ENERGY, FOOD AND MAN - 2000 A.D. AND BEYOND

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The author investigates the role of the food industry and energy problems and offers alternative solutions to these problems.

Introduction

Energy has been on most people's minds in recent months. This is not because of an intense scholarly interest in the energy industries. In fact, it stems from one simple condition - shortage or threat of shortage.

Energy and its use is not new to man. Man learned early to use his own energy to do some of his work. Also, he harnessed the energy of other animals. During the past century and one half or so, man progressed rapidly through a series of mechanical contrivances designed to do most of his work, move him from place to place, and provide for his creature comfort.

The source of the energy for the vast majority of this "progress" has been the fossil fuels - coal, crude oil, and the distillate products thereof and natural gas. Thus, man has chosen as his main source of energy a relatively easily accessible item, of finite quantity, which when consumed is non-reuseable, and pollutes his air, water, and land. The frightening thing is that in the short span of a few hundred years, man will have consumed a resource which nature has taken since creation to form, and probably will never form again.

So, what are the issues here? Although the energy situation is a multifaceted problem, this paper will cover these issues.

1. The nature of the current and future energy situation.

2. The role of the food industry in the energy picture.

3. Some alternative solutions to energy problems in the food industry.

Demand for Energy

In 1970, the United States consumed almost 67 quadrillion BTU's of energy. The National Petroleum Council projects our annual energy consumption to increase to 125 quadrillion BTU's by 1985 and to some 200 quadrillion BTU's by 2000 A.D. To make the quantities slightly more mangeeable, the 2000 projection converts to in excess of seven billion tons of coal. This happens to be more energy than the entire world used in 1968.

To establish a world wide perspective, the United States, with about 6% of the population, presently consumes about one-third of the world's annual energy use. By 2000 A.D., we in the United States could well be in the position of having 2% of the world's population, and consuming about half of the world's annual energy use. How long can we continue such an imbalance? Especially since the U.S. has changed from a surplus to a deficit condition in the production of energy, and we must depend on the rest of the world for an increasing share of our energy needs.

Not only has energy consumption increased, the form in which it is consumed has changed. In 1925, we converted 75% of our energy from solid fuel and the rest from liquid fuels, natural gas and hydroelectricity. Currently only about 20% of our energy comes from solid fuels and 80% comes from liquid fuels, natural gas and hydroelectricity. Form will become much more important in the section under supply of energy.

In short, we (United States) are exhibiting an ever increasing demand for energy, while becoming a smaller proportion of the world's population, and more dependent on the rest of the world for our energy supplies. Also, we have become heavily dependent upon the cleaner and more mobile fuels.

Supply of Energy

Supply has three aspects:

1. Annual production of energy from existing sources.

2. Reserves of fossil fuels.

3. New energy sources.

U. S. Production

The data in Table 1 gives an indication of United States production and importation of energy at current levels. We are now importing about 12% of our energy needs, largely oil.

Matching projections of U.S. energy use with production from the National Petroleum Council's Committee on U.S. Energy Outlook, the picture is shown in Table 2.

These projections reveal that domestic production will not keep pace with demand. Imports of energy (largely oil) are estimated to increase from 12% to 35% of the nations needs. Secondly, domestic oil and gas production will decline from the current 64% of total usage to 19% in 2000 A.D. Coal will decrease slightly. Nuclear energy generation will jump from a negligible percentage in 1970 to some 81% in 2000.

In summary, we will be changing form and importing much more of our energy in 2000 A.D. than now.

Reserves of Fossil Fuels

The area of fuel reserves is one where considerable controversy and difference of opinion exist. There are many estimates of reserves available, with wide discrepancies in size, depending on the source of the data. The discussion which follows will attempt to establish the relatively fixed nature of our fossil fuel reserves and will not become involved in the controversy of who has the best estimate.

These estimates of quantities in reserve say nothing about the cost of exploiting the individual resources. It is assumed that as the "bottom of the barrel" is approached, the cost of extracting each additional unit will climb and probably exponentially.

Coal is the most plentiful of our fossil fuels. Current usage is about 580 million tons per year. Estimates of useable coal reserves range from 200 years to several thousand years. However, according to U.S. Bureau of Mines estimates, we could multiply current usage by five in 2000 A.D. and still have some 400 years supply of coal left.

The United States currently is producing about 11 million barrels of crude oil per day. Using the United States Petroleum Council estimates of discovered reserves of 425 billion barrels and ultimately discoverable reserves of 810 billion barrels, this gives us somewhere between one and two hundred years supply of crude oil at current production rates. The problem is one of usage (presently 17 million barrels/day) and rate of increase of usage (estimated to be 26 million barrels/day in 1980 and growing). If we can import the differences between production and usage, then these oil reserve figures will hold. If we can't then we will use up our oil reserves in a much shorter time. The current Middle-East situation casts grave doubts upon our ability to close the oil portion of the "energy gap" through imports.

Information from a variety of sources would raise very serious questions about the validity of the petroleum council's estimates

TABLE 1

Domestic Supply, Imports and Total Consumption of Energy
By Type of Fuel, United States, 1970

	Trillions $(10)^{12}$ BTU's	Percent
Domestic Supply		
Oil	21,048	31
Gas	22,388	33
Hydropower	2,677	4
Geothermal	7	-
Coal and Nuclear Utilized	13,302	20
Total	59,422	88
Imports		
Oil	7,455	11
Gas	950	1
Total	8,405	12
Total Domestic Consumption	67,827	100

Source: "U.S. Energy Outlook", National Petroleum Council, December 1972.

TABLE 2

U.S. Domestic Energy Output Potential
From Conventional Energy Sources, Energy Use Estimates
Quadrillion BTU's/Year
1985 & 2000

	1985	Percent	2000	Percent
U. S. Products				
Oil	22	18	21	11
Natural Gas	15	12	15	8
Coal	20	16	30	15
Hydro	3	2	4	-
Nuclear	16	13	61	31
Total	76	61	131	65
Imports needed to balance	49	39	69	35
Consumption estimates	125	100	200	100

Source: "U.S. Energy Outlook", National Petroleum Council, December 1972.

of our oil resources. These studies put our proven reserves at about 10 years at current usage rates and cast grave doubts about the potential utilization of most of the "potentially discoverable reserves" of oil. This serves to point up a real "creditability gap" regarding all our energy reserves. Should the smaller reserve estimates be true, then it is all the more urgent that effort be put into alternative energy sources.

Some possible relief may be forthcoming in terms of oil shale and tar sands reserve of some 75 billion barrels which are relatively accessible. However, the investment to get this oil is high, and the quality of the product is questionable.

Natural gas production in the United States is currently 22 trillion cubic feet/year. Using the National Petroleum Council's estimates of discovered reserves of 679 trillion cubic feet and ultimately discoverable reserves of 1,857 trillion cubic feet, at current rates, we have somewhere between 31 and 84 years natural gas reserves. However, if we use these up at a faster rate (40 trillion cubic feet estimates for 1985), then the reserve will not last as long.

There may be a small amount of relief (2 trillion cubic feet/year) from synthetic gas. This will be produced at a significantly higher cost than natural gas.

Fissionable material for nuclear reactors also have their finite limits. Depending on annual rates of usage, we will have used up some 400,000 to 700,000 tons of uranium ore out of a potential reserve of 1,625,000 tons by 1985, according to A.E.C. estimates.

Hydropower presently supplies about 4% of total United States energy. As all the major sources of hydropower from rivers have been exploited, this source will continue to diminish in relative importance as a source of power.

In short, all of our fossil fuels have finite limits and are being used up or are being projected to be used up at increasing rates.

At this juncture, the reader is probably wondering impatiently, why doesn't he mention imports of traditional energy sources to make up the differences between domestic production and rising energy demands? Of course, there are reserves of all the traditional fossil fuels in the rest of the world, and we are importing and will import them to augment our own production.

There are a number of points to be made about importing energy. First, imports are expensive and will become more expensive. Second, the world's reserve of fossil fuels are finite. Third, there is increasing competition for the rest of the world's fossil fuel reserves. Fourth, the assumption that the energy rich countries will automatically follow the economic incentive and supply us with energy in trade for dollars is an extremely dangerous one. Recent activities by many oil exporting nations to limit production and extend the like of their fossil fuel, resources provide adequate support for this point. Fifth, when an increasingly large proportion of your energy needs must be supplied by less than friendly and stable governments (Persian Gulf), the situation does not lend itself to the tranquility of projected steady long term growth. Sixth, even if we could use the rest of the world's fossil fuels, we would only be postponing the inevitable for a relatively short period.

New Energy Sources

In order to meet this country's and the world's ever increasing demand for energy, some new or not presently commercially exploited sources of energy are:

1. Gasification of coal
2. Geothermal energy
3. Wind
4. Wave power
5. Magnetic energy
6. Solar energy
7. Extension of fission reactors - eg. breeder reactors

8. Hydrogen fusion (tritium - deuterium or deuterium-deuterium)

The list is by no means complete and each potential energy source has physical limitations, cost and technological constraints relative to its commercial usage. The interest here is not to lapse into a lengthy discussion of the pros and cons of each source. It is, however, appropriate to indicate that new sources of energy exist and can be made available at a certain cost over a given time period, to replace and/or augment existing fossil fuel sources.

Energy Crisis in Perspective

The spotty "outs" or limitation on gasoline or diesel fuel, the cold class rooms and the closing of businesses for lack of fuel that we have experienced recently are not the energy crisis. These are important, to be sure, to those who have experienced and will experience them. But, they are merely symptoms of the real energy crisis. That is plainly and simply, the increasing rates of use of a resource with finite limits. We are blindly committed to fossil fuels. There is only so much of these fuels in this country and the world. Our demands in these limited resources are growing rapidly each year. This is the energy crisis.

The author does not want to be classed with the "prophets of doom". But, if we persist on our present path, our society will eventually grind to a halt for want of fossil fuel. This will not happen today or tomorrow. If current estimates of reserves are wrong and we can't import adequate energy, it could well happen within our life time. That thought, dear reader, is what motivates authors who don't want their activities constrained by other's lack of foresight.

Energy and Food Industry

Now that we have at least a sketchy idea of the energy situation, the remainder of these remarks will be directed toward the relationship of the energy industry to the food industry. Energy in the food industry is only one segment of the total energy picture and is interrelated with the rest of the society. However, it will be useful to use this industry to point up the long range challenges confronting the energy industry in the not too distant future.

The Food Industry as a User of Energy

Currently there is no accurate estimate of the total energy used in the production, processing, distribution, and consumption of food in the country. Rough estimates range from 12-15% up to 25-30% of total energy use. However, it might be useful to look in detail at each of these four segments of the food industry and try to identify some of the major areas of energy use.

In food production, fuel for basic farm work requires about 3% of total U.S. gasoline and diesel fuel used. For fertilizer manufacture, over 2% of the nation's natural gas is used in NH_3 fixation and processing of phosphate rock and potash. Also, large amounts of natural gas and LPG are used in grain drying. These figures say nothing of the energy used in transporting the inputs to the farms, in the manufacture of the machinery and equipment used on the farm, in the manufacture of insecticides, sprays, etc. In addition, about 3% of the nation's electricity used is on farms.

Energy use in food processing includes plant operations, machinery construction and installation, building construction. Other energy users are product movement to and through the plant and storage of the finished products. Packaging in all its forms requires a tremendous amount of energy to create the multitude of packages, transport them to the processing plants and then provide for their disposal or reuse after consumption.

Distribution involves energy use for transportation, storage, refrigeration, and further processing when necessary. Warehouse and food store construction, operating and equipping requires sizable energy use. In all these segments mentioned here, energy is required for information and people movement within and between firms and industries.

Consumption of food requires energy in final preparation, at home or in the eating establishment. A University of Illinois engineer established that the McDonald's chain alone annually used enough energy to supply electric power for the cities of Pittsburgh, Boston, Washington and San Francisco. Waste disposal or recycling requires huge increments of energy.

In summary, the various segments of the food industry use large amounts of energy. Total food industry usage could well exceed 30% of total national energy use.

The Food Industry as a Producer of Energy

The most obvious form of energy produced by the food industry is in the food energy generated for man and animals. Second, energy from various by-products of many commodities. Third, animal refuse may be a source of energy. A proposal has been made to dry and burn animal refuse from the feed lots in the West to get the methane gas.

Questions may be raised in terms of the physical input-output relationships of energy usage in the food industry. In short, what are we getting (energy-out) for what we are putting in (energy-in)? Many would wonder if our present system is as efficient, in terms of energy use, as it might be.

One partial comparison indicates that Chinese wet rice agriculture produces in excess of 50 BTU's of energy for each BTU of human energy expanded in farming; while our farming system yields one-fifth of one BTU per BTU of fossil fuel energy expanded. These relationships may not be precise and what similar relationships for other segments of the food industry are, is not documented at present. The point to be made here is that when measured in terms of energy use rather than dollars, the efficiency of the food industry may look entirely different. Modifications in our present system could have a significant effect on this "energy efficiency ratio".

The Energy Crisis in the Food Industry

The food industry, as with the rest of our society, is locked into the fossil fuel syndrome as a source of energy. The entire fabric of the production, processing, distribution, and consumption segment of the food industry is covered with examples of man's efforts to substitute mechanical energy for human and animal energy. We pride ourselves that one man on the farm now feeds some fifty people in the country. This is really false. It is one man plus a lot of mechanical energy plus the rest of the food distribution system that feeds those fifty people.

In addition, we are at a point of no return in the food industry. To provide our people with their present food needs and desires, it would be physically and economically impossible to go back to the horse for horsepower as many have suggested. This takes no account of future changes in food needs or desires.

Also, we are becoming committed to the "cleaner" fuels - natural gas, LPG, and fuel oil for much of our energy needs in the food industry. Unfortunately, it so happens that these fuels are shortest in supply and have many competitors for their use. These "cleaner" fuels are more mobile as well. In many cases, these mobile fuels are used in fixed work places due to ease, convenience, and cleanliness. The so-called fixed places fuels or solid fuels - principally coal and nuclear fuel have taken a back seat in the food industry.

In sum, the food industry has become completely dependent on fossil fuels as a source of energy. It is forced to compete with ever growing energy demands of the rest of society against a limited supply of these fossil fuels. In this sense, the food industry is no different from any other industry. However, since most of us want to continue eating, the food industry has been given and probably will be given priority in getting its fuel needs satisfied. This does not erase the longer range question: "Are we spending too much energy to satisfy our food (nutrient) needs?"

National Goals, Energy Policy and the Food Industry

A digression is necessary at this point to broaden the discussion for a short period.

We have recently decided, as a Nation, to make a concentrated effort to "clean up the environment". The principal concern with fossil fuels is in air pollution abatement. Although there is some concern with such things as oil spills in the water, petro chemical wastes in the water, damage to scenic beauty with strip mines and offshore drilling. The pertinent issue is that we have said to the energy industries, "either use only the 'cleanest' of your fuels or clean up the fuels you use". The only problem with this is that the "cleanest" fuels are in short supply and the investment to clean up the "dirty fuels" is enormous.

To the energy industry side of the picture for a moment, then we will get the two back together. As a nation, we have truly spoken to the energy industries with "forked tongue". Each segment of the energy industry is faced with its own set of federal regulating bodies, some 61 in total. Each segment has seemed to have been allowed to pursue its own course to short run profit maximization. Public posture has been, "Don't bother me with such technicalities - there will always be plenty for everyone." This, in a sense, is the curse of a resource rich country. It is easy to take a short run view and let the other fellow worry about tomorrow. The only problem here is that "the other fellow" turned out to be nobody. Our population-resource ratio has just now come to such a point where a few people are aware that we can't pursue our present course indefinitely. However, those few have very little to say about energy matters.

To say that we don't have a national energy policy is only partly true. We have no positive direction toward the solution of our nation's long range energy problem. However, we have a "non-policy" which has been termed by some "drain America first". This is the culmination of all the short range exploitation in our energy rich country. There was always more around the corner for the taking. Well, we are rounding the corner to find our needs greatly in excess of our resources and the gap is widening.

Thus, the confrontation. One side says, "Clean things up." The other side says, "We can't or it will cost too much." The public says, "You guys fight it out, but don't stop my energy from coming in ever increasing amounts and quit fouling my environment." A hopeless mess! No, not really. But, for us to work our way out of even the short range crisis, some hard decisions must be made as to how clean the environment must be?; how much will be invested to clean up the "dirty fuels"?; who will have priority in existing fuels? and what can we do to work ourselves out of this situation.

How is all this pertinent to the food industry? Very simply the food industry is a very large user of the so-called "clean fuels" that are so short and for which there is so much competition. The remainder of this paper will discuss some possible remedies to the energy crisis in the food industry.

Alternative Solutions to Energy Problems in the Food Industry

In order to look at our alternatives in a logical manner, we will consider them in three separate time frames:

Short Run -
Basically the present and a few years hence when no major change can be made in either the food or energy industries.

Transitory Period -
Out to 2000 A.D. or a few years beyond when considerable change and research for further change is possible.

Long Run -
Out to 2100 A.D. or so, this is the time period when major changes will have to be made in the energy industries and drastic changes into food industry most surely will be forthcoming.

Short Run

In this and the next few years, we pretty much must live with things as they are in terms of basic elements in both the food and energy industries. Given this situation, there are three basic decision courses which can be pursued:

1. Do nothing
2. Conserve energy
3. Decide on a positive approach to long range energy problems

These are not "either-or" decisions. It is possible to have elements of all three courses in the public policy framework at the same time. Let's look at each decision course individually.

In spite of all the publicity and inconveniences caused by the "energy crisis", there is considerable sentiment in this country to simply do nothing. The energy companies, with their huge fixed investments in single use facilities, would most probably be quite content to follow this policy. "Let the consumer adjust, why should we?" The myriads of governmental bureaucracies which never have had central direction and tend to resist change even more fiercely than large companies, would be pleased with the status quo. Again, "let the other guy change". The average man on the street has not been pinched enough or long enough to be angry enough to do something about the situation. Even if he was mad enough, he doesn't know what to do and isn't nearly as well organized or as powerful as the energy lobbies. Thus, "Nero fiddled while Rome burned."

Secondly, we can apply all the known measures to conserve existing supplies of fossil fuels. We can get our cars tuned up, check our tire pressure, drive more slowly, insulate our homes, turn off the lights, limit air conditioner use, and many other positive remedies to make more efficient use of energy. We might slow down the rate of increase in energy use. Or maybe keep the rate of increase constant rather than increasing. However, these measures are treating the symptoms and not the problem. Granted, we can do little more of a concrete nature than this in the short run. But, we must not be allowed to be lulled into thinking that conservation will solve the energy crisis. To the contrary, conservation will only postpone the inevitable by a pitifully short time period.

There is one item of business that must be accomplished in this short run period if we are to have energy for the long haul. We must, as a nation, decide to take positive action concerning ways to solve our long run energy problem. This is, indeed, probably the most critical decision that will face man in the next few years. Wars and politics, even space problems, take a minor role when we consider the energy of a nation and the world. Without energy, these trivial concerns are meaningless. For man can do nothing about these without energy.

Given the existing energy lobbies, bureaucratic inertia and man's indifference, the arrival at such a critical decision point will be no small matter. However, it is one great positive contribution that we can make to our future generations by providing them with adequate energy to live their lives as they please and not shackle them with our mistakes.

Transitory Period

In discussing these last two time segments, the assumption will be made that the decision just discussed was made; and based upon the best available information massive investments have made to perfect the combinations of technology necessary to utilize alternative energy sources. For without such a decision, the transitory and long run period would be one long nightmare of energy shortages culminating in a grinding halt to society as we know it.

The author will not be so presumptive as to choose the alternative source or sources of energy for the country. He has neither the technical competence nor the omniscience to make the decisions. For purposes here we will assume that the decision has been made and that research and development has begun, in earnest, on new energy sources.

Changes during this transitory period would be forthcoming in three major areas that are pertinent here:

1. Technology
2. Institutions
3. Food industry

Technological change will center around the phasing out of fossil fuel use and the phasing in of the new energy source(s). The problem here is pain minimization in the reemployment of resources from the fossil fuel industries to the new energy industries or else where depending upon skills (people) alternate use capabilities (capital).

It is conceivable that the new energy source itself will not require institutional changes in its own behalf. That is, the basic makeup of institutions would be unaltered by a change in energy source. However, the more likely case in the new energy sources may make possible certain institutional changes or may itself be effected by changes in institutions.

The same can be said for the food industry. The basic institutional structure in the food industry may not change with the new energy source. However, it is quite likely that a considerable interaction will take place between institutional and technological change which will effect both elements. An excellent example of this might be the extraction of heavy hydrogen (deuterium oxide), from sea water for use in a fusion process for energy, generation. As a by-product organisms such as plankton and algae could be filtered from the water to yield a new source of protein from human consumption. There would be institutional and technological elements of change from both points of view.

Long Run

As we stretch the time frame toward 2100 A.D., one can conceive of a situation when the alternative combination of energy sources of the day can provide adequate energy for the food industry of the day and, indeed, approach a tenuous equilibrium situation. Such a situation is possible even when both elements are in a stage of flux. Over a very long time, the use of several alternative energy sources can be envisioned as well as several alternative "nutrient delivery systems"[1/] to supply our people's food needs.

The condition which we must avoid in the future is getting locked into one source of energy which is of fixed quantity as we are at present. A quote from Arthur C. Clarke is an appropriate way to end this paper.

"The heavy hydrogen in the seas can drive all our machines, heat all our cities, for as far ahead as we can imagine. If, as is perfectly possible, we are short of energy two generations from now, it be through our own incompetence. We will be like Stone Age men freezing to death on top of a coal bed". ..."In this conceivably enormous universe, we can never run out of energy or matter. But, we can all too early run out of brains."[2/]

FOOTNOTES

1/ Journal of Food Distribution Research, Volume IV, No. 3, September 1973.

2/ "Profiles of the Future", Arthur C. Clarke, Harper & Row, 1973.

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