, and by far the most controversial, is that we must reevaluate our foreign policy toward the Middle East. This is an especially emotionally-charged issue in an election year. Yet until there is a settlement of the outstanding differences between the Arab states and Israel, the threat of war endangers us all. Any solution must take into account the legitimate interests of both Arab and Jew, and their right to live on lands sacred to their three religions. Practically speaking, this requires an international guaranty that Israel will be secure within those boundary lines that existed in 1967. It also dictates, I believe, the establishment of a West Bank Palestinian state — whether independent or affiliated with Jordan — which accepts the sovereign rights of Israel.

A solution will not come quickly. The 25 years of intermittent warfare, with the tragic loss of lives on both sides, cannot easily be wiped from memory. But the initiative begun by Secretary of State Kissinger should not be allowed to lapse. One may disagree with Sadat, Assad, Hussein, and Arafat, but they represent the moderate forces in the Middle East. Less malleable men will replace them if peace efforts fail.

These proposed cornerstones of U.S. policy are not easy to accept. We are dependent upon and will continue to be dependent upon oil which belongs to other nations. The power of the oil companies to set prices has been replaced by a multinational organization with quite different objectives. We are faced with the need to initiate a more even-handed foreign policy toward Israel and the Arab states when the frustrations of our failure in Southeast Asia are still before us.

It is not an easy time. But 1776 wasn't a bed of roses either.

Dr. Bent is Associate Professor of Public Administration at Cornell University's Graduate School of Business and Public Administration.



The Oil Industry Fights the Big Lie

Rawleigh Warner

Remember, during the Arab oil embargo in the winter of 1973-74, when newspapers and television were filled with all sorts of stories of oil industry "conspiracies" to gouge the public? Fleets of company tankers, went one highly publicized tale, were standing off U.S. ports, waiting to discharge their cargoes until prices rose to the levels the companies wanted.

As it turned out, this "conspiracy" — like many others during that period — was a myth, a reflection, perhaps, of public frustration over service station lines and higher prices. The fact was that tanker movement was normal. Three federal agencies, a governor, a U.S. senator, and the Federal Energy Administration branded the rumors groundless. But this myth has persisted in the public mind, for denials never rate the news space that sensational charges receive. Even today, many people recall the story as "proof" that the oil companies are cheating the consumer.

The point is that such myths do incredible damage, even as they satisfy the public's need for scapegoats and the media's compelling (and commercial) need to make news entertaining.

Facts Vs. Myths

The oil industry has its back to the wall. We are battling to gain public understanding of the realities of our business. The public, we know, is suspicious. Several presidential candidates have found in this suspicion a lively political issue; once again, big oil companies are cast as villains. Yet one has only to look at the facts, and then at the myths and their consequences, to ascertain the damage being done to the companies and, in the long run, to the consumer's ability to obtain a secure, adequate supply of energy. The *facts*, simply stated, are these:

- ☐ The United States is dependent on imports for about 40 percent of its oil supply.
- ☐ The cost of this imported oil is set not by the companies but basically by the oil-exporting nations in the Organization of Petroleum Exporting Countries (OPEC).
- ☐ In the past three years, OPEC has quintupled the companies' costs for this oil.
- ☐ An increase of this magnitude could not possibly be absorbed by the companies; it had to be passed to the consumer, and the consumer, quite understandably, is unhappy.
- ☐ There is no *worldwide* shortage of crude oil. But there continues to be an acute shortage of *U.S.*-produced petroleum. In fact, the shortage of U.S. crude — and the dependency on imports — is steadily growing worse.
- ☐ The only relief can come through measures to reduce dependence on foreign oil: continued emphasis on conserving fuel, accelerated research into alternate energy sources, and — most critical of all over the next two decades — an intensified effort to find and develop more domestic oil and gas, especially offshore.
- ☐ This domestic energy development will require hundreds of billions of dollars in investments over the next decade. It cannot be accomplished without the consumer being asked, in the end, to pay the cost.

Such hard facts are not easy to accept. They spell the end of the era of cheap energy — a condition Americans have long taken for granted. So some people, not liking the facts, prefer to believe myths that will "explain" an unpalatable situation. Let me mention three of the more common ones.

Myth No. 1: *The oil companies make obscene profits.* If the companies' profits weren't so high, prices — so the argument runs — could be lower. But it's not that simple. This myth came to life because 1974's profits were considerably higher than 1973's. But most of the increase was acounted for by nonrecurring inventory profits, which occurred when the drastically higher crude oil prices imposed by OPEC raised the value of company crude oil inventories. And these inventories had to be replaced at the new, higher costs. At the same time, the companies were taxed on these "paper profits," so that they actually resulted in a net cash drain. By 1975, these "inventory profits" disappeared, and earnings for the 25 largest oil companies were down an average 23.6 percent.

The oil companies' rate of return on average shareholders' equity for the 15 years from 1960 to 1974 was 12.3 percent, roughly the average for all U.S. manufacturing companies. Last year, Mobil's rate of return, on this basis, was 12.3 percent. Yet, according to Chase Manhattan Bank, petroleum's rate of return should average 15 to 20 percent for the industry to attract the capital needed to develop the energy required by the economy.

Myth No. 2: *The oil companies are a monopoly, conspiring to fix prices.* Again, look at the facts. If we are monopolistic, we are not very good at it. No single company accounts for more than 8 percent of U.S. oil production; there are some 8,000 competing exploration and production companies. In refining, no company has more than 9 percent of the capacity, and the share held by the major companies is smaller than it was two decades ago. And in marketing, the situation is even more competitive.

The motorist has, on the average, more than two dozen brands to choose from in any state. Oil is actually one of the *least* concentrated industries; much less so, for example, than the steel, automotive, or aluminum industry; less even than our frequent critics, network television.

Myth No. 3: *Breaking up the oil companies will benefit the consumer by making the industry more competitive.* Once more, the facts, please. The industry is already fiercely competitive. Far from independent marketers being squeezed out of business, their market share has grown from 25 percent to 33 percent over the past decade.

Still, there seems in all this to be an underlying assumption that bigness is bad. Yet this same bigness, the ability to achieve economies of scale, is responsible for much of the bounty underlying America's standard of living. When, for example, $7 billion is needed to build a pipeline to make Alaska's oil resources available to the American consumer, it is the bigness of the oil companies that gets the job done. Without the bigness, Alaskan oil would remain in the ground.

The Damage Myths Do

But these myths — and others like them — are believed by a large segment of the public. The result has been public pressure to "punish" the oil industry. And Congress has responded. More than 750 energy bills have been dropped into the hopper over the last two years, many of which would alter the industry's whole structure. Congress has already eliminated the depletion allowance *only* for large oil companies (while retaining it for other extractive industries). Congress has also reduced the companies' ability to compete against foreign oil companies overseas by modifying the foreign tax credit (which is not a "tax break" for the companies, but merely a protection against double taxation that all major trading nations provide to their nationals doing business in foreign countries).

But that was just the beginning. Congress last year refused to phase out the "emergency" price controls imposed on oil in 1971 until after the 1976 elections. Other industries have long since been relieved of this stricture. And now, even more threatening, there is a serious move in Congress — endorsed by some of the leading contenders for the presidency — to break up the 20 or so largest oil companies into non-integrated segments.

Breaking up America's oil companies would inevitably result in higher consumer prices.

How, under this hostile fire, can the oil industry be expected to do its part in meeting America's still-rising energy demand? Under constant attack, the industry finds it more and more difficult to maintain the confidence of investors. And yet a sharply increased pace of investment will be needed — especially if dependence on foreign oil is to be reduced — if the companies are to raise vast sums over the next decade for energy development.

Anatomy of a Myth

It is critical that the public learn to sort out myth from fact. With just that in mind, we made a point of tracking down the famous tanker rumor mentioned earlier, which is still being cited as evidence of the conspiratorial nature of oil companies.

Here is what we found. The rumors appear to have begun in New York, early in December 1973. A man in Montauk, Long Island, called the *New York Times* to report what he called an unusual number of oil tankers gathered offshore. A Staten Island resident notified the Newark (N.J.) *Star-Ledger* that he had seen a lot of tankers accumulated in New York's lower harbor. Both papers checked with the Port Captain and the Coast Guard. They were told the flow of tankers was normal for that winter's peak demand for oil. If anything, there were too few for an area short of gasoline. There was no story.

But the rumors continued. All through December, newspapers, wire services, and radio and television news desks received calls from people who had seen or heard of "fleets of oil tankers" standing in harbors or offshore. The Coast Guard checked as many reports as it could. It compared radioed notices of expected ship entries with actual arrivals 24 hours later. Reporters were told there was no significant increase or any hold-up of flow through the harbor or at sea. Accordingly, no news stories were published or broadcast.

Still the calls to newsrooms persisted. Oil company spokesmen, queried by the press, explained repeatedly that it would make no sense to delay ships for an increase in oil prices. Under the price controls then in effect, shippers were held to a sale price based on what they had initially paid for the oil. The U.S. price was, in effect, established from the moment the oil was pumped aboard. Besides, what sense would it make for the companies to keep a tanker under way at an average cost of about $15,000 a day? But just when the rumor seemed to be dead in New York, it cropped up in Chesapeake Bay and at approaches to Philadelphia, off the Florida and Texas Gulf Coast, and in the Great Lakes. Thousands of barges were said to be jamming the Mississippi and Ohio Rivers — all waiting for prices to go up.

Then, during Christmas week, an airline pilot was supposed to have seen a group of tankers clustered 500 miles southeast of New York. Since there was no corroboration, the "story" was not used.

Finally, on December 29, the *Times* printed some of the rumors, since Governor-elect Brendan T. Byrne of New Jersey had stated publicly that "the tankers were out there waiting for their price." The story also recounted that port captains along the Northeast Coast reported "at least two dozen tankers waiting for space at dockside." Since each tanker held at least 50,000 tons of fuel, they were talking about well over a million tons of oil being held up. But an analysis of normal traffic disclosed that an average of 8 tankers a day enter New York harbor at winter's peak. Each normally averaged a day and a half in a holding anchorage, accounting for a total of 12 tankers in New York alone. The remaining dozen were spread from Maine to Virginia.

Official statements now began to support oil company denials of "news stories" that a shortage of storage space was preventing the proper flow of petroleum. The alleged shortage was investigated by authorities in Connecticut, Massachusetts, and Pennsylvania. Connecticut Governor Thomas J. Meskill announced that tankers lying off New Haven were waiting merely "for dock space or tidal changes."

William E. Simon, then Federal Energy Administrator, called the rumors "unfounded in fact" in a statement distributed by the wire services on January 3, 1974. He explained that pricing regulations prevented price increases through shipping delays. He cited Federal Maritime Commission and Department of Transportation reports that tanker movements were "normal and in accordance with the usual patterns observed in the past."

U.S. Senator Jacob Javits of New York told a television interviewer that "we can't kid ourselves by laying [the energy crisis] at the doors of the oil companies." He added, "the fact that you hadn't seen all those tankers before is just the fact that you hadn't been out in the harbor before. There's nothing unusual about all those tankers. . ."

The rumors, however, continued unabated, and there was continued speculation on radio and TV. On January 11, Captain Frank Oliver of the Port of New York felt obligated to state that, despite persistent reports, tankers arriving in New York were neither backed up nor delayed. "This year's port activities are normal," he stated.

Getting on with the Energy Job

Why take the time and trouble to refute old myths at this late stage? Because they still crop up and get in the way of the hard decisions on energy this country has yet to make.

With myths laid to rest, the truth comes into clearer perspective:

- ☐ The oil industry *is* competitive.
- ☐ Its profitability is certainly *not* out of line with that of industry generally, and is low in terms of the capital expenditures it must make in the years ahead.
- ☐ Most importantly, oil is an industry in which the consumer benefits from economies of scale and the efficiencies of integration; breaking up America's oil companies would inevitably result in higher consumer prices.

Once people understand these truths, they will be less likely to support the opportunistic politicians who campaign against the oil industry. We may then get in Washington a new dedication to a sensible energy policy.

Mr. Warner is the Chairman of Mobil Oil Corporation.

The U.S. Petroleum Industry and National Energy Consumption

Theresa Flaim
Duane Chapman

As a result of the oil embargo and the energy crisis of the fall of 1973, the petroleum industry is currently undergoing its most intensive public investigation since the original Standard Oil Trust was dissolved in 1911. While most questions about the industry center around traditional concerns — for example, are the profits of petroleum firms excessive? — we wish to examine whether both the industry itself and government policy have contributed to current U.S. energy problems.

We will address three major areas of concern: the structure of the industry; governmental policy; and market control, firm growth and political influence. Before beginning with a discussion of the structure of the petroleum industry, it is appropriate, however, to state the measure by which we evaluate competitive performance.

Industry advocates would argue that the petroleum industry is *workably* competitive. And since most manufacturing industries in the U.S. do not meet the criteria of *perfect* competition, it is worth emphasizing what workable competition means. It is a term used to describe an indus-

try which does not have all the classical properties of a perfectly competitive market, but for which *no change in public policy could improve its performance*. Most of the confusion surrounding whether or not the petroleum industry is workably competitive is really a misunderstanding about what the appropriate measure of performance should be. Historically, the measure of performance has been whether or not the industry provided an abundant supply of high quality petroleum products at relatively low prices, and generally the industry merited high marks. This criterion was certainly understandable when supplies of crude oil were thought to be abundant. But now that domestic reserves and production are being depleted, now that dependence upon imports is growing and foreign reserves are controlled by an international producer cartel, the earlier criterion of workable competition may be inadequate or even an irrelevant measure of performance.

Industry Structure

Given the classical definition of competition, it is easy to see why many people are so concerned about the number of firms in any industry. While not strictly accurate, it is generally true to say that the fewer firms existing in a market, the easier it is for them to cooperate instead of compete, to keep the price of a product high, to extract monopoly profits, and to create a socially inefficient allocation of resources by restricting production.

Is the petroleum industry characterized by too few firms to permit active competition? Mobil Oil Corporation in a recent advertisement points out that there are only 3 major television networks and these control about 75 percent of their market, while there are "... more than 8000 companies engaged in oil production, some 130 in refining and about 15,000 in wholesale marketing." Petroleum is, in fact, one of the least concentrated of the big manufacturing industries. The problem is that concentration — the number of firms controlling a certain percentage of the market — is only an indirect measure of cooperation among firms.

The most dominant form of cooperation — and the least documented — is joint ventures among the industry giants. In spite of the lack of information about joint ventures, we

do know from both public and private sources that almost all of the majors — the 20 or so largest firms — share in joint foreign operations and joint domestic pipelines with at least one other major and with many smaller firms as well. We know, for example, that both Texaco, Inc. (second largest by sales in 1974) and Standard Oil of California (fourth in 1974) own 50 percent of the Caltex Petroleum Corporation whose 1974 revenues were $4 billion. We know that British Petroleum might own as much as 54 percent of Standard Oil of Ohio by 1984. We know that joint ownership of oil wells, leases, and reserves is common and compatible with efficient production practices. And though the extent or effect on competition is unknown, we also know that "swapping" petroleum products is a prevalent practice among firms.

Viewed in isolation, these interrelationships would not be particularly objectionable. It is the combination of joint activities which we believe exists at many levels and in many forms in the industry that makes cooperation among firms so prevalent and competition so unlikely. The significance of joint activity is, then, that it renders the low national concentration of the industry meaningless as a criterion of competition since it necessitates cooperation rather than competition among firms. And it will be impossible to determine the real structure of the industry until it is required to report complete information about these joint activities.

In a competitive market, especially a market in which demand is growing as rapidly as the demand for petroleum has grown, one would expect that a dominant position in the industry would be difficult to maintain because it is easy for new firms to enter the market. For example, Exxon, in its testimony before the Senate Judiciary Subcommittee on Antitrust and Monopoly in January of 1975, stated that "the relative ranking of the largest [petroleum] companies has changed significantly over time, demonstrating the competitive vying among firms." However, the facts portray stability rather than change.

According to *Fortune*, the top 20 petroleum firms — ranked according to sales in 1974 — were Exxon, Texaco, Mobil, Standard Oil of California, Gulf, Standard Oil of Indiana, Shell, Continental, Atlantic Richfield, Occidental, Tenneco, Phillips, Union Oil of California, Sun, Amerada-Hess, Ashland, Marathon, Cities Service, Getty and Standard Oil of Ohio. An interesting picture emerges. The top 7 companies in 1974 were the same top 7 in 1954. The top 20 companies in 1954 were reduced — through various mergers and acquisitions — to 17 by 1974.

The impression of stability among the major firms is supported by the findings of a study covering an earlier period of the industry. Melvin de Chazeau and Alfred Kahn, in a book entitled *Integration and Competition in the Petroleum Industry*, reported that the top 16 gasoline marketers in 1926 were included in the top 19 in 1954. Moreover, the top 7 marketers in 1926 were the top 7 in 1954. Thus, they concluded that the period from 1927 to 1954 "showed far more stability than change in ... [both] the identity .. [and] the relative positions of the majors." Much of the change within industry leaders is, in addition, due to mergers and acquisitions.

But we cannot understand the structure of the petroleum industry simply in terms of joint ventures, or lack of change in company rankings. The structure of the industry is further complicated by the fact that the majors are vertically integrated. They are, in brief, involved in the production, transportation, refining, and marketing of petroleum products. The arrangement raises some discomforting objections. In the past, the strongest argument against vertical integration was that such firms would utilize tax subsidies to claim most of their profits at the production level and "squeeze" rivals in other activities. According to Thomas G. Moore, in an article in *The Structure of American Industry*, in 1967 the integrated firms in the industry claimed 63 percent of their profits from production, 6 percent from transportation, 21 percent from refining and marketing, and 10 percent from petrochemicals. A major question about vertical integration is whether the arrangement is more efficient than having separate firms involved in each of the industry's activities. While there are obvious advantages for the oil firms themselves, it is questionable whether vertical integration results in any cost saving for society as a whole.

Government Policies Affecting Petroleum

State and national policies have frequently been used as instruments to organize certain forms of cooperation. Prorationing was a state-enforced method of supply control developed in the 1930's and effectively eliminated in 1972. It was instituted to replace the disastrous law of capture which led to technically inefficient production practices and the "boom and bust" price cycles of the industry's early history. Under prorationing, production was allocated among producers and based upon monthly forecasts of the demand for petroleum. After World War II, cheap imported crude oil threatened the system of prorationing; import quotas (established in 1959 and eliminated in 1973) enabled producers to control supply and stabilize the price of petroleum.

Government policies have worked to promote excessive production and consumption of energy.

Government tax subsidies, while not affecting cooperation among firms, affected both the structure of the industry as well as the level of production. The oil depletion allowance (eliminated for large companies in 1975) and other special tax credits available at the production level, provided multibillion dollar tax subsidies to those firms involved in the production of petroleum and almost certainly encouraged higher levels of production than would otherwise have occurred. The combination of tax subsidies and import quotas further accelerated the depletion of inexpensive domestic petroleum by stimulating production at home while limiting the amount of foreign petroleum that could enter the U.S.

Many independent analysts of the petroleum industry believe these Government policies created our current energy problems and in particular fostered unusually high dependence upon petroleum. But the industry sought these policies and encouraged the institution of import quotas, the depletion allowance, and other special tax provisions.

Market Power, Firm Goals, and Political Influence

Perhaps the greatest difficulty in analyzing the economic impact of any industry's behavior is that economists are trained to evaluate economic performance from the perspective that firms are basically competitive and concerned only with maximizing profits. Firms are not viewed as concentrations of economic power with considerable interest in, and influence upon, government policy. Nor is it generally believed that the firms may pursue growth and power, as well as, or in place of, profit maximization.

Many of the largest petroleum firms today are direct descendants of the old Standard Oil Trust which was dissolved in 1911. Exxon, for example, was formed from almost half of the assets of the original Standard Oil. Firms which have histories equivalent to many human generations may have conscious ob-

jectives about growth which may have priority over a desire to make as much as possible in profits during any one year.

Coupled with monopoly power, pursuit of growth as an objective can have undesirable effects. For instance, at least one major petroleum firm took steps to eliminate competing types of transportation. In his statement before the Senate Subcommittee on Antitrust and Monopoly on February 26, 1974, Bradford C. Snell detailed how Standard Oil of California, General Motors, and Firestone Tire bought and scrapped the electric transit systems in major cities throughout California. Snell relates that in April 1949, a "Chicago federal jury convicted General Motors of having criminally conspired with Standard Oil of California, Firestone Tire and others (including Phillips Petroleum) to replace electric transportation with gas or diesel-powered buses and to monopolize the sale of buses and related products to local transportation companies throughout the country." Securing future avenues for growth in automobile, bus, and gasoline sales, these companies worked actively to eliminate relatively pollution-free public transportation systems in major cities throughout the United States.

Petroleum firms are moving into uranium and coal, the two energy forms likely to experience the greatest future growth. Major oil companies account for 20 percent of domestic coal production, 30 percent of coal reserves, 25 percent of uranium milling capacity, and over 50 percent of uranium reserves, according to a 1971 report by the House Subcommittee on Special Small Business Problems. The same source reports that oil, natural gas and coal companies controlled 65 percent of uranium reserves and 69 percent of uranium milling capacity in 1970. Moving into coal and uranium production is a logical step for petroleum firms concerned with future growth. The danger, of course, is that it will eliminate interfuel competition by placing uranium and coal within the control of petroleum firms.

Troublesome issues of public accountability are raised by recent disclosures of the manner in which some of the major companies have worked to influence government policy. Proceedings before Federal courts, the Securities and Exchange Commission and elsewhere show that 5 percent of the major petroleum corporations have engaged in illegal contributions to political funds and to regulatory agency personnel in the United States. If our previous conclusion is correct — if government policies have, in fact, worked to promote excessive production and consumption of energy — then we must question the extent to which this end has been achieved through illegal or improper means. Though we have no unique insight to offer, we do insist that these actions raise issues which are basic to political democracy, and the resolution of these issues will influence the process by which future government policy is made.

Ms. Flaim, a Ph.D. candidate in the Department of Agricultural Economics at Cornell University, is writing her dissertation on the structure of the U.S. petroleum industry. Dr. Chapman is an Assistant Professor of Resource Economics in the same department.

Those Oil Company Profits

C. C. Garvin, Jr.

If oil company profits were wiped out overnight, what would happen to the average price of a gallon of gasoline, heating oil and other petroleum products? Would it fall 20 cents? 10 cents? 2 cents? Opinion polls suggest that most people believe the price would drop by about 20 cents. But the average price would be reduced by only about 2 cents a gallon. This is roughly the profit margin that competition has maintained in the oil industry since the 1950's.

Surveys have long shown that people believed profits generally account for a far bigger slice of prices, and price increases, than is actually the case. And they apparently think this in spades about oil profits. So the charges were understandable when prices for petroleum products went up drastically after the oil embargo in late 1973 and the subsequent quadrupling of oil prices by the Organization of Petroleum Exporting Countries (OPEC). Since those difficult days, people have been in no mood for explanations about why higher oil company profits in 1973 and 1974 were not responsible for the huge petroleum product price increase, or about why these profits have worked to the benefit of consumers concerned about the continued availability of energy supplies. Moreover, people are taking little note of the fact that even though prices have stayed high, oil company profits are now down again.

The hue and the cry about profits persists, and could result in action to weaken the oil industry further, precisely when the country needs a strong one. The United States faces critical choices in energy policy, choices which should be based on hard facts. This country now imports over 40 per cent of its oil. More than 80 percent of the world's oil reserves are controlled by OPEC.

And even OPEC's reserves are not inexhaustible. We must find alternatives — in the short and medium term to reduce our dependence on OPEC, in the long run to replace oil as reserves become depleted. Unfortunately, the task will be expensive, and without financial resources the oil industry will not be able to play its part.

Those who think oil profits are too high will not be worried by this need. They will say that our financial resources are more than ample, that the sheer size of oil company profits is excessive. Exxon, they might note, earned $2.5 billion last year.

But it is not profits, it is profitability that counts. Profits must be related to the investment which produced them. For the decade ending in 1974, the year of historically high oil profits, the petroleum industry's return on beginning-of-year equity averaged 13.1 percent. The comparable figure for all U.S. manufacturing concerns was 13 percent. True enough, with return on equity exceeding 19 percent, 1974 was an exceptional year for oil companies. But this figure is of questionable significance in view of the substantial decline in oil earnings in 1975. Every industry and company has its ups and downs; it's the trend of events over time that tells a story. And the trend for the oil industry does not suggest excessive earnings.

Despite this, many people do feel that the oil industry has been getting rich at their expense in recent years. So let's take a look at what happened in the 3 years following 1972, the last year preceding the so-called energy crisis; and let's take Exxon as an example since it's the company I know best. In those 3 years, Exxon's total revenues more than doubled. By 1975 they were $26.2 billion higher than in 1972. Of this, $22.7 billion went to pay the higher costs of crude oil, purchased products, and taxes; $2.5 billion was needed to meet higher costs of labor and supplies; and only $1 billion, out of the total $26 billion, remained as increased profit to Exxon.

By far the largest piece of Exxon's expanded revenues went into the coffers of the OPEC countries. Their greater take, together with increases in the more routine costs of doing business, accounted for 97 cents out of every new revenue dollar. Eliminate the entire growth in Exxon's profits and 97 percent of the problem would still remain.

These statistics will not make it more pleasant for consumers to pay their bills for gasoline or heating oil. But they do suggest the substantial competition which has existed in the oil industry. Further evidence of this competition is found in the fact that for decades prior to 1974, the industry furnished petroleum products to consumers at modest prices — prices that rose for most of the post-war period at considerably less than the general rate of inflation. Even with the OPEC imposed increases, today's price of gasoline in the United States, in real terms, is only 4.5 percent above the 1960 price.

Today's price of gasoline in the United States, in real terms, is only 4.5 percent above the 1960 price.

Now, what exactly was behind the jump in the oil industry's profitability in the extraordinary year of 1974? Contrary to what many people seemed to think at the time, 1973 results were essentially unaffected by the energy crisis, which did not emerge until the latter part of the year. Though profits in 1973 were up, the increase can only be understood in light of the relatively depressed 1972 earnings to which they were being compared.

The year 1974 was a different story. On January 1, OPEC's huge hikes began to take effect, so that by year-end foreign crude oil prices were 4 times what they had been in late 1973. The companies did not share in OPEC's bonanza of revenues. In fact, their profits from producing OPEC oil went down, not up. But the OPEC increases did play an indirect role in pushing up company earnings. For one thing, they created large, one-time inventory profits. Since at least the time of the embargo, the prices of petroleum products have been controlled by governments in nearly all oil consuming countries. A number of these governments allowed product prices to rise in order to reflect the new raw material prices, and inventory profits were a consequence. To a major extent, these profits were illusory since the inventories had to be replenished with higher cost oil.

The OPEC increases also pushed up energy prices generally throughout the world. As a result, there were profit gains in 1974 for companies producing oil and gas outside the OPEC sphere, notably in the United States. Although the U.S. Government had been controlling prices for crude oil and petroleum products since 1971 (and natural gas since 1954), it allowed a limited increase in the price of "old oil" while letting other domestic crude oil prices rise toward world levels. This was done in at least partial recognition of the fact that higher prices were a necessity, both to encourage energy conservation and the expensive new projects that would boost domestic energy production.

Finally, quite apart from the oil and gas business, the demand for petrochemicals was strong in 1974, and this improved the earnings of many oil companies.

But these gains did not persist. Partly because of economic recession and partly because of the high world prices, oil consumption began

to fall, and most observers now expect its future growth to be less than half the historic rate. As a consequence, we now have large, costly surpluses in virtually all phases of the oil business — surpluses unlikely to be erased for several years. It was these conditions, together with plummeting petrochemical sales and higher U.S. taxes, that caused oil industry profits to fall by about 25 percent in 1975.

But what has the oil industry done with its higher profits? It seems to me that this is the central question for energy consumers. The answer is that the industry has restrained dividend increases, stepped up borrowing, and plowed back more into the business than it has earned. Even though the Government has not yet leased many promising new areas offshore, the number of wells completed in the United States has shot up 34 percent in the last three years. Exploration and capital expenditures are at record highs. In 1975, with profits of $2.5 billion, Exxon alone spent $4.5 billion in capital and exploration expenditures — more than half of that in the United States. And over the next 4 years, the company plans to spend more than $19 billion for these purposes.

Despite both the present world crude oil surplus and slower growth, most estimates are that the world will need almost twice as much energy by 1990 as it does now. And most of the increase must come from oil and gas. The alternative to expanding the energy supply would be a stagnant world economy, too weak to create new jobs or to fund adequate social programs. Conservation is extremely important, but it is not enough. An enormous effort is called for, one that by most estimates will require the oil industry to invest at 3 to 4 times the rate of previous years. In the United States alone that could mean investments of $25 to $40 billion a year.

Capital needs are soaring mainly because we have already found most of the world's readily accessible oil. The major new discoveries will come primarily in remote and harsh frontier areas — like Alaska, the North Sea and the deep waters off the east and west coasts of the United States.

The industry is already doing a lot. Whether it can sustain its efforts or do more will depend on the policies which our own and other governments adopt. We badly need policies that will encourage both energy conservation and new resource development. Instead, Congress has so far failed to end controls on natural gas prices, which have long been held below the price equivalent of alternative fuels and, more importantly, below replacement cost. The recently enacted Energy Policy and Conservation Act also works in the wrong direction. By reducing the average price of domestic crude oil, it will stimulate consumption while it diminishes the funds that the industry could use to increase supplies.

Worst of all are the "divestiture" proposals presently being considered in Congress. Some of these proposals would force vertically integrated oil companies to break up by function into exploration and producing, transportation, refining, and marketing companies. Others would bar oil companies from developing alternative energy resources such as coal or uranium. Supporters claim that these measures would increase competition and lead to lower prices and more energy supplies. But the actual consequences would more likely be chaos in the industry, a slowdown in energy development, reduced efficiency, and quite possibly less rather than more competition, because some of the fragmented and weaker new companies would probably not survive.

I do not mean to imply that even with the right policies the solutions to our energy problems will be easy, much less quick. We face complex, painful decisions. Broad public understanding, great patience, and a balancing of opposing interests will be needed.

We will also require an energy industry able to generate and attract the capital necessary for the enormous task ahead. It is in this light, and in that of their historical reasonableness, that the profits of the oil industry should be assessed.

Mr. Garvin is President of Exxon Corporation.

The Oil Industry: its Pricing and Structure

Ralph Nader

National energy policy has arrived at a crossroad. One path leads toward energy policies determined by giant vested interests in the energy production industry and its indentured servants in the White House and the Congress. The other path leads away from our history of autocratically determined energy policies and toward energy policies decided by more democratic processes. The struggle between the narrow self-interests of the energy industry and the diverse interests of energy users underlies the debate over energy pricing and industry structure, the two areas that I will discuss in the pages that follow.

The Energy Policy and Conservation Act (EPCA), reluctantly signed by President Ford in late December, has basically settled the struggle over crude oil pricing for the next 40 months. It is helpful, however, to review what was at stake in the 2-year-long struggle over oil price controls between a congressional majority and two presidents. It was not, contrary to the standard oil industry rhetoric, a choice between government regulation and "free market" pricing. There was no free market option. In the context of a world oil market where the price is set by the OPEC cartel, the choice is between our government setting the price of domestic oil and letting domestic producers charge a monopoly price set by a cartel of foreign governments.

In fact, for over 2 years about 40 percent of domestic crude oil was not price controlled and was therefore free to rise toward the monopoly price of imported oil. During much of 1975 the $2 Ford tariff on top of the OPEC price for imported oil permitted domestic producers to charge American consumers the equivalent of the OPEC price *plus* $2 for uncontrolled domestic oil. Hence, domestic producers were receiving by far the highest well-head price for oil in the world for 40 percent of their production.

The EPCA has resolved the recent mix of OPEC priced and American priced domestic oil production. It has ruled against monopoly pricing in favor of American pricing of American oil. Most of the production from "old oil" properties will continue to sell at $5.25, a price which was permitted to increase 50 percent (from $3.50 to $5.25 per barrel) in 1973 by friendly regulators in the Nixon Administration. The price of some of the production from old oil properties (stripper oil) and all production from so-called "new oil" properties will finally be regulated at about $11.25 per barrel, an increase of about 220 percent over the $3.50 price of early 1973. A price escalator provision will permit adjustments for inflation.

This recent history of domestic crude oil prices is helpful when deciphering oil industry laments about declining profits. The truth is that profits on crude oil have grown drastically in the past few years: consumer payments to domestic crude oil producers have risen from $11.7 billion in 1972 to $13.1 billion in 1973, to $21.5 billion in 1974, and to $24.5 billion in 1975. In the past 2 years alone, then, the oil companies (and royalty owners) have collected about $20 billion more for domestic crude oil than they would have received for the same oil at pre-embargo prices. The much protested changes in the depletion allowance and foreign tax credits will reclaim only a small fraction of this annual windfall (about $2 billion in 1975). This kind of arithmetic explains the 71 percent average increase in the reported profits of the 25 largest American oil companies from 1972 through 1975. The much touted decline of oil company profits in 1975 over 1974 is simply the result of exceptional windfall profits in 1974 and a recessionary overcapacity in the transportation, refining, and marketing sectors of the oil industry rather than the consequence of an inadequate price for domestic crude oil. Profits on domestic crude oil actually increased in 1975.

Domestic producers were receiving the highest wellhead price for oil in the world for 40 percent of their production.

The energy industry has repeated its favorite misleading catch phrase of "free market pricing" to argue for deregulation of both natural gas and oil. As in the case of oil, the fact is that deregulation would mean OPEC pricing of American energy, since deregulated gas would rise toward the Btu equivalent price of OPEC oil. Many customers of unregulated intrastate gas have already suffered the burden of this monopoly pricing of unregulated gas. *The Texas Observer* recently reported that some Texas farmers who depend on unregulated gas to power irrigation pumps are being put out of business by price increases. In the face of unprecedented energy industry and White House propagandizing, the U.S. House of Representatives did, however, sidetrack deregulation of interstate sales of natural gas, probably for the life of this Congress.

An energy issue remaining before Congress in 1976 is how to deal with the industry's non-competitive structure and practices, which would create non-competitive energy prices even in the absence of OPEC monopoly pricing. Facing a choice between increased regulation of a non-competitive industry or breaking the industry into competitive elements, Congress is moving toward a break-up of the industry in the form of proposed divestiture legislation.

The energy industry, with its standard use of distorted analysis, asks "why pick on us" and points to other industries where anti-competitive concentration appears to be greater because a smaller number of companies dominate the industry. The problem with this standard response is that the energy industry giants, while more numerous than the leading firms in autos, steel, or aluminum, have developed a web of joint operations and corporate interlocks that are unique; these arrangements facilitate anti-competitive behavior to a degree not readily apparent from examination of the usual industry concentration

ratios. The major oil and gas producers have extensive partnerships with each other and with smaller companies in domestic operations through joint ventures in lease bidding, exploration, development, production, and pipelines. In foreign operations the joint ventures of the majors include production concessions, tankers, pipelines, and refineries. At the refining and marketing levels, both here and abroad, there is an anachronistic bartering of crude oil and refined products through "exchange agreements" among ostensible competitors. Finally, the board of directors of many of the major energy companies interlock indirectly through shared positions on the intermediary boards of directors of major banks and non-energy corporations.

The oil company cartelization of our domestic energy industry, as well as the world oil market, has led to a multitude of negative consequences. Concentration, joint ventures, and exchange agreements suppress potential competition and thereby thwart the price and efficiency benefits that a competitive industry would provide. The unaccountable wealth and power of the closely knit energy industry has been used to corrupt the political processes of the United States and other societies which they are supposed to be serving, not subverting. And the giant multinational oil companies are conducting their own foreign policy of supporting the OPEC cartel. They have hundreds of billions of dollars at stake in maintaining the OPEC monopoly price, because they hope eventually to price their U.S. reserves of oil, gas, and coal at the OPEC level rather than at regulated or competitive prices.

The symbiotic relationship between the oil companies and the OPEC cartel has been recognized by many commentators, including *Fortune* magazine, which has noted that "lacking a formal scheme for sharing cutbacks, OPEC has improvised a temporary means to prevent its self-destruction. In effect, the group is letting the major oil companies allocate the reductions among the producing countries."

Jamshid Amuzegar, Iran's Interior Minister, expressed the cartel's point of view when he said, "why abolish the oil companies when they can find the markets for us and regulate them? We can just sit back and let them do it for us."

Judge Savage subsequently became a vice-president of Gulf Oil, one of the defendants in the case.

We cannot rely on enforcement of the antitrust laws to disrupt the anticompetitive structure and practices in the industry. A long history of aborted antitrust cases and failure to initiate antitrust actions has demonstrated the political insulation of the energy industry. When the successors to the Standard Oil Trust and other oil companies conspired to control oil production, transportation, and marketing in the 1930's, the Justice Department initiated the so-called Mother Hubbard Case in 1940. War intervened, however, and by 1951 a compliant government agreed to a dismissal of the case. The *International Oil Cartel* case, brought against the Seven Sisters in 1953 because of their cartelization of the world oil markets since the mid-thirties, became a sham by ignoring the regulation of production. The consent decrees used to settle the case, according to the Senate Subcommittee on Multinational Corporations, "did not impair the major companies' ability jointly to control production, and through production, the world market." When a Federal grand jury in Virginia indicted 29 oil companies in 1957 for using the Suez crisis as an opportunity illegally to raise gasoline prices, the case was transferred to Tulsa, Oklahoma, where Judge Royce A. Savage dismissed the case despite strong evidence of price fixing. (Judge Savage subsequently became vice-president of Gulf Oil, one of the defendants in the case.) Since 1962, the Justice Department has been "investigating" the potential anti-competitive consequences of the Colonial Pipeline, a joint venture of nine of the largest oil companies. The investigation is reported to be still "active" today. The 1960s also was a period when the Justice Department tolerated a wave of mergers among large oil companies and among oil and coal producers which greatly increased energy industry concentration.

The historical absence of checks on the cartelization of the energy industry has permitted the anticompetitive growth of vertically integrated giant companies and their web of partnerships and cooperation. Yet since the petroleum industry's anticompetitive structure and practices are harmful to consumer interests, the oil companies should be restructured into competitive elements. As Anthony Sampson, author of *The Seven Sisters*, has commented, "in the end, the only legitimacy, the only reason for allowing the big companies to exist, is that they are serving the consumers either in the short term or the long term."

The divestiture legislation which the Senate Antitrust Subcommittee has drafted is a step toward a competitive energy industry. It would require the largest 15 oil companies to split into three segments: exploration and production, transportation, and refining and marketing. This would create a situation where all refiners have access to crude oil supplied by competing producers and where competing non-integrated refiners would have a vested interest in lower crude prices so they could compete at the marketing level by lowering produce prices. The separation of pipeline ownership from the other segments of the industry would avoid opportunities and incentives for pipeline owners to use their position to control crude and product markets.

The oil companies are spending millions of dollars in an anti-divestiture campaign. They are warning that divestiture is impractical and will lead to inefficiencies and therefore higher petroleum product prices. The basic weakness of the oil company arguments is that they deny that the free enterprise system will work when the shackles of cartelization are removed.

The simple truth is that the oil companies have always attacked government policies which would foster competition and have embraced government policies which would aid cartelization. Oil companies shaped the depletion allowance, stimulating vertical integration, so that they could shift profit taking to production where taxes were lower. They created the demand prorationing by governments of producing states, precipitated by the 1930 glut of oil from the East Texas oil field, because it permitted the regulation of supply which all cartels require to hold prices up. They supported Congressional approval of the Interstate Oil Compact and Connally Hot Oil Act because it made state demand prorationing workable. They supported IRS treatment of royalty payments to foreign governments as income tax payments because it reduced their American income tax drastically and subsidized the export of production capital to more formally cartelized regions. They supported the oil import quota system in effect between 1959 and 1973 because the limit on imports prevented foreign oil production from pushing down the price of domestic crude oil.

Oil company complaints that divestiture is impractical have to be taken with a grain of salt. Gulf, Sun, and Continental have in recent years separated internal management along the lines that divestiture legislation would require. Exxon wants to have it both ways. It told the Senate Antitrust Subcommittee that its production, transportation, refining, and marketing segments are inherently interdependent and not amenable to divestiture. Exxon even responded to a request for a breakdown of financial data among functional segments of the corporation by claiming that "Exxon Corporation's financial records are not maintained on a functional or segment basis." Yet the Subcommittee staff subsequently learned that Exxon had been telling exactly the opposite story to state taxing bodies seeking to tax Exxon as a "unitary business" liable for a tax calculated from its income on its entire operations. When speaking to these states, Exxon claimed that its functional levels are not interdependent and that "each of these functions is managed and accounted for on a functional operating basis. Each is a segment of a plaintiff's total corporate enterprise, but each has its own accounting, budgeting, and forecasting, its own management and staff, its own profit center, its own investment center, its own physical facilities, etc. The profit or loss of each function is separately and accurately computed."

According to Exxon's own words, then, divestiture of its vertically integrated segments appears to be practical after all.

Mr. Nader is Director of the Center for The Study of Responsible Law.

U.S. Still Faces Critical Energy Shortage

Frank Zarb

If energy were a problem of medicine rather than of economics and resources, we could describe its 3 clearly discernible stages: chronic, acute and critical.

Any chronic condition, by definition, has a long history. Gradually, perhaps imperceptibly, it grows in seriousness and complexity over an extended period, erupting from time to time in acute and often dangerous seizures. These same characteristics are typical of the present energy crisis.

Over the last 75 years, the United States economy has shifted to oil and natural gas and away from coal. Granted, oil and gas are more flexible and efficient, yet the stark geological fact remains that coal constitutes 90 percent of our proved, economically recoverable reserves, while oil and natural gas together amount to 7 percent. The resulting pressure on oil to satisfy almost 50 percent of our total energy demands has led to the depletion of our more accessible, and hence, cheaper American reserves. The natural tendency to exploit the least costly reserves inevitably led both to the increased development of low-cost foreign oil and to its growing use in the United States. As often happens in the advance of a chronic condition, its progress began to accelerate. The United States reached this point in the 1960's and early 1970's.

During this period, low prices, environmental restrictions on the use of coal, and the proliferation of the automobile fostered a growth in the demand for petroleum of more than 4.5 percent a year. By 1970, domestic production had reached the limits of its capacity, settling into a persistent decline from 9.6 million to the present 8.2 million barrels a day — a production loss of almost 10 percent.

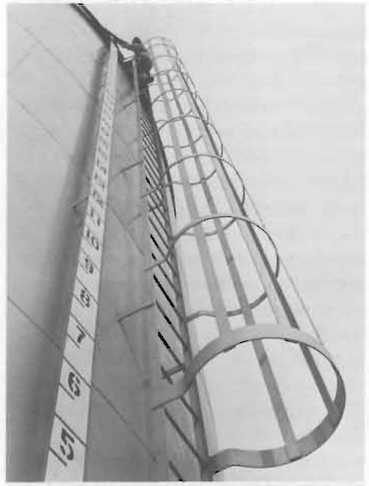
Simultaneously, another disturbing trend developed. To counteract declining domestic production, oil imports began to surge upward. In the decade between 1960 and 1970, oil imports rose from 19 to 23 percent of consumption, an increase of 4 percent. Between 1970 and 1975, imports jumped to 37 percent of consumption — up 14 percent in 5 years. In half the time, we had more than trebled the rate of demand for imported petroleum.

Our condition of growing dependence, serious enough in itself, was complicated further by the intense economic and political nationalism rising in the Middle East, the area possessing most of the world's known oil reserves. Decisions on production and price, once the almost exclusive province of the oil companies operating in the Middle East, were gradually taken over by the governments in the area. The power to decide the price and the volume of oil produced and shipped, combined with resurgent nationalism, gave some members of OPEC the ability to mount an embargo. The October 1973 Arab-Israeli War provided the occasion, and at that point our condition became acute.

The interruption of so significant a portion of our oil supplies caused a variety of disruptions in the American economy, ranging from long delays at service stations to significant increases in unemployment. These urgent and immediate problems, requiring radical treatment, forced us to allocate supplies and control prices, both of which proved relatively successful in managing this acute stage.

However, even though this acute energy condition is behind us, we are still faced with a collection of symptoms that indicate an aggravated and, in some respects, worsening condition.

The first symptom takes the form of price increases related not to the



dictates of the marketplace but to the economic needs of the producer governments. Each increase exerts some inflationary pressure on the U.S. economy. Although the increase may itself occur just once, it triggers in its wake an augmented daily transfer of wealth from the U.S. economy to the oil producing nations. This transfer shares some of the characteristics of a tax, diverting capital from productive domestic investment and redistributing it elsewhere.

The second symptom: in the absence of effective action, the amount of oil we import from the Middle East, relative to our total imports, can only grow as reserves in other nations are depleted, and as Canada reduces its exports.

The third symptom: Our domestic oil production is continuing to decline.

The fourth symptom: Our reserves of natural gas, excluding those in Alaska, are at their lowest level since the mid-fifties, and, under present conditions, natural gas production could be expected to decline consistently over the next decade.

The fifth symptom: Over the same period, the demand for energy, though rising at less than historic rates, will grow by an annual average of almost 3 percent.

Taken together, these symptoms add up to a prognosis of disaster. In the absence of effective government action, with imports rising to almost 14 million barrels of oil a day by 1985 and the oil producing countries strengthening their control over the U.S. petroleum market, OPEC's ability to manipulate prices would be enhanced immeasurably and the temptation to do so would be nearly irresistible. In fact, without government action, we estimate that by 1985 the U.S. would be importing more than half its petroleum needs, most from unstable Middle Eastern suppliers. At that point, another embargo would produce a far more acute reaction in the U.S. economy than the embargo of 1973.

Fortunately that grim prospect has been mitigated to some degree by passage of this year's Energy Policy and Conservation Act. The cumulative effect of this new law will be to prevent our dependence on unstable supplies of imported oil from rising appreciably over the next 2 or 3 years. For the longer-term, from now through 1985, the law will allow us to depress the amount of imported oil by roughly 8 million barrels a day below a projected level of 13.5 million barrels. Rather than buying close to 14 million barrels a day from abroad, we can reduce the volume to about 6 million. The real value of energy, expressed in its price, will foster growing efficiencies in energy use, and add an incentive to produce more energy from domestic resources.

A gain of 6 million barrels is a healthy and encouraging improvement. Yet there is more to be done. As I am writing, for example, the evidence points to positive action by Congress on development of the naval petroleum reserves for civilian use, thus adding significantly to domestic production as early as next year.

To reduce our long-term vulnerability to supply interruptions, we must, in addition, increase our production of natural gas. But there is every reason to believe that exploration for and development of new natural gas reserves will be inhibited by continued controls on its price, resulting in a loss of nearly 5 trillion cubic feet of production in 1985. Where the loss can be made up with oil, it will be imported oil, perhaps 3 million barrels a day.

Coal can be used primarily to supplant imported oil in generating electricity. By 1985, coal production could almost double, reaching more than a billion tons annually. However, its production and use are governed almost totally by long-term utility demand, environmental issues, and the availability of adequate transportation. Long-term demand for coal will not materialize in an atmosphere of uncertainty about the future course of environmental regulations or in the presence of overly stringent air quality standards greater than those needed to protect human health.

Clearly, there are limitations to the use of coal to generate electricity. Though the U.S. could almost double its coal production by 1985, there are major uncertainties. And solar power cannot be expected to fill the gap in the absence of some wholly unexpected breakthrough.

We will have to rely heavily on increased nuclear capacity to ensure adequate supplies of electricity in the face of demand that is growing, albeit at less than historic rates. Its advantages are undeniable: it is cheaper than imported oil and coal; it does not pollute the air; its safety has been proven over more than two decades; and ample domestic nuclear fuel is available. However, since nuclear power plants require the longest leadtimes of any type of generating plant, it is disturbing that almost 100,000 megawatts of planned nuclear capacity have been cancelled or postponed since June of 1974 — an action due, in part, to the large capital investment necessary.

Just as a doctor might prescribe a series of treatments for a seriously ill patient, so our economy must adopt a regimen that will restructure the way we produce and use energy. Much of the treatment is already underway in the form of the Energy Policy and Conservation Act. As a result, my prognosis for the future availability of energy, though guarded, is optimistic.

But we have still to go through the critical period in energy, since a crisis, strictly defined, is that point in the course of an illness when it becomes clear whether the patient will, or will not, recover. In brief, I do not know yet whether we will use the means at our disposal to rebuild the strength of our domestic energy system.

Mr. Zarb is Administrator of the Federal Energy Agency.

"A Coal Miner Looks at the Energy Crisis"

Arnold Miller

I was born in the mountains of West Virginia, and my views are the views of a coal miner. Coal mining is hard, dirty work, and when you have time to think on the job, you mainly think about your survival. I have spent most of my life just trying to survive, and what free time I had left over I spent on trying to reform the union I belonged to. This is hard work, too. So my views are generally geared to getting from one day to the next.

Yet when I was still working underground, long before I knew any people who called themselves environmentalists, I ran across what the founder of the Sierra Club, John Muir, said: "When we try to pick out anything by itself, we find it hitched to everything else in the universe." I think that is about as true as any idea I ever heard. You can't talk about coal without talking about energy. You can't talk about energy without talking about oil. You can't talk about oil with talking about politics. You can't talk about politics without talking about corruption. You can't talk about corruption without talking about companies that are so big that they can give half a million dollars to a politician without its even showing up on their books. You can't talk about companies like that without talking about energy, because they supply it. And you can't talk about energy without talking about coal. So I will talk about all of these things, and if I wander around, you can blame it on the Sierra Club. That is what the coal industry does.

I still run into people who think that the coal industry died when the railroads converted from steam to diesel locomotives. They are very suprised when I point out to them that their electrical appliances burn coal. They don't see it because it is delivered by wire. The steel that goes into their cars could not have been produced without coal. That is true even if they are driving a Japanese car, because it is exported American coal that the Japanese steel industry uses. I am sure, though, that you all know enough about our economy to realize that coal is the basis of it. If we stopped digging coal in September, the country would shut down in October, after the stockpiles ran out. It is that simple.

We are producing, at this point, about 630 million tons of coal a year from 24 states. West Virginia and Kentucky are the leading producers. They account for about 40 percent of last year's total between them. Other principal coal-producing states are Pennsylvania, Ohio, Illinois, Indiana, Virginia, Tennessee, and Alabama. In the West, there is production in Oklahoma, Arkansas, Iowa, Kansas, Missouri, Wyoming, Montana, Colorado, Arizona, Utah and New Mexico. The big reserves are in the Rocky Mountains and the Northern Plains.

All this coal is being mined by an estimated 150,000 men, which makes coal one of the most productive industries in the country. About 125,000 of those men belong to the United Mine Workers (our total membership, including retired miners, is about 200,000). You can get some sense of how the coal industry has changed through mechanization by realizing that 30 years ago we were producing roughly the same amount of coal every year, but then it required a work force of about 600,000 to do it. Today the coal industry is about 98 percent mechanized.

More than half of the coal we produce goes to electric utilities. We deliver about 90 million tons to the steel industry. We export about 57 million tons. We deliver the rest to a wide variety of other industries, particularly those producing chemicals, which rely heavily on coal and coal by-products.

Mainly because of mechanization and the high productivity that results from it, the price of coal traditionally has stayed low. That is, the price to the consumer. The hidden cost of coal is the one we pay — the people who mine it. It is a big price. We get killed. Since the Bureau of Mines started keeping records of such things back in 1910, about 80,000 of us have been killed. No other industry comes close to that. And we get black lung from exposure to fine coal dust in the mine air. That problem has been with us through the history of the industry, but the companies and the company doctors have denied it even existed. They were still denying it in 1969 when the Public Health Service finally got around to releasing a study it had been sitting on for 6 years which showed that 100,000 or more miners and retired miners were afflicted. And

"afflicted" isn't a strong enough word. Dying of cancer is no worse. This old disease has become worse with mechanization because the high-speed mining machines stir the coal dust up much more intensely than in the old pick-and-shovel days. We have had our technological progress in coal, just as in other industries, but we are still being smothered to death.

We have learned from bitter experience that when you fight the coal industry, there are terrible odds against you. The concentration in the industry is extreme. Of course, the industry says this is ridiculous. The industry spokesmen are always pointing out that there are 5,000 mines and 1,200 mining companies. And then they ask how any industry with that many companies in it could possibly be concentrated. They get away with this question because so few people know anything about the industry. But the simple fact is that 15 companies produced 301,208,359 tons last year, which was 51 percent of the total. The top 50 companies combined produced 400,000,000 tons — two-thirds of the total. I am not an economist, but you don't have to be one to know that any industry which has half of its production controlled by 15 companies is concentrated. It is more concentrated, in fact, then these figures indicate.

First, let me list the top 15 companies by their coal industry names, and you can see how many you recognize. Peabody, Consolidation, Island Creek, Clinchfield, Ayrshire, U.S. Steel, Bethlehem, Eastern Associated, North American, Old Ben, Freeman and United Electric, Westmoreland, Pittsburgh and Midway, Utah International; and, in fifteenth place, a group made up of Central Ohio Coal, and Southern Ohio Coal.

If you have ever heard more than 5 of those names, you must have grown up in Appalachia, or you have been studying the industry. But the next question is harder. Who owns those 15 companies? How many of them speak for themselves?

Peabody Coal is a wholly-owned subsidiary of Kennecott Copper. Consolidation Coal is a wholly-owned subsidiary of Continental Oil. Island Creek is a wholly-owned subsidiary of Occidental Oil. Clinchfield is a wholly-owned subsidiary of the Pittston Company, which operates oil refineries and owns the Brink's armored car company. Ayrshire Coal is a wholly-owned subsidiary of American Metal Climax (Amax). U.S. Steel and Bethlehem own their own coal-mining operations. Eastern Associated is a division of Eastern Gas and Fuel. North American Coal is independent. (You have to get down to number nine on the list to find an independent coal company.) Old Ben is a wholly-owned subsidiary of Standard Oil. Freeman Coal and United Electric are wholly-owned subsidiaries of General Dynamics. Westmoreland Coal is independent. Pittsburgh and Midway is a wholly-owned subsidiary of Gulf Oil. Utah International is independent, but not strictly a coal company. It has world-wide operations in copper, iron ore, and other minerals. And that last group — Central Ohio Coal, Central Appalachian Coal, Windsor Power House, Central Coal, and Southern Ohio Coal — is a division of American Electric Power, the biggest private utility company in the world.

You realize very quickly that the coal industry is not what it seems to be at first glance. You have oil companies controlling two of the top three. Kennecott Copper controls the biggest of them all — a company which produced nearly 72 million tons last year and plans to double that by 1980. This one company, which gets about 80 percent of its coal from strip mining, produces about 12 percent of the industry total. In fact, Peabody alone outproduces the combined effort of the 7 companies at the bottom of the top 15. What is true of all the giants is that ordinary citizens can't get at them. They are not accountable to us. They should be, because there are some important questions they should be forced to answer — and not just with the usual symphony of public relations they pump out whenever they are being criticized. First of all, they should be forced to explain how they are going to deal with the future energy needs of this country.

Lately we have had truckloads of studies indicating one thing: by 1985, the United States will be running out of domestic oil and domestic gas, and relying even more heavily than we already are on supplies imported from the Middle East. Most of the studies also give some passing mention to coal. Some of them point out that we will need to produce about 1.5 billion tons of it a year in order to keep our lights burning. That is more than double the 600 million tons per year we produce now. In effect, it means building a whole new industry on top of the one we already have. But there is no way the coal industry will be producing 1.5 billion tons a year by 1985 — or for that matter, at any time soon after that. The bigger companies, with effective control of their market, have no incentive to expand except when they are absolutely certain in advance of selling every ton of coal at acceptable prices. Their goal is to remove every last bit of risk from the business (except in the area of safety, where they are still willing to take all kinds of risks).

The hidden cost of coal is the one we pay – the people who mine it . . . We get killed.

This was true even before they started being devoured by the oil industry: it is twice as true now. The oil industry knows that you don't refine more gasoline than you think the country will need, because if you do, the price will go down. In the days of competition you had less chance of manipulating the total production. These days, when competition in the oil industry is a joke, you can manipulate whatever you feel like manipulating, starting with the White House and the Interior Department and going on from there. The biggest oil-coal combines are sitting on vast reserves of readily recoverable coal. But that coal will come out of the ground only when the men who own it can be sure of the price they will get for it.

That is a simple objective, but it immediately becomes complicated. Coal, oil and gas are largely interchangeable as far as electric utilities are concerned. They all produce Btu's. Many generating plants have been designed to take any or all three. If coal were still 100 percent competitive, there would be an incentive to mine more of it, sell it to the utilities at the lowest possible prices, and undercut oil and gas, which are increasingly difficult to find and bring to market, especially if you have to go overseas to do it. But coal is not 100 percent competitive.

Let us look at a few aspects of the current energy situation. We are already using 24 trillion cubic feet of natural gas per year. Demand has increased about 7 percent per year since World War II. There is no leveling off in sight. The Federal Power Commission says we have a 65-year supply of natural gas, but that figure is based on a demand increase of 1.4 percent a year, which is ridiculously out of date. Some experts see us running out of domestic gas reserves by 1986. With luck, assuming there are more undiscovered reserves than we think, we might make it to 1995.

We are not quite as badly off in oil reserves, but the forecast is no more encouraging. We were using 14.7 million barrels a day in 1970. We were producing 11.6 million barrels a day from domestic wells; that gave us a deficit of 3.1 million barrels a day. We made it up with imports. Looking ahead, even the most conservative estimates for 1985 show

domestic demand running at 30.2 million barrels a day, more than twice the consumption of 1970. With luck, domestic wells will be producing 15 million barrels a day.

That is a deficit of 15.2 million barrels a day to be accounted for. It has to come from the Middle East, for the most part. In the back of my mind right now is the question: what are we going to do with all those B-52 bombers now that they are not bombing Cambodia any more? I don't think it is wrong to start worrying about what the Pentagon is up to — or will be up to. When we have too much dependence on foreign supply, as we now do, the temptation to go in there on some flimsy pretense and clean out all those sheiks will be strong. If the B-52's are too clumsy, we will do it with subversion and the C. I. A.

We don't have to do that, of course. We could be pouring money into research that would speed the day when we can convert to pipeline gas and synthetic gasoline. Very few people have come to grips with one vitally important fact. That fact is if we wanted to, we could run this country on coal. Not tomorrow, no. But, with a sufficient commitment, we could be doing it before 1985.

Some time in the future, we will be running this country with fast-breeder nuclear reactors, though I won't live to see it. When my children are my age the first of these reactors will be making an impact. Beyond that, we will get the sun's energy harnessed. My children won't live to see that — at least not on a nationwide commerical scale. Meanwhile, we ought to be concentrating on figuring out how to use our conventional fuels. We have just about run out of gas. We are low on oil. What about coal?

We sit squarely on top of the largest readily available supply of coal on earth — about 1.3 billion tons in all, with about 390 billion tons considered to be readily recoverable. That is a 600-year supply, at current consumption levels. Even when you double or triple our consumption, the supply will outlast any conceivable period of demand.

Coal overshadows gas and oil in terms of available reserves. The U.S. Geological Survey figures that coal accounts for 87.1 per cent of all the energy we have left. Oil is 3.5 per cent. Gas is 4.6 percent.

Our energy problems are getting worse, not better, and there is little hope that we will find a solution by relying on the huge energy monopolies that dominate the scene. One could devote a book to possible solutions to the crisis, but two points remain clear: coal must be the cornerstone, and the public's voice must be represented increasingly in the decisions which shape our energy policy to come.

Mr. Miller is President of the United Mine Workers of America.

A Step Towards Independence

Harold Bierman
Seymour Smidt

In order to achieve some degree of energy independence, the experts have recognized the need for both conservation and expanded production. This Country now faces a situation, however, where the investment risks for increased production in such sources as oil shale and oil sand are so great that private industry has backed off from the massive funding that is needed.

And for good reason. In the past few years, oil reserves have been sold at a wide range of prices based on the reservation price of the countries and companies possessing the oil. Since there is no guarantee that prices will not be reduced in the future, private oil companies have been reluctant to invest in projects where the expected cost would be equal to or larger than the current world price. While a decrease in oil prices would be warmly welcomed by most of the world, it would be disastrous to corporations that had just spent billions on plants which could only produce oil at a higher marginal cost than the market price.

The Federal Government should guarantee, therefore, specified returns for approved energy projects. This is not to say that corporations may not earn profits above the guaranteed return; rather, they should always earn at least the minimum agreed upon returns. Oil would only be produced in volume for a "profitable" market; it would not be produced when economically undesirable. Because of additional facilities and the larger capacity for producing energy, the United States would have more flexibility and less reliance on foreign sources.

If, for example, the world oil price were significantly more than the long-run average cost of producing exotic domestic oil, the company would earn high excess returns and the Country would be supplied with increased oil production. Yet, if the world oil price were somewhere between the long-run average cost and the marginal cost of producing the exotic domestic oil, the Government would pay a subsidy and the facilities would be used to produce oil. Finally, if the world oil prices were less than the marginal cost of producing the exotic domestic oil, facilities would be placed on a stand-by basis or operated at a minimum level, and the company would be subsidized because a stand-by productive capacity is an asset to the economy.

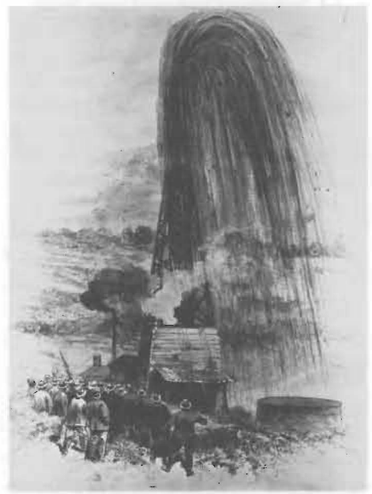
This scheme contains a few complexities. A mixture of price-cost relationships through time might be the basis of a fair return without Government subsidy, even if the price were, on occasion, to drop below long-run average cost. When the oil price is never equal to or greater than the long-run average cost, the company definitely would have to be subsidized.

The concept of a subsidized return is quite different from President Ford's call to Congress to "support ... energy prices at levels which will achieve energy independence." Government price support could lead to a situation where oil production would continue when the world oil price falls below the marginal cost. The suggested subsidy procedure would, in contrast, shut down or drastically reduce production during such periods. It would not lead — as price supports might — to excess returns to private industry arising from Government payments.

The allowed return should be the minimum necessary to ensure the desired level of productive capacity. This minimum return should be less than the normal risk adjusted return, since it is guaranteed — with an upside potential — by the Government. Although there is some probability of a very large return (if technological break-throughs occur or if the price of oil is increased), there is a greater chance that the agreed upon minimum return will be earned.

The exact computation of the subsidy is beyond the scope of this discussion, but some basic principles can be described. The Government and the firm would have to agree both upon a depreciation procedure and an expensing versus capitalization procedure for acquired assets. The firm would be allowed the agreed-upon return, and the Government would pay a subsidy when earned revenues are insufficient.

Two basic situations, which may often occur, require some explanation. When, first of all, the asset is consistently in a low income or a loss situation and the Government has to pay a subsidy, the firms would be allowed a net income equal to the defined asset base times the allowed return. If the actual income is below the allowed income, the Government would make up the difference; that is, the firm would earn a return on investment in each period of life of the investment equal to the allowed return. Both company and Government would be satisfied: the company because it has earned the predicted return that it defined as acceptable in undertaking the investment; the Government because it has obtained productive capacity (possibly of a stand-by nature).



When, secondly, a company earns an excess return on investment for one or more periods, this excess belongs to the company if it has not been subsidized. Since the Government has made no subsidy and the Country has received the benefit of the productive capacity, no action is required by either company or Government. If there were need for a subsidy, however, its computation would consider excess profits that have been earned in the past. On the other hand, if a company were to earn excess profits, and a subsidy had been previously paid, the firm would refund all or a portion of its subsidy to the Government.

In all situations the need for a subsidy (or the appropriateness of a refund) should be determined by the time value of money using the allowed return as the time discount factor. This kind of calculation is well-known and easy to implement when there is agreement upon a depreciation schedule.

The allowed return could be adjusted to bring forth the desired level of investment; if desired, the Government could further stimulate investment by granting investment allowances, tax credits, or accelerated tax depreciation (including immediate expensing). Combined with the suggested allowed return procedure, these additional investment incentives could actually reduce the over-all cost to the Government — because of differences in the Government borrowing rate and the allowed return — while at the same time facilitating investment by reducing the amount of capital that private industry would have to raise for approved projects.

One valid justification for the Government offering allowances for desirable investments is that the dollar cost facing the industry is not necessarily equal to the social cost of the investment. Frequently the social cost is higher than the industry cost because of such negative consequences as ocean, river or air pollution. In the present economic situation, where the economy has slack resources, the social cost may be less than the explicit dollar cost. Yet the Government should make an attempt to have private industry make decisions on a real cost rather than dollar cost basis: one way to accomplish this is through an investment allowance.

The Government may, in addition, wish to subsidize the initial investments in this type of oil production to start the learning process that could lead to much lower costs than are currently anticipated. Given the

magnitude of the energy problem facing the world, the Government should investigate all possible means of stimulating production and productive capacity. The guaranteed minimum return is one solution that deserves consideration.

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Nuclear Fission: The "Future Technology" Whose Time Has Passed

David D. Comey

The electric utility industry is finally waking up to the fact that its $80 billion investment in nuclear power plants it has built or ordered is turning out to be a mega-lemon. So many utilities have been cancelling nuclear plants faster than they are being ordered that, for the last 2 years, we have had a *de facto* moratorium on nuclear plant construction.

That moratorium makes sense: the U.S. nuclear power program never got de-bugged before it mushroomed from the designing of small prototype reactors to a full-scale commitment to a fission-based economy. Commercial aviation had at least 60 years to scale up from Kitty Hawk to the 747. Commercial nuclear power tried the same thing in less than 10 years, and failed — failed dangerously. Thanks to bureaucratic intrigue and ineptitude, the safety testing that was supposed to have been finished in 1969 is now schelduled to begin in 1977! Meanwhile there are almost 60 reactors in operation and 75 more under construction.

We are just beginning to appraise realistically the magnitude of the problems swept under the rug in the 1960's by the Atomic Energy Commission and Congress's Joint Committee on Atomic Energy. But there seem to be 5 major problem areas:

- ☐ Making nuclear power plants a reliable and economical source of electricity.
- ☐ Ensuring an adequate and reliable fuel supply for all the nuclear plants presently planned.
- ☐ Safeguarding nuclear plants against sabotage and preventing plutonium and other weapons-grade nuclear material from falling into the hands of terrorists.
- ☐ Storing high-level radioactive wastes for the next 250,000 years.

Because these areas are germane to how we solve our energy problems, I want to explore them in some detail.

Economics and Reliability

The cost of electricity from nuclear power plants has turned out to be far more than anyone predicted. Capital costs have escalated at a higher rate than inflation. A nuclear plant that would have cost $200 million 7 years ago now costs $1.1 billion. The price of uranium has recently skyrocketed from $6 a pound to the current price of $36 a pound. Not even oil prices have increased so dramatically.

Every 2 years, the utility industry weekly, *Electrical World*, surveys the total generating costs for the most modern electric generating plants. This "Steam Station Cost Survey" was published last November 15th, and demonstrated that, although fuel costs for nuclear plants were far lower than the fuel costs for coal-fired plants, the nuclear plants' far larger fixed charges (taxes, interest, depreciation) pushed the total generating cost more than 30 percent higher than the cost of coal-generated electricity. The nuclear industry, however, continues to run advertisements claiming how many millions of dollars nuclear plants have saved the consumer. Yet these claims refer only to fuel costs. When the total generating costs are figured, coal is cheaper than nuclear in almost every case.

The reason for these high fixed charges is clear enough: nuclear plants have a poor reliability record and consistently operate at low capacity. Although the nuclear industry and the AEC projected that nuclear plants would operate at 80 percent capacity over their 30-year lifetime, they have averaged — during the past three years — a mere 55 percent. Worse still, as these plants pass the 10-year mark, their average capacity drops to 39 percent.

The explanation for this low capacity rests with the build-up of radioactivity in the primary system. In order to avoid excessive radiation exposure, management often must employ a large number of workers for repair of this system. A repair man can, for example, receive maximum permissible exposure after working on the primary system for just a few minutes. And because this exposure has "burned him out" for the next 3 months, thousands of workers have had to participate — in some cases — in the repair of a single nuclear plant. Since the radioactivity of these plant systems increases with plant age, repairs are likely to become even more time-consuming as the plant gets older. The results are predictable: higher costs, long outages, and lower capacity.

Fuel Supply

Most of the uranium in the United States is mined from a geological formation known as the "Colorado Plateau", a four-state area encompassing much of New Mexico, Utah, Arizona and Colorado. Since proven reserves will last only through 1985, the U.S. will need to find the equivalent of 10 new Colorado Plateaus to fuel the number of nuclear plants projected for the year 2000. In that this is clearly impossible, we will have to import uranium. At present, the non-communist nations willing to export uranium in significant quantities are Gabon, Niger, Zaire and South Africa. Inasmuch as there is now a "Uranium Institute" in London that promises to become a UPEC, the switch from oil to nuclear fission hardly guarantees energy independence. The projection for such independence must, in brief, face a geological reality.

In a recent *Fortune* article — "We May Find Ourselves Short of Uranium, Too" — nuclear proponent Ralph Lapp argued that the fission program makes little sense unless we build breeder reactors which can turn natural uranium into fissionable plutonium fuel. But the breeder reactor has run into difficulties: the very high neutron flux in a breeder reactor causes the metal fuel assemblies to swell. This swelling reduces the coolant flow between the fuel rods and runs the risk of a fuel meltdown throughout the core. Although the principal solution to the problem is to have more space between the fuel rods, this would reduce the breeding rate and would adversely affect the doubling time (the amount of time it takes to double the original inventory of fuel).

So far, then, the news — even to an advocate of nuclear power — has not been good. Take, for example, the breeder reactors to be constructed on the Clinch River in Tennessee. Once expected to have a doubling time of 8 years, it is now predicted that its doubling time will be 40 years. The French breeder reactor, the only large one that has operated successfully, has a doubling time of 60 years. Such figures strongly suggest that the breeder reactor will never be a significant source of fuel.

Nuclear Plant Safety

If a primary coolant pipe in a nuclear reactor accidently ruptured, the water in the reactor's fuel core would be lost, and the fuel rods would, consequently, heat up rapidly and begin to melt in about a minute unless an emergency core cooling system began to operate. A reactor core meltdown would be a major accident, causing heavy casualties and property damage.

Yet no full-scale test of an emergency core cooling system (ECCS) has ever been conducted. In a series of six tests on a small mock reactor in 1971, however, the ECCS failed in *all* six attempts. Semi-scale tests are not scheduled to be run until next year, and no full-scale tests are planned at all. Thus, assurances of reactor safety have no experimental data base. And though reactor manufacturers use complex computer programs to "model" how the ECCS will function during an accident, one recently resigned AEC expert on these computer programs described them as classic examples of "garbage in — garbage out."

A nuclear plant that would have cost $200 million seven years ago now costs $1.1 billion.

The reliability of the ECCS at operating nuclear plants has, moreover, turned out to be much lower than expected. During a recent accident at the Browns Ferry plant in Alabama, all 3 sub-systems of the ECCS failed to function. Fortunately, no piping rupture was involved, so no reactor meltdown occurred. But the incident did demonstrate that the entire ECCS is a questionable safeguard.

Other incidents are similarly discomfiting: At Zion, Commonwealth Edison's large nuclear plant 30 miles north of Chicago, the emergency diesel generators which supply power to the ECCS are reported to have a failure rate of 46 percent; the plant had been operating for more than a year before it was discovered that the ECCS had been wired backwards. At Commonwealth Edison's Quad-Cities plant, the ECCS on Unit 1 was rendered inoperative by jumper cables put on the control panel by an electrician who thought he was attaching them to Unit 2, which was not operating at the time. The error was not discovered until a test on Unit 2 went awry. Meanwhile, Unit 1 had been running without its ECCS safeguard.

Nuclear plant safety is further undermined by poor quality control during construction. Defective welding, for instance, has been discovered at a number of plants. At Zion, a welder who testified at the AEC safety hearing noted that 135 uncertified welders had worked on the plant, and the subsequent AEC inspection revealed hundreds of defective welds. Because of poor quality control during construction of the Palisades nuclear plant in Michigan, its owner, Consumers Power Company, is now suing the reactor manufacturer for $300 million.

Safeguards Against Saboteurs and Terrorists

A nuclear power plant can be easily sabotaged. Recent AEC studies report that half a dozen trained saboteurs could take over a nuclear power plant and rig it with high explosives sufficient to cause a reactor core meltdown that would kill hundreds of thousands of people. Using the threat of this accident,

they could make virtually unlimited political or monetary demands. Although we have erected enormous air and missile defense systems to protect our large cities, we are, ironically, surrounding many of these same cities with nuclear reactors whose fuel cores contain 1000 times as many fission products as a Hiroshima-sized weapon. The radioactive contents of these reactors can be spread over a large area by the use of *conventional* explosives easily obtained by terrorists or criminals. A nuclear reactor on the edge of a major city is the perfect Trojan horse.

Storage of Radioactive Wastes

The high-level wastes from nuclear reactors must be sealed off from the environment for more than 250,000 years. At present, the government has no definite plans on how to handle these wastes for such a long period of time. It had planned to dispose of them in an abandoned salt mine in Kansas, but this project was abandoned because of leak problems. A subsequent project near Carlsbad, New Mexico now faces insurmountable problems.

The alternative now being most considered is to store the wastes in some retrievable form on or close to the surface of the earth where cooling systems will keep the wastes from melting through their containers. Since this storage must be protected from sabotage, warfare, and earthquakes for the next 250,000 years, many consider the plan unrealistic if not lunatic.

Conclusion

In 1975, the nuclear power program added — after subtracting the enormous energy demands of the uranium fuel enrichment plants — just over 1 percent to the U.S. energy supply. Abandonment of nuclear power over the next 10 years would create, therefore, only a small ripple in the economy. The public and the investment banking community are beginning to realize that other energy sources offer better economy, require less capital, and create many more jobs than nuclear power. Nuclear fission seems to have become a "future technology" whose time has passed.

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Nuclear and Coal Power: A Comparison

Sidney Siegel

The role of energy in sustaining and advancing modern industrial society is fundamental. Since the Industrial Revolution, we have increasingly replaced human labor with inanimate energy obtained from a variety of sources: falling water, coal, petroleum, and, most recently, nuclear fuels.

As energy-based societies have flourished, however, there has been a significant change in man's impact on the natural environment. Although at first the environmental damage was small and we seemed to believe there was an infinite sink to absorb pollution, it has become obvious — particularly in our lifetime — that industrial pollution has grown excessive and must be controlled.

Since it would be meaningless to discuss a single energy system in any absolute sense, I will, in what follows, compare both the environmental impact and the economics of coal and nuclear power, and show why nuclear energy is this country's best bet for the future.

In 1975 the United States was able to generate its electrical power, which made up 10 percent of its energy consumption, from a variety of sources: hydro, gas, oil, coal, and nuclear. By 1985, a newly constructed electric utility plant will not have these options. The new plant will not look to hydro, which is almost totally committed; it will not draw significantly on gas, since its supply is limited and should be used principally for domestic heating; it will not, one assumes, depend on oil, which is being imported in ever increasing amounts. In short, coal and nuclear power are the only real alternatives.

The Environmental Impact — Nuclear Fuel

For the remainder of this century the nuclear choice will almost certainly be confined to a conventional light-water reactor fueled with slightly enriched uranium. This typical 1000 MWe (megawatt electric) nuclear power plant produces 6.6 billion kilowatt hours of electric energy per year at a bus-bar cost of 24 mills per kilowatt hour. To support such a plant, uranium must be mined and, subsequently, enriched to 3 percent U-235. Later the spent fuel must be reprocessed and the wastes stored.

The reactor and its supporting elements in the fuel cycle affect the environment in various ways. Principally at the uranium mine and mill, about 12 acres of land are removed from further use. Approximately 7 billion gallons of water are evaporated at the power plant. And several hundred thousand curies of gaseous radioactivity (Kr-85) are released into the atmosphere, chiefly at the chemical reprocessing plant.

Given a 1000 MWe nuclear plant, the impact on the health and safety of the general public and the plant workers themselves has been determined: the principal origin of occupation fatalities, mining causes 0.1 deaths and 3.6 injuries per year. Occupational health defects — chiefly latent cancers caused by Rn-222 and other radio-nuclides — occur at the rate of 0.01 per year among miners, and 0.07 per year among all other workers in the full cycle. Radioactivity from the entire fuel cycle — largely tritium and Kr-85 — is released mainly at the fuel processing plant, and is responsible for a latent cancer rate of 0.03 cases per year.

The Environmental Impact of the Coal Cycle

A typical 1000 MWe coal-fired plant produces 6.8 billion kilowatt hours of electric energy per year at the cost of about 28 mills per kilowatt hour. This plant requires 2.9 million tons of coal per year: about half is mined underground and the remainder is stripped from the surface.

Using the best of technology presently available for air pollution control, the plant still emits 24,000 tons of sulphur dioxide, 27,000 tons of nitrous oxide, 2,000 tons of fly ash, and 6 million tons of carbon dioxide per year. Strip mining disturbs, in addition, 720 acres of land per year — most of which probably cannot be reclaimed.

This 1000 MWe coal-fired plant is typically the cause of 1.1 miner deaths and 47 miner injuries a year. Due to the mining of coal for this plant, about 0.6 cases of black lung disease — the principal occupational health hazard — occur each year. Even with stack-gas scrubbers, the general public suffers from sulphur dioxide emissions. In fact, the most reliable current data estimate that these emissions cause 5 deaths a year and a much larger number of serious respiratory ailments. Finally, in transporting millions of tons of coal each year for the fueling of a 1000 MWe plant, 0.5 people are killed in highway accidents and many more are injured.

Comparison of Nuclear and Coal Cycles

How, then, do the two forms of electric generation compare? Because of a bus-bar generation cost differential of nearly 5 mills per kilowatt hour, a 1000 MWe nuclear plant costs $30 million less per year — a 20 percent saving over coal. Moreover, under normal operating conditions, the coal-fired plant irrevocably disturbs 60 times more land, requires 100 times more rail transportation, and uses 20 percent less water for cooling.

In a comparison of health and environmental hazards, the data heavily favors nuclear power. A 1000 MWe coal plant causes 10 times more miner deaths, 7 times as many occupational injuries, and 60 times as many cases of serious disease. Among the general public, the figures also support the use of nuclear power. Sulphur dioxide emissions cause about 100 times as many deaths due to respiratory disease as those caused by cancer resulting from radioactive effluents.

Although most of the data weighs heavily against coal, nuclear power does create two unique problems from which the coal cycle is free: the ultimate disposal of radioactive wastes, and the possibility of severe reactor accidents.

The high level wastes — fission products and long-lasting actinide elements — are separated from the spent fuel at the chemical plant and can be stored there up to 5 years. Although no final repository for the wastes has yet been selected, the most likely prospect appears to be deep underground storage in bedded salt deposits. Using prudently assumed dissolution and leaching rates, University of Pittsburgh Professor Bernard Cohen has shown that the release of radiologically hazardous substances from such a repository leads to a far lower human dose rate than now exists from natural radioactivity in the upper 600 meters of the earth's crust. The resulting rate of cancer induction is, then, miniscule.

The subject of catastrophic nuclear accidents has been most fully explored in the recent Rasmussen Report. The report analyzes the probability of severe reactor accidents and the likelihood of various consequences to the public. At the extreme end of the probability range, there are accidents that could occur about once in a billion years of reactor operations and cause 5000 deaths and $15 billion in property damage. At the near end of the range, the probability of a reactor meltdown is assessed at about once in 20,000 years of reactor-operation. Such an accident has about a fifty-fifty chance of causing 5 deaths from cancer. These numbers should be compared to the epidemiological evidence that points to approximately 5 deaths from respiratory disease regularly occurring year in and year out, due to routine sulphur dioxide emissions from the coal plant. The typical nuclear plant poses a *risk of 1 in 20,000* for 5 deaths to occur; the typical coal plant almost certainly *takes that toll each year.*

The nuclear energy cycle is, in summary, economically preferable to coal, its most realistic and available alternative. It makes fewer demands on resources and transportation, causes far fewer occupational deaths and injuries, and is much less hazardous to the general public.

To paraphrase Lord Acton — all power pollutes, but nuclear power pollutes the least.

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Fusion Power: Why, When, and How

James Powell

Earth already depends on one operating fusion reactor that functions very reliably at negligible cost.

Unfortunately, or perhaps fortunately, this reactor is 93,000,000 miles away and delivers its power at comfortably low temperatures and intensities. Fusion reactions in the sun are very slow, even at the extremely high densities and temperatures of its core, and the sun takes billions of years to convert its hydrogen to helium. At the temperature levels necessary for fusion — that is, hundreds of millions of degrees — hydrogen forms a "plasma", a state of matter in which electrons are not attached to nuclei. In this state, matter is a very good conductor of electricity and interacts very strongly with magnetic fields. Because of its gravitational field, the sun is an inherently stable fusion reactor, and its hot plasma cannot expand and dissipate into space.

An earth-bound fusion reactor has tremendous disadvantages compared to the sun. It must invest large amounts of high grade electrical energy to reach plasma temperatures at which fusion reactions become significant, and it must ensure that these reactions take place in a very short time, since it is not possible to devise stable confinement for the plasma. Depending on the confinement concept, characteristic reaction times for a practical reactor range from a billionth of a second to a few seconds.

It would be impossible to burn the sun's primary fuel, ordinary hydrogen, in a fusion reactor on earth. If heavy hydrogen (that is, deuterium) is used, however, reaction rates are fast enough: fusion reactors could convert deuterium to helium. At least in principle. There is approximately one atom of deuterium for every 7000 atoms of ordinary hydrogen on earth, and a gallon of water contains potential deuterium fusion energy (including products of deuterium-deuterium fusion) equivalent to the thermal energy of 10 barrels of oil. The earth's oceans contain enough deuterium to supply man's energy needs for billions of years with a trivial extraction cost.

Fusion reactors may burn other fuels besides deuterium. The easiest fuel to burn is a mixture of deuterium and tritium (deuterium = D = a hydrogen isotope with 1 proton and 1 neutron in the atomic nucleus; tritium = T = a hydrogen isotope with 1 proton and 2 neutrons in the nucleus). The DT fuel cycle generates a hundred times more fusion energy per unit of plasma than DD fuel will, even assuming that all the intermediate reaction products (a helium isotope and tritium) from DD fusions are completely burnt to Helium-4 in the plasma. For this reason, the mainline of fusion research effort has concentrated on the DT fuel cycle. Tritium is far too scarce to be a practical reactor fuel since it is radioactive with a short half-life (12 years). Yet by one of nature's quirks it can be manufactured in a self-sustaining fusion reactor. High energy neutrons resulting from DT fusions can react with lithium in a blanket around the plasma to produce tritium to replace that burnt in the plasma. In fact, the reactor can be designed to produce enough surplus tritium so that the number of fusion reactors could double every few months, if availability of tritium were the only limit. Resources of lithium are not as great as deuterium, but there is enough lithium on land and in the oceans, extractable at a reasonable cost, to meet all of man's energy needs for millions of years.

Fusion is thus one of the three major long-term energy sources, along with fission and solar energy. If it can be developed and is economically practical, it should be much more acceptable than fission, since problems of long-term radioactive waste disposal, safety, and safeguards for fissionable materials are not a concern. As for the choice between fusion and solar energy, economics will probably be the determining factor.

Why, then, fusion? The question is easily answered — because of its tremendous potential, it must be developed.

We now must deal with two additional questions, which can be combined: how — through what approach — will they reach the market? And when will commercially practical fusion reactors be in operation?

There are four mainline approaches now being followed in world fusion research: Tokamaks, mirrors, theta-pinches and laser-pellets. The first three seek to confine the DT plasma in strong magnetic fields at low densities for a span of approximately one second. The magnetic field configurations required are too complex to be described in detail here, but essentially Tokamaks have fat doughnut-like plasmas, mirrors have roughly spherical plasmas with fan-shaped extensions at the sides, and theta-pinches have plasmas shaped like bicycle tubes.

Work on the physics of magnetically confined plasmas is proceeding rapidly at a number of laboratories in the U.S., USSR, West Germany, England, France, Japan, and Italy; and confinement at near power reactor-like densities, times, and temperatures will probably be demonstrated by the early 1980's for Tokamaks and possibly also for mirrors and theta-pinches. A number of Tokamak experiments of substantial magnitude are now under way; large experimental Tokamaks, some with DT fuel, will operate in the next few years — the TFTR in the U.S., the T-20 in the USSR, JET in Europe, and a large device in Japan.

Even after adequate confinement has been demonstrated, much research on the physics of magnetically confined plasmas will have to be carried on. This will include methods of controlling long plasma burns, minimization of impurity effects (which could shut off the plasma), heating, and refueling. These problems will have to be more or less solved before the next step, an experimental fusion power reactor (EPR), can be taken. The U.S. program envisions operating an EPR in the late 1980's. The EPR would generate several hundred thousand kilowatts of fusion thermal power.

Large fusion experiments tend to be very expensive. The TFTR reactor in this country, for example, will cost well over $200 million, and an EPR will cost substantially more. This price tag undoubtedly slows the pace of fusion development substantially, but more significantly, it also narrows the number of approaches one can follow. Tokamaks now receive the largest portion of the fusion research effort, but other types should also be explored.

The next step beyond EPRs is expected to be a demonstration reactor, or DEMO, which should show that a commerical reactor can reliably operate over sustained periods of time and produce a net electrical output of several hundred thousand kilowatts. This reactor is projected to operate in the late 1990's.

Considerable technological development will be necessary for the DEMO. If it is a Tokamak, for example, the reactor will require the following: superconducting magnets with inner bores of approximately 40 feet operating at maximum magnetic fields of about 100 kilogauss, breeding and recovery of tritium from lithium (either as a liquid or solid compound) blankets which surround the plasma, pellet refueling, intense high energy neutral beam heaters for the plasma, high capacity vacuum lines, and so on. Development in these areas has already begun and will rapidly grow as plasma performance is demonstrated.

The first commercial fusion reactors should start operating about the year 2000.

Yet the most difficult technological problems will probably be associated with the materials for the reactor blanket. With DT fuel, 75 percent of the fusion reaction energy is released in the form of high energy neutrons, with each neutron carrying approximately 14 million electron volts of energy. In contrast, only about 5 percent of fission energy is released as neutron energy, and its average energy is much lower, about 2 million electron volts. As a result, the damage rate to materials will be considerably greater in a fusion reactor, both as a result of the greater energy per particle and the higher fraction of total energy. Tests on materials in fission reactors can help to indicate what the best choices are, but a good materials development program needs large test volumes at high neutron intensities and the neutron energies that are characteristic of fusion reactors. Unfortunately, such facilities will not be available for a number of years. In fact, one of the functions of an EPR would be the testing of large volumes of materials under conditions approaching those in a DEMO.

Once a DEMO is successfully operated, commercial reactors of a somewhat larger, more economic output — 1 to 2 million kilowatts, for example — would then be constructed. As in the case of early fission power reactors, a number of fusion reactors would have to be built and operated before fusion power generation costs could approach those of established energy technologies. At this point, it is very difficult to predict the ultimate cost of fusion power, since there are too many unknowns. Fusion will certainly have a negligible fuel cost, though blanket replacement costs may be appreciable, depending on material lifetime under irradiation. In general, since fusion power reactors will require large plasma chamber volumes, typically thousands of cubic feet, they will operate at lower power densities than fission reactors. This may result in some cost penalty for the fusion reactor; however, as with the fission cycle, the major part of total plant cost is external to the reactor. It will involve such components as buildings, turbines, switch yards, cooling towers, and so on. Approximately three-quarters of total plant cost appears to be tied up in such balance of plant costs. The direct reactor price tag would make up a relatively small part of the total cost.

But when will fusion reactors be in commercial operation? If progress continues as expected, the first commercial reactors should start operating about the year 2000, and economically competitive reactors could then follow in approximately 10 years. As to the question "how?", unless present fusion program directions change radically, the first generation of commercial fusion reactors will be Tokamaks.

The laser-pellet approach could possibly lead to a change in direction. This concept is very different from the three magnetic confinement approaches. Instead of confining the DT fuel at low densities for a second or so, a small pellet, initially at solid or near solid density, would be crushed in a billionth of a second by a very intense laser beam to a density several thousand times its starting value. A large fraction of the pellet would then undergo fusion before the density of the expanding pellet drops too low for fusion to continue. The process would yield on the order of 10 KWH of electrical energy per pellet explosion. Experiments with presently available lasers have achieved crushing to densities about 100 times the initial density, and it should be possible in the next few years to reach reactor-like conditions with more powerful lasers. The real impediments to practical laser fusion reactors appear to be the present low efficiency of lasers and the very long service life — billions of pulses — required for a power plant. If pellet gain or laser efficiency can be increased a factor of 10 or so, then the energetics of laser fusion become very attractive.

The necessarily long service life of lasers and mirrors represents a difficult but not insoluble problem. Similarly, the blanket of a laser pellet reactor must withstand hundreds of millions of pellet explosions without serious damage. This can probably be achieved by using wetted wall or ablative surface blankets, and by keeping the blast chamber large enough — on the order of 50 feet in diameter — to minimize shock effects.

If I were writing on this subject 10 years from now, it would probably be much easier to define the best approach to fusion and its likely date for commercial use. Enough plasma physics experiments would probably have been done to clearly choose the optimum confinement approach. Although researchers would still be struggling over which of several blanket materials should be used, they would have a more detailed understanding of their relative advantages and disadvantages. In 20 years, the material choices would be narrowed down to 1 or 2, but costs, though much better defined, would still remain somewhat uncertain. In 30 years, costs should be well defined.

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The Business of Windmills

Louis Divone

The search for a reasonably cheap and clean source of power has revived a growing interest in wind energy. Yet it has been used for centuries; the ubiquitous multibladed water pumping windmill helped win the west as much as the Winchester. It wasn't, in fact, until the Rural Electrification Act of the late 1930's that the windmill gradually disappeared from the countryside.

The advantages of wind energy systems are obvious enough. In a world of increasing pollution and diminishing resources, they represent a way to relate wisely with the natural environment. They draw upon a renewable, domestic, ecologically benign energy source which utilizes no water and few resources. Still, wind energy tends to evoke conflicting, even polarizing responses in most people: it is looked upon as either an instant panacea or an impractical dream. It is, of course, neither. As in any other business enterprise, the same issues of economics, product performance, market penetration, institutional constraints and public values will apply.

Although the windmill — or wind turbine generator as it is now called — is a comparatively simple energy conversion device, the development and commercialization of economically viable wind systems is no easy matter. It is not a question of technical feasibility, since several large experimental systems were built principally in Europe during the 1940's. Designers are, nonetheless, faced with a number of problems, particularly those associated with improving the structural dynamics and the aeroelastic characteristics of the wind turbine.

I can be more precise. It has been said, not without some truth, that large wind turbines are really vibration and fatigue testing machines which produce energy as a sideline. Though design work indicates that energy costs decrease with size, increasing the size of the systems creates worsening structural dynamic conditions. Since the rotor is the single largest cost item, the primary R & D trust must address, then, the development of cheap, durable, structurally sound large rotor blades. The application and extension of the analytical and fabrication processes developed in recent years in the helicopter industry is expected to be the source of major improvements over past systems.

In discussing the technical aspects of wind energy, one must remember, however, that almost anything will work. That is, any asymetrical device — be it on a horizontal, or a vertical, or any other axis — can be placed in a breeze and made to produce power. The measure of cost per unit power ($/kilowatt or $/horsepower) — the usual method of comparing power plants — is relatively meaningless for wind turbines. It can in fact be very misleading, since one can place a generator of any power rating on the back of any rotor and achieve any cost per unit power desired. But the unit may only produce that power when an occasional gale blows. Rather, the key criteria are the cost of energy produced (cents per kilowatt hour — equivalent to the rate shown on your electric bill) and the value of that time — varying energy in a particular application.

The amount of wind at a particular site will, of course, determine the number of kilowatt hours produced for a given machine. The energy cost can be chiefly figured by amortizing the capital cost of the machine over its lifetime. Recent design work estimates that a large 1.5 megawatt system built for an excellent 18 m.p.h. mean wind speed site could produce electrical energy at a cost at the site of 2 to 3 cents per kilowatt hour. Used as a "fuel saver" for relatively remote areas primarily using oil and having an 18 m.p.h. average wind, such a system would be economically viable now. Yet, while there are such locations, they represent only a very small market — one certainly insufficient for any commercial venture. The challenge then, is to achieve comparative costs in large areas such as the Great Plains, where the wind may blow at an average of 12 m.p.h. This requires higher performance and simpler and cheaper machines than currently exist.

Since the largest "conventional" wind turbine envisioned is about 2 to 4 megawatts, still rather small compared to most utility industry power plants of 100 to 1000 megawatts, a large number of units would be needed. This need for a large number of units is not entirely a disadvantage, however, in introducing a "new" technology. It allows risks to be taken at a low individual unit cost, with commitments for multiple units being made after data are available from the first unit.

Stimulated by these estimates, events are moving — after 30 years of relative inactivity — quite rapidly in the wind energy field. A number of companies are developing small prototype systems, and hope to find a receptive market. The Federal wind energy program has grown from nothing to a $14 million a year effort since June 1973.

Designed for the Energy Research and Development Administration by NASA's Lewis Research Center, the first large modern experimental system has recently been completed. Located about 50 miles west of Cleveland, the new system — at 100 kilowatts and 125 feet in diameter — has the second largest rotor ever constructed and is being utilized to identify problem areas and develop components. In a short time, construction by industrial contractors will begin on two higher powered replicas of this machine and on two larger machines of 1.5 megawatts and 200 feet in diameter. These machines will be the largest ever constructed and, if located at a windy 18 m.p.h. site, will produce 6 million kilowatt hours per year — equivalent to the energy use of about 600 — 1000 homes. These first megawatt scale machines are expected to cost about $2.5 million each, exclusive of development; if produced in some quantity the price would drop to the order of $800,000. Sites are presently being selected from utility company proposals to test and evaluate these experimental systems in actual utility operations commencing in 1977 and 1978.

And research continues in other areas. Nearly fifty projects are exploring techniques for locating and validating high wind sites, developing smaller systems for farms and rural homes, and investigating such advanced concepts as vortex generators, vertical axis machines, and offshore wind turbines.

The future is, I believe, promising. Wind energy systems are closer to becoming economically practical in high wind regions than many other alternate energy systems under investigation. Though these wind systems will not be able to serve urban areas needing large blocks of power, in the not too distant future they could supply energy to high wind rural areas — those areas primarily dependent on oil and natural gas and too small or isolated for either coal or nuclear power.

Given the high probability of inflating conventional power prices and depleting fuel supplies, we cannot afford to ignore the potential contribution of wind energy; indeed, we will likely need the contribution of all feasible energy sources to navigate the turn of the century successfully.

Dr. Divone is Chief of the Wind Energy Conservation Branch, U.S. Energy Research and Development Administration.

The Power of Solar Energy

Barry Commoner

Solar energy is the richest resource on earth, and the least used. If the solar energy reaching the earth were converted into electricity and sold at current prices, it would be worth more than $500 billion a day. Yet we use only a few hundredths of 1 percent of that energy, chiefly to raise crops for food, fiber, and lumber. What can be done to make more use of this huge resource? Can it be reasonably expected to replace the dwindling, expensive, and environmentally hazardous nonrenewable fuels on which we now depend?

As late as 1973 the conventional answers to these questions — answers provided by government agencies — have been uniformly negative. Taken from a task force report of the National Petroleum Council's massive study on the "U.S. Energy Outlook," the following summary is typical: "Because it is so diffuse and intermittent when it reaches the earth, solar energy can be put to no foreseeable large-scale use over the next 15 years, even with appreciable improvements in technology. Both the large area over which solar energy must be collected and the cost of collection and conversion equipment prevent the widespread use of such devices as solar evaporators, solar desalinators, solar heaters, solar cookers, solar furnaces, solar cells, solar houses, etc."

For a long time this view has dominated the government's attitude toward the development of solar energy and has contributed to the general public impression that solar energy is some sort of visionary, faintly ridiculous idea that might, or might not, turn out to be helpful some time in the next century.

Nonetheless, most of the different kinds of solar devices have been built and successfully operated, some of them a long time ago. A solar still for producing fresh water from salt, covering 50,000 square feet, was built in Chile in 1872; a 4.2 horsepower solar steam engine operated in Pasadena, California in 1901; a 20 horsepower engine operated in St. Louis in 1908; and a 50 horsepower engine pumped irrigation water from the Nile in 1913. Solar collectors for home heating have been common in many countries (including Florida and California in the United States) for a number of years, and both MIT and the University of California were actively involved in their research in the 1940's.

A 4.2 horsepower solar steam engine operated in Pasadena, California in 1901.

Such accounts are often regarded as quaint sidelights in the history of industrial technology — a kind of museum of devices that have been left behind in the march of energy technology. However, as the economics of energy production rapidly changes, these devices, or their technological descendants, do become practical. That prototypes already exist is an important step toward that goal, for they give the engineer something to work on, to modify and to improve.

It is useful at this point to contrast solar energy with the only other source that might be regarded as equally long-lasting: nuclear fusion. Since the development of the hydrogen bomb, we have had evidence — indeed, more evidence than most of us want — that huge amounts of energy can be derived from the fusion of atomic nuclei. The technical problem is to "tame" this enormously energetic process so that it can produce energy usefully, in a device that is not likely to be vaporized in the process. The temperature involved in the fusion process is so high that no known substance can withstand it, and the reacting material must be contained by magnetic forces in a field derived from intense electric currents. Elaborate and enormously expensive research to develop such devices is under way, supported by $74.7 million in the 1973 Federal energy-research budget (compared to $4.2 million for solar energy). Apart from the "thermodynamic overkill" involved in attempting to boil water with a source that operated at some 100,000°, the effort to develop a fusion reactor appears to be grossly out of balance relative to the effort given solar energy, for no one can be certain that fusion will *ever* work, or that if it does, it can be economically practical.

The reason usually advanced for the remarkable failure to make practical use of what we already know about solar energy is that the devices are so expensive as to be uncompetitive with conventional sources of energy. (It might be noted that this argument has never been advanced about nuclear fusion, although it is clear from theory alone that the capital costs of such devices — if they ever work — will be very much greater than the costs of solar devices of the same capacity.) However, unlike physical realities, the realities of economics, particularly as they apply to energy, are far from eternal. For example, the over-all price of energy in the United States has increased by more than 125 percent since 1970. And we have already noted how rapidly economic changes have altered the competitive positions of nuclear and coal-fired power plants. Thus, it would seem worthwhile, given that solar power devices do exist and can perform very useful tasks, to find out what it would take in financial costs to bring them into commercial operation.

Such an assessment has been made by a panel of government experts that was assembled under the leadership of Dr. Alfred Eggers of the National Science Foundation in order to help conduct a study entitled "The Nation's Energy Future," under the direction of Dr. Dixy Ray (head of the AEC at the time) in response to a presidential directive. The report, which was published in December 1973, recommended a 5-year, $10 billion research program, of which $200 million, or 2 percent, was to be devoted to research on solar energy. Some $1.45 billion was assigned to research on fusion, and the breeder reactor received $2.844 billion, or 28 percent of the entire budget. Nuclear energy as a whole received about 40 percent of the total research budget.

The report was supposed to plan a research program to develop new sources that might alleviate that energy crisis. It is appropriate, therefore, to examine the research priorities assigned to breeder, fusion, and solar energy (as indicated by the proposed expenditures) in comparison with the contribution that each of these three new sources of energy might make to the nation's future energy budget — if the research actually succeeded.

According to the Ray report, the investment of $10 billion in the proposed research might be expected to increase the total amount of energy available from domestic sources from the equivalent of about 34 million barrels of oil per day to 57 million barrels per day. The investment of 40 percent of the research funds in nuclear power (largely for the breeder) was expected to account for 32 percent of this increase. Solar energy (together with geothermal and hydroelectric power) was expected to contribute 1.7 percent of the anticipated increase in domestic energy. Since solar energy was assigned 2 percent of the research budget, there seemed to be a reasonable match between the report's research priorities and the expected results.

I was surprised and troubled by the smallness of the proposed solar research budget.

When the report appeared, I was surprised and troubled by the smallness of both the proposed solar-research budget and the expected results. Accordingly, I attempted to obtain a copy of the report of the Solar Subpanel (IX), which, I knew, included a very distinguished list of experts in the field, assisted by an equally distinguished list of 56 consultants. In response to my first inquiries I was told that there was no such thing as a Subpanel IX report. Since such an omission would have meant a revolution in bureaucratic procedure hardly credible in the Washington of 1973, I asked for help from someone whose inquiries might perhaps receive a more helpful response from the AEC — Senator James Abourezk of South Dakota, who is vitally interested in solar energy. His efforts also failed. When the White House, at Senator Abourezk's request, asked the AEC for the Subpanel IX report, all that that supremely powerful institution (Mr. Nixon was President at the time) received and sent on to Senator Abourezk was another copy of the "Futures" report. Finally, like a genie materialized by the appropriate incantations, the Senator was informed that the report did indeed exist and that a copy was available in the AEC room. This turned out to be a dim photocopy of a hazy carbon; but it has brilliantly illuminated the obscurities of solar utilization.

The Subpanel IX report describes in meticulous detail what it would cost in research expenditures to bring the various types of solar devices into practical operation and how much they could contribute to the national energy budget. If the various solar technologies were developed according to the subpanel's recommendation for "an accelerated orderly program having a high probability of success" at a cost of $1 billion, they would contribute a total of 21 percent of the nation's electrical demand, or about 5.5 percent of the total energy budget, in the year 2000. (Dr. Ray's report recommended an expenditure of $200 million, or half the amount the subpanel recommended for a "minimum viable" research program.)

At a recent Congressional briefing co-sponsored by the Environmental Study Conference and the Emergency Task Force on Energy Options of the Scientists' Institute for Public Information, Dr. Joseph

Lindmayer, President of Solarex Corporation, a pioneer in the development of photovoltaic cells, commented that "there are no technical barriers to low-cost and large-scale use of [solar energy]. The real barriers are market development, user education, availability of capital and manpower." He went on to assert that "if there would be no resistance and everyone would be totally committed to such a development, in 10 years we could develop a cost-competitive photovoltaic system that is competitive with a utility on an on-site situation."

Solar cells are now made by a series of rather delicate hand operations and are therefore so expensive that it would cost about $10,000 for 1 kilowatt of electric generating capacity, compared to current costs of $460 per kilowatt for nuclear reactors and $300 per kilowatt for coal-fired plants. Citing such disparities, the AEC, assessing solar energy as an alternative to the breeder, claimed that useful solar electric power could not be achieved in the "foreseeable future."

The Subpanel IX approach to the potential of the photovoltaic cell was to work out what research effort would be needed to reduce the manufacturing costs by producing, for example, thin silicon crystals in a continuous ribbon rather than slicing up a thick one by hand. This approach was in keeping with earlier experience with the manufacture of transistors — quite similar to photovoltaic cells in structure and operation — in which mass-production methods reduced the price about a hundredfold.

On this basis Subpanel IX proposed an "orderly milestone schedule" for the development of solar power from photovoltaic cells. I cite the proposed schedule: 1977 — cell-manufacturing technology developed to bring costs to $5000 per kilowatt; 1981 — costs reduced to $500 per kilowatt and a central power-station design completed; 1985 — 10-million-watt photovoltaic systems installed in communities and large industrial plants; 1986 — completion of a pilot plant to manufacture photovoltaic cells to provide power at $300 per kilowatt; 1990 — construction of photovoltaic power systems of 100-megawatt capacity for use in towns and power networks. In sum, according to the Subpanel IX report, "the achievement of the cost goals of this program will result in the production of economically competitive electrical power (cost of 10 mills per kwhr) by the year 1990. The projected rate of implementation of this solar energy conversion technology will produce more than 7 percent of the required U.S. electrical generating capacity by the year 2000."

There are no technical barriers to low-cost and large-scale use of solar energy.

To reach this goal, Subpanel IX proposed research expenditures of about $100 million; this figure was reduced to $35.8 million in Dr. Ray's final report. Thus, whereas the breeder was assigned $2.844 billion in research funds in the now abandoned hope that it would contribute 21 percent of electrical demand in 2000, the photovoltaic cell, which was capable of achieving one-third of that power output, was assigned about 1 percent of that amount. And the overall solar-energy program, expected by Subpanel IX to contribute 21 percent of the national electrical budget in the year 2000, was assigned a total of $200 million in research funds. For approximately the same expected contribution to the energy budget, the breeder was assigned more than 14 times the research support given to solar energy.

Such gross disparities in the effort being made to develop nuclear and solar energy, which still persist despite recent efforts by Congress to redress the balance, help to explain why, despite its inherent practicality, solar energy remains a tenuous dream in the United States.

The economic and environmental problems that this country faces cannot be swept away in a flood of sunlight, but solar energy can play its special part in the effort to solve each of them. Solar energy could at once begin to supply a large part of energy now used for space heat, hot water, and — with very little further development — air conditioning. The householder would not only enjoy reduced bills, but would also be relieved of the specter of constantly increasing ones. In effect, by purchasing a solar heater now, the householder could establish a hedge against inflation. And if solar collectors were to be installed on a sufficiently large scale, the resultant decrease in the demand for fuels might, if the law of supply and demand retains any of its force, reduce the rapid rate of escalation of energy prices, and thereby help to check the pace of inflation generally. Any major effort to install solar collectors in the nation's 60 million homes would require the construction of up to $200 billion or so of equipment. Unlike oil refineries or nuclear power plants, constructing these solar systems would be simple in technology and ample in its demand for diverse kinds of labor. The devices could be built by auto workers in idle auto plants or by plumbers, carpenters, and metal workers in small community-based shops. Such a program, based, for example, on government loans to support the manufacture and purchase of solar systems, could significantly reduce unemployment.

Nor is the manufacture of solar devices — not only simple collectors, but solar steam plants and photovoltaic power-plants — likely to contribute to the growing shortage of capital. The chief reason for the increasingly intense demand for capital for the production of conventional sources of energy is that they are heavily affected by the law of diminishing returns. Every barrel of oil that is produced makes the production of the next barrel more difficult and more costly in invested capital; every new environmental and safety problem that is uncovered in a nuclear power plant makes the next plant more complex, and more demanding of capital. In every conventional energy source, the productivity of capital — the energy produced per dollar of capital invested — has fallen sharply with increased production.

In contrast, the capture of solar energy can be continuously expanded with no decrease in capital productivity because the production on one unit of solar energy in no way makes it more difficult or costly to produce the next. Sunlight falls continuously over the earth, and its use in one place does not diminish its availability elsewhere. Unlike conventional energy sources, solar energy will not become progressively more demanding of capital as its use expands.

Dr. Commoner is a professor at Washington University's Center for the Biology of Natural Systems. This article is excerpted from Dr. Commoner's new book, The Poverty of Power, *published in May, 1976.*

U.S. Fails to Confront Energy Crisis

Congressman Al Ullman (D-Oregon)

The energy crisis. The phrase has become bland with use. Gone are the days when we waited at the end of a long line for a few gallons of gasoline. We no longer read about the threat of natural gas shortages. The OPEC nations have ceased in our imagination to be the evil sultans of our destiny. Even gas wars are back.

The once desperate calls for Congressional action have given way to platitudes: "The market economy is working." "Prices are changing and consumers and producers are reacting to energy shortages." But is the market economy working to our ultimate security?

Last year this Nation consumed more gasoline than it did in 1974. And it's getting worse. Auto company presidents are announcing that America is going back to the big car. Gas stations are again giving bargains to drive in for a tankful.

The number of operating oil drilling rigs — a traditional measure of exploration — is well below a year ago. About the only vestige of the crisis still in sight is the 55-mile-an-hour speed limit.

But the energy crisis hasn't disappeared. It's become an invisible crisis confined to numbers and graphs — and to public and political inertia. Despite the promise of Alaska's North Slope and offshore deposits, domestic production is still depressed. We are drilling for reserves that are deeper and more costly to reach. Yet our consumption of oil grows each year — with a dramatic jump expected when we pull out of the current recession.

Experts now tell us that the day is quickly approaching when we will import half our oil from abroad. During the week of March 12 — for the first time in history — imported oil (crude oil plus refined products) exceeded domestic oil production. That's alarming when you consider that our oil payments to cartel nations already far outstrip surpluses earned from our agricultural exports. And there is no balance in sight.

The political and economic costs of our inability to face long-range energy demands loom enormous. As long as one or more foreign governments control the major power supply for U.S. industry, we cannot write a secure foreign policy. Simply put, our freedom of action is limited, and our agreements must take into account an invisible third party.

The campaign for energy independence will be long and costly. The expense of creating a strategic oil reserve, or harnessing the sun, or developing the breeder reactor is incredibly large.

Certainly the Government has not lacked for tactics and solutions. Almost 3000 energy bills have been introduced in Congress since the oil embargo of 1973. They deal with the trivial to the serious: from a proposal for heatless Federal holidays to the Administration's $100 billion Energy Independence Administration program. Almost every standing committee in Congress has worked on one plan or another to shore up our crumbling energy base.

Yet 2 years after the embargo we are a long way from setting forth a comprehensive national energy policy. For 2 years Congress and the President and his advisors have debated our domestic and foreign energy posture. We have used any number of measures to decide the proper balance between the price and quantity of foreign and domestic oil — between the price of new oil and old oil — between refinery production in large and small companies.

In the end, we produced a compromise which, temporarily bringing down the price of oil, gives the President a pocket full of stand-by powers and establishes distant fuel efficiency standards. We now have a law that is probably more a measure of the Country's mood than its economics.

Too often the Country forgets that Congress was conceived — and, in fact, remains — very much a mirror of public opinion. If voters perceive that we need stiffer defenses, Congress will increase defense appropriations. If business and labor agree that we need more money in circulation to arrest a recession, then Congress will move behind a tax cut.

But the energy crisis produced confusing — and often conflicting — signals from across the land. Diplomats and soldiers talked of invading the Middle East. President Ford's answer was higher prices on imported oil despite the impact on inflation and recession. Some wanted to commit billions of dollars to the development of solar energy. Others preferred nuclear power. Many more still believe that the energy shortage is a fraud cooked up by the big oil companies. Each argument had its voice in Congress as we struggled to fashion a national energy policy.

It wasn't long before people became used to paying 60 cents for a gallon of gas. We learned to live with higher heating bills. The lines were gone and the fear of acute shortages was past. The energy crisis vanished, or so people thought. And the pressure on Congress to take stern, long-range measures — like taxing excess gasoline consumption — abated. Suddenly, the question of energy became a rather listless point of political debate between Congress and the White House. Recently, the President managed only 24 lines on energy policy in his 10-page State of the Union message.

While everyone still agrees that "something must be done," a voter in South Boston who depends on imported oil and a voter in northern Louisiana who depends on the natural gas produced in his backyard can't agree on what must be done.

Whatever we finally decide to do about the invisible energy crisis, we must deal with a couple of obvious facts. First, the earth's supply of oil, despite finds in Mexico and the North Sea, is being rapidly depleted. The United States consumes about 30 percent of the world's production; our industry — hence, jobs and income — depends to a great extent on oil and gas. Second, foreign producers will demand what the market will bear, and seeing little resistance on our part, will exert enormous leverage over the affairs of the industrial world. No one can put a dollars and cents limit on what we can pay for foreign oil, but as we approach the limit we will be suffering dramatic social dislocation.

In the next century I imagine the sun will do much of our work. In the meantime, beginning now, we must set standards for energy conservation and industrial fuel conversion to sources of power other than oil and gas. For lack of any national consensus and any real leadership from the White House, Congress passed an energy bill that gestures toward, rather than faces head on, the demand for cutting our use of oil.

The Ways and Means Committee has developed an energy program now before the Senate that points the way to independence without threatening the delicate progress of economic recovery. The bill uses the tax code as both a carrot and a stick to bring gradual but certain reduction in the consumption of oil — especially foreign oil — and encourage industry to convert to other sources of power. It imposes a schedule of import quotas which accommodates projections for a gradual economic recovery and heavy regional dependence on foreign residual oil. What foreign oil does arrive would be divided up among private refiners — large and small — according to sealed bids at a public auction. I believe market forces can work along general Federal guidelines, especially when we are dealing with a commodity as critical as oil.

This energy program would speed up amortization of equipment used in industrial conversion to more abundant fuels such as coal or uranium. It sets, in addition, automotive fuel efficiency standards that would save an enormous amount of oil before the end of the decade. Efforts to impose a tax on excess use of gasoline failed; but it doesn't alter the fact that effective fuel conservation must begin at the gas pump.

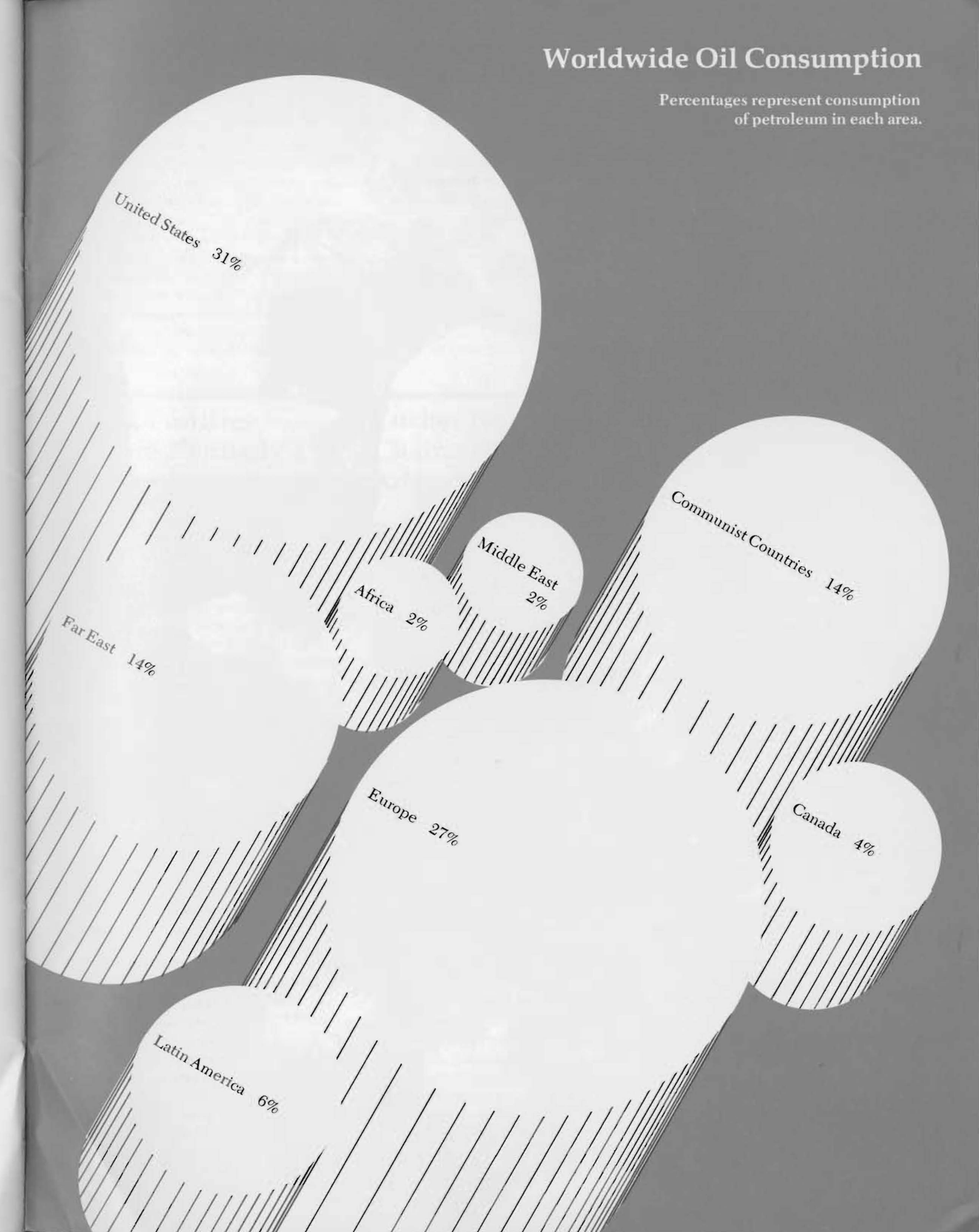
This energy bill is a message to the world that we will not import unlimited foreign oil. It is a message to the oil companies that they can't count on mounting supplies of OPEC oil for their refineries, that they must restructure their production. The bill sets the nation on a gradual, long-range swing toward a new energy base, toward a new energy ethic.

But this Nation seems unready for the hard answers — or, at least, this Government is.

In the past, when the Nation's back was against the wall, we found an answer. We have a history of meeting crisis with unity and force, and of emerging victorious. But must we wait for another crisis — another embargo — to awake the Country to action? Our performance so far seems an admission that America doesn't believe that the energy crisis is real or that our energy sources are limited.

The task before us all is to anticipate crisis — to move ahead of public opinion — with a comprehensive energy program. We can already measure the result of doing nothing.

Congressman Ullman is Chairman of the Ways and Means Committee.



AROUND & ABOUT B&PA

Lind Testifies Before Kennedy's Energy Committee

Although energy conservation will play a vital role in maintaining U.S. prosperity in the face of growing scarcity and rising prices, saving energy for its own sake could be disastrous. This point was made by B&PA Professor Robert C. Lind in testimony before the Subcommittee on Energy of the Joint Economic Committee.

"Energy conservation must be viewed in economic terms and should not be implemented when its costs exceed its benefits. The ultimate form of conservation would be to eliminate the use of all energy and, consequently, destroy the economy. The absurdity of such an approach is obvious," Lind noted.

Dr. Lind's testimony was quoted extensively by Senator Edward Kennedy, Chairman of the Subcommittee on Energy. In his appearance before the Commerce Committee, Senator Kennedy also had the full text of Professor Lind's testimony read into the Congressional Record.

Tucker Named Chairman of Advisory Council

Richard F. Tucker has been named Chairman of B&PA's Advisory Council. Executive Vice President of Mobil Oil Corporation, Mr. Tucker replaces Nelson Schaenen, Sr., who served as Chairman for the past 16 years.

Before his retirement in 1967, Mr. Schaenen was President and Chairman of the Executive Committee of Smith Barney and Company. He has agreed to remain on the Advisory Board as an ex-officio member.

International Directory Set for Fall Mailing

An international B&PA alumni directory will be published this fall and distributed free of charge to those graduates who send in the requested information.

Conceived by Jean-Louis Bravard (MBA '76), the new directory will list home and office addresses and business positions. The international directory is the first step in establishing a School-wide listing of all B&PA alumni.

Those international alumni who did not receive a questionnaire should send information to the following:

International Directory
Graduate School of Business
and Public Administration
Malott Hall
Cornell University
Ithaca, New York 14853

Student Phonathon: Approximately 35 B&PA students called alumni at the School's two-night phonathon on February 18 and 19th. Because so many students signed up for the phonathon, several volunteers had to be turned away. Thanks to such enthusiasm, the School raised $4,426.00 for faculty research, student loans, library acquisitions, and so on.

B&PA Health for Seminar Business Executives

B&PA will offer a program entitled "Health Care: A Challenge to the American Corporation" from July 6th to 9th. To be held in Malott Hall, the 3-day seminar will explore current health issues and options before U.S. corporations.

The seminar will emphasize, in particular, how management can contain the skyrocketing costs of health care.

If you wish further information, please contact Prof. Douglas R. Brown, Program Director, at Cornell's Graduate School of Business and Public Administration.

Smiley Appointed to PSC Post

Robert H. Smiley, Assistant Professor of Business Economics, has been granted a one-year leave of absence to work as Special Assistant to the Chairman of the New York State Public Service Commission.

Professor Smiley will analyze the economics of such key issues before the Commission as the tradeoffs involved in electricity-generating alternatives, plant site decisions, accounting and financial issues in public utility regulation, efficient rate structures, and life-line rates.

Malott Wing: Construction of the Malott wing is proceeding on schedule, according to Dean Justin Davidson. The new addition, funded by an anonymous donor, will be completed by January, 1977. Details of the wing have been described in previous issues of the Executive.

Dyckman Named Fellow in ARIA

Professor Tom Dyckman has been designated a Fellow in the Accounting Researchers International Association (ARIA).

Based on Dyckman's contribution to accounting research, the honor recognizes his "long-standing and immense contributions to accounting thought ranging from behavioral experiments, analytical contributions, and masterful surveys of past individual research findings." Professor of Accounting and Quantitative Analysis, Dr. Dyckman joins a select group of 10 other Active Fellows in ARIA.

Alumni Dinners Draw Over Four Hundred

B&PA Alumni Association dinners were held in Chicago, Washington, Boston, and New York during the past March and April. To be held annually, the four dinners drew over 400 B&PA alumni.

Addressing both the Boston and Washington gatherings, Professor Fred Bent spoke on "OPEC: The Limits of U.S. Power." Before alumni in New York and Chicago, Professor Hal Bierman wove his way through the intricacies of capital budgeting in a review and forecast.

The chairmen for the four dinners were as follows: Al Suter ('59) and Howard Greene ('48) in Chicago; Benson Simon ('62) and Mike Hostage ('55) in Washington; Bruce Holmes ('52) in Boston; and Bob Gardiner ('49) in New York City.

If you are interested in helping organize next year's dinner in any of the four cities, please contact Ted Lewis, Assistant Dean.

Jarvie and Loynd New Council Members

Charles L. Jarvie and Richard B. Loynd have been named to the School's Advisory Council.

Mr. Jarvie (MBA '59) is Manager of Procter and Gamble's Industrial Food Division. Mr. Loynd is President of Eltra Corporation.

Made up of leaders from the business, health, and public sectors, the 26-member Council meets with Dean Justin Davidson twice a year to discuss such matters as curriculum, School policy, faculty recruitment, placement, and admissions.

Two Professors Appointed to BPA

John C. Wheeler and Thomas G. Rundall have been appointed to the BPA faculty, Dean Justin Davidson recently announced.

Professor Wheeler will receive his Ph.D. in June of 1976 from the University of Michigan's School of Public Health where he concentrated on the efficiency and costs of ambulatory medical care production.

Professor Rundall will be granted his Ph.D. from Stanford University's Department of Sociology in June, 1976. His main areas of interest are in sociology, social psychology, and organizational theory.

Kover and Swieringa Win Teaching Awards

Professors Arthur J. Kover and Robert J. Swieringa have received the Justice Foundation Awards for outstanding teaching for the 1975-76 academic year.

Dr. Kover, Assistant Professor of Organizational Behavior, joined the faculty in 1970. Before coming to B&PA, he was Vice President and Manager of Research for Foote, Cone and Belding.

Dr. Swieringa is an Associate Professor of Accounting. Before assuming his present position at the school in 1974, he taught at Stanford University's School of Business.

Women's Career Forum Held at Malott Hall

Organized by the B&PA Women's Association, a "Women's Career Forum" was held in Malott Hall on March 12th.

The day-long Forum was composed of a series of panels that explored the problems that women confront in such areas as personnel, accounting, finance, production, marketing, and media communications. Drawing upon successful women executives in these areas, the Forum — headed up by Jessica Factor, a second-year MBA student — attracted more than 300 students from Cornell, Wells College, and Cortland State.

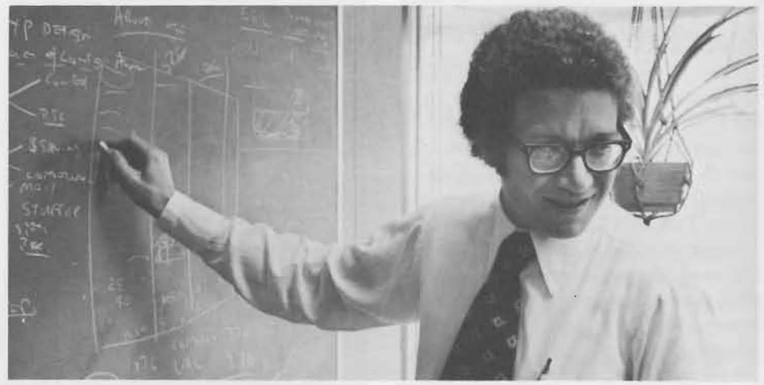
The Forum was opened by keynote speaker Frances ("Sissy") Farenthold, recently appointed President of Wells College. Discussing the difficulties that women continue to face in the marketplace, Ms. Farenthold called for passage of the Equal Rights Amendment which would grant women their rightful place in both the public and private sector.

The Forum was supported by grants from Continental Can, Mobil Oil and Oppenheimer & Company.

Executive Forum

During the past academic year, B&PA hosted several nationally-known figures in its new lecture series, the Executive Forum. This semester the following participated in the Forum: Charles P. Bowen, Chairman of Booz, Allen and Hamilton; and James J. Needham, former Chairman and Chief Executive Officer of The New York Stock Exchange.

Profile
S. Craig



"Look, most people can recall 3 or 4 favorite advertisements. These ads are usually highly creative, a bit fantastical. But that doesn't mean they necessarily work. Successful ads sell products."

Professor Sam Craig noted that too often the creative copywriter, who wants to receive kudos from his peers, ignores the ingredients of success. Advertisements can't be too complex or too far removed from the consumer's daily experiences, he noted. "They have to be believable, relatively simple, relevant. And they have to stress the benefits of buying the product they're promoting." They may be advertisements that grate on people's nerves; they may be the type a copywriter would prefer not to mention when talking to friends at cocktail parties, he said. But they increase market share.

Since receiving his Ph.D. from Ohio State University in 1971, Professor Craig has published over 20 articles and technical papers on a wide range of topics in marketing. Particularly intrigued by the problem of how to communicate effectively, he has studied the use of humor and fear as a vehicle of persuasion in advertising.

"I won't attempt to define humor. But most practitioners agree that some humor in an ad can be effective." It can help capture the attention of the audience, reduce counter-argumentation, and enhance the creditability of the speaker. And that creditability does rub off on the product. Yet the danger is, Craig added, that humor may distract the audience from the message, and consume time that could be used for direct promotion.

The actual results are, he added, a bit mysterious. "No one has really explained why humorous ads for Alka-Seltzer, Benson and Hedges, and Volkswagen worked. Or why the same kind of ads for Rheingold, Betty Crocker rice, and Quaker Oats failed."

While some advertisers build their ads around humor, others threaten consumers with dire consequences if they don't buy a particular product or take a particular action. Yet research does suggest that the arousal of fear works best at moderate levels. "If the ad is too frightening, the audience is not persuaded at all."

In this area, you have to distinguish between the threat of physical and social consequences, Craig said. Ads playing on physical fear tend to be public service ads dealing with such areas as cancer, auto safety, blood pressure, and smoking. Although fear appeals may persuade the audience for the moment, they have less impact on actual compliance. "Someone may be threatened by an ad. He may agree that it's a good idea to get his blood pressure checked. But he may not follow through."

Ads that portray the social implications of not buying a given product seem to have a stronger influence, he noted. Few can forget, Craig noted, the deodorant, the toothpaste, or the mouthwash that promises a successful dinner party or a full love life. "They may not have much creative impact, but they get the message across."

Professor Craig recently completed a paper which discusses the relationship between repetition and advertising effectiveness. "Up to a point, repeating an ad does increase recall. But more is *not* necessarily better." There is, he stated, an optimal level of repetition. Beyond that level, the marginal impact of additional replays of the same ad is minor. At even higher levels of repetition, "wearout" occurs. "Recall is, in fact, actually diminished; the advertiser would do better at lower levels of repetition."

After graduation with an MS from the University of Rhode Island in 1966, Professor Craig worked as a marketing representative for IBM's data processing division for three years. "When I first started with IBM, I had no plans to go on for a Ph.D. But when I discovered that I was spending most of my free time with academics, I knew that was where my real interest lay."

Before coming to Cornell in 1974, Professor Craig taught at Ohio State University in the College of Administrative Science, and was assistant director of the University's computer information center. He lives a short distance from Cornell with his wife, Marilyn, who is completing her doctoral dissertation in research methodology.

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