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ALTERNATIVE ENERGY SOURCES AND ENVIRONMENTAL CONFLICT

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Our present energy dilemma has been created by a series of major policy misadventures in several areas during the past ten or twelve years. These areas are: (1) our oil import policy; (2) our research policies, particularly concerning fossil fuels; (3) our basic data programs; and (4) our natural gas regulations. From 1962 to 1967 I was responsible for the oil import policy. During that period and later as Director of the Bureau of Mines I was responsible for research policy and for basic data policy. While I was with the Federal Power Commission I was responsible for the regulation of natural gas at wellheads. I have now moved to the Atomic Energy Commission and I wish you all well.

My task is to bring you an overview of energy. The best way to encapsulate my view is to regard energy as a strategic commodity. If we are out of zinc, we can switch to aluminum, but only if we have the additional electric power required to make the aluminum. If we are out of aluminum, we can switch to steel, but again only if we have the needed electric power where we need it. If we are out of coal, we can switch to oil, if we have the needed energy resources. But we cannot do without energy.

We can look upon our economic situation, or that of any individual, community, or country, as being the result of its ability to control and use energy. If we look at U.S. history over the last hundred years, there is virtually a one-to-one correlation between increased energy consumption and increased gross national product in real terms. If we look over the world at any given time, we also find a good correlation between the per capita energy consumption of any country and its per capita gross national product.

Energy consumption is thus the counterpart of our material standard of living. The present situation consequently represents a serious threat to our well-being. Over the next generation we will have to repair our public policies and change our individual feelings and attitudes toward the overall energy picture. Otherwise we will begin to fail as a nation. We may have started to fail already because of our misunderstanding of this essential commodity.

Since the end of World War II our economy has been charac-

terized by a totally unconstrained use of energy. I recall that as a child I was constantly being reminded by my parents to turn off the lights because electricity was relatively expensive. Electricity became cheap after World War II as we reaped the benefits of economies of scale in producing it. Similarly, as technology advanced in the oil, coal mining, and natural gas businesses, we found that supplies began pressing on the market, and those energy sources also dropped in price. From 1947 to 1970 the cost of coal dropped by something like 50 percent in real terms. The cost of natural gas at the point of usage also fell markedly. We began to look upon energy as virtually a free good. We began to make economic decisions that were liberal in use of energy but conservative in use of other forms of capital.

Our casual attitude toward energy supply is shown also in the inefficiency with which we have used it. Take oil, for example. Starting with the oil reservoir, we recover on the average about 30 percent of the oil in place. If the price were higher, or our technological efforts greater, that percentage would increase. In fact, it has been increasing by about 1 to 1.5 percent per year. It was just over 15 percent at the end of World War II.

In converting oil into electrical energy, our system is about 32 percent efficient. Combining this with our 30 percent recovery, we are now down to about 10 percent of the energy in place. We then run the electricity through a notoriously inefficient distribution system, losing another 2 or 3 percentage points in the process. Finally, we may apply the electricity to lighting by means of incandescent lights, from which we get more heat than light. Overall, this entire chain is perhaps 4 percent efficient, from oil in the ground to light in the home, relative to the energy initially in place.

In every step of the oil use chain great economies could be made without much effort. The 4 percent could be about doubled simply by shifting from incandescent to fluorescent lights and by tightening the distribution system to eliminate some of the losses that we now have. The 32 percent efficiency in converting oil into electrical energy could be raised with known technology to about 40 percent. By advanced technology now in the pilot stage we could get into the low 50's, almost a 40 percent increase in efficiency. Economic and technical possibilites exist for raising the present 30 percent initial recovery of oil to at least the 60's and possibly, later on, into the 80's.

We have not made these efforts to raise efficiency because we have regarded our energy sources as being superabundant, no

matter how we abuse them. Notwithstanding our abuse during this long period from 1947 to 1970, more and more energy became available at ever-increasing prices. It is now clear, however, that all this time we were incurring a deficit. We will be paying for that deficit for a long time to come.

We misregulated natural gas because under the circumstances we had no alternative but to hold down price. The natural gas industry is composed of three segments: production, long-line transmission, and local distribution. Before 1900 local distribution of manufactured gas was controlled. Lower than free market prices were created by virtue of that control. After 1938 long-line transmission companies began to be controlled with economic regulations, and again economic rents were created. From 1938 to 1948 abundant supplies of natural gas were pressing on the market. But after 1948 the supply and demand relationship changed, and all the economic rents that had been created by the regulation of the production and transmission began to migrate back into the fuel price. The price of natural gas, which was commonly four cents per cubic foot in 1948 and 1949, had risen to twenty-one or twenty-two cents by 1951, a remarkable turnaround for so short a period.

About 1954, as a result of the Phillips decision, the Federal Power Commission had no choice but to begin to regulate natural gas prices. That created substantial demand. Natural gas became the fuel of choice for economic reasons, not only in homes but also in industry. In fact, 65 percent of our natural gas now goes into industrial uses and only about 35 percent into commercial and household uses. About half of our natural gas is used for purposes which could easily be switched to other fuels. When we look back on this period of natural gas regulation, we can see the errors. But in my judgment the errors were not in influencing the supply side. Our error was in failure to have counterpart regulations to restrain demand.

The oil import control program is another area where it is now evident that errors were made. Here we began what Dave Freeman has described as the policy of drain America first. We limited oil imports, but we did not try to force additional investment in research and exploration in the United States. We did not follow through.

Some statistics are interesting here. In 1965 we were consuming about 11 million barrels a day and importing 2.5 million barrels a day. We had about 4 million barrels a day of excess capacity. By 1970 excess capacity was essentially zero. Our demand was up to about 13 million barrels a day, but because of oil import

controls, our imports had increased to only about 3 million barrels a day. All that we accomplished during the period of oil import controls was to hasten the depletion of domestic reserves.

Our basic data began some years ago to give signals of the current situation that were pretty easily perceived by experts. In 1967 and 1968 I was making public statements to congressional committees that we were about to enter a period of severe energy shortages. But it was difficult for people to believe the signals we were getting because the data came from suspect sources. Our oil data came from the oil industry. Our nuclear data came from the Atomic Energy Commission. The gas data came from the gas industry. The coal data came from the Bureau of Mines, which was regarded as a captive of the coal industry. We were getting our data free, and they were worth just about what we paid for them because nobody believed them.

People do not believe the data even now. There is still a broadly based quarrel in Washington about whether there is a natural gas shortage. Some experts are willing to testify that we have a conspiracy, that the oil companies are shutting down their gas supplies and not delivering them to market in the expectation of eventual regulation.

Finally, our research policy has been, in retrospect, disgraceful.

In 1947 two significant research and development actions began. The first was the establishment of a civilian Atomic Energy Commission leading to the development of atomic energy as an additional energy option. The second was the Synthetic Liquid Fuels Act which bestowed on the Secretary of the Interior the authority to go out and look at oil shales, coal, and other resources in the United States, in order to develop new supplemental fuels.

The atomic energy activities culminated in a viable industry. It is reaching the point where we can see nuclear power providing 10 to 15 percent of our electricity requirements by the late 1970's and as much as 60 percent by the year 2000. That is a success story.

The Synthetic Liquid Fuels Act was not a success story. The petroleum industry argued that the federal government should not conduct research that would increase interfuel competition. The Eisenhower administration went along with the industry, and in 1954 funding for the act was terminated. If the synthetic liquid fuels program had been pursued with the same vigor as the nuclear energy program was pursued by the Atomic Energy Commission,

we would probably have seen a continuation of the relatively orderly transition from one source of energy supply to another which has characterized the history of energy consumption in the world.

The period of orderly transition in this country begins with animal power, which was our predominant source of energy before the Civil War. During and after the Civil War we went to coal, which was king for close to a hundred years. Then oil became the predominant resource, followed by gas in the 1940's. Now we are suffering a hiatus in terms of a further smooth transition because national polices have fallen out of step with market and technical realities.

One of the areas where policy has fallen out of step is prices. A guide for our oil import control program was stable product prices. The unstated premise was that we would protect our crude oil market but would not allow a rise in gasoline prices. That has been a key element in bringing about the current gasoline and heating oil dilemma.

The present shortage is often attributed to the inability to find sites for refineries because of environmental considerations. The fact is that we can site refineries in the Southwest and the Southeast without difficulty. Louisiana, for example, is delighted to have new refineries in the tidewater, as are other places in this country with tidewater locations.

It was not for purposes of control that the oil companies refused to construct refineries, or because they were unsure where additional crude supplies would come from. They knew that the crude supplies would either come from the outer continental shelves of the United States or be imported in foreign bottoms. Therefore, they could have located their refineries at tidewater sites and taken it either way. But during the last three administrations the oil companies had been jawboned every time they made a price move. They are now providing the United States with an object lesson in basic supply and demand economics. There has now been a three-year hiatus in the construction of refineries.

I was myself part of the jawbone exercise. I incurred the wrath of domestic producers in 1967 and 1968 and again in 1970 and 1971 when I was in the Bureau of Mines by trying to keep the lid on prices as the other side of the coin for oil imports. But economics ultimately will win out. We drove margins down to the point where refinery construction was not attractive. The oil companies will not now be able to add capacity fast enough to

avert a crisis in heating oil supplies either this winter or next. The gasoline shortage probably will be worse next summer than it has been this summer.

There are two root problems in our current policy. The first is the exponential growth in demand. Since World War II we have been on a sky ride of energy consumption. Overall, consumption is going up about 4 percent per year compounded, which amounts to doubling every eighteen years. No resource base can stand that.

Let us look at how demand growth has affected natural gas. At the moment we have known natural gas resources of about 250 trillion cubic feet. The American Gas Association tells us there is yet another 1,200 trillion cubic feet to be found, which they regard as plenty. The AGA's estimate is the result of a simple extrapolation from the explored provinces to the unexplored provinces down to a depth of 30,000 feet. It is a reasonable projection of technology for the next twenty to thirty years.

We consume 25 to 30 billion cubic feet annually. At that rate of consumption, the supplies estimated by the AGA would last about fifty years. But this ignores exponential growth. Since World War II consumption of natural gas has been rising 7 percent per year, which means doubling every ten years. If this were to continue, our demand for natural gas would be 50 billion cubic feet in 1983 and 100 billion cubic feet in 1993. At that rate of compounding, if we assume a ten-year dedicated reserve, the last of total known reserves plus to-be-found reserves as estimated by the AGA would have been committed by 1985 or 1986.

The Geological Survey estimates that 2,100 billion cubic feet are to be found. A little greater depth and a little greater extrapolation out to the continental shelves and margins accounts for the difference between their estimate and that of the AGA. If the higher estimate proves correct, the total supply would last for another nine years, until 1994 or 1995.

What I am saying is simply that, regardless of how large the resources seem from a base year perspective, when exponential growth in demand is applied to them, the supply disappears in a frighteningly short period. There is hardly any resource that can outlast six or seven doublings. Consequently, we have to ask ourselves if we can sustain basic growth at the current pace.

At the moment we are really not yet in a resources crisis in natural gas although, projecting the situation as I have just done, we probably will be in a generation or so. A little further on, the same may happen with other resources. But until then, if we

wanted to, we could solve all of our energy problems simply by converting all American industry to coal and burning it raw, if we were willing to do that. We have the technology. It is just a matter of changing grates for the most part. It would be disruptive, but given the time and a national objective that we were going to convert everything to burning raw coal in three to five years, we could do it without rippling the economy. The principal costs would be dirtier air and substantially higher mortality among miners.

While we do not yet have a resources crisis, what we do have is a crisis created by management failures, a compounding of errors in policy and environmental constraints.

It is worth while to spend a minute looking at public attitudes toward energy because these must be taken into account in policy formation. These attitudes are based, in part, on economic, and, in part, on environmental considerations. When people think of energy shortages they think of the oil companies as bandits. The Federal Trade Commission is now embarked on another massive antitrust suit against eight major oil companies. I think that a Gallup Poll would show that 80 or 90 percent of the people support that sort of attack. The oil industry is just too much; it is on every corner. People do not like oil companies.

The same is true of coal mining companies. My own experience in the coal mining field, while I was Director of the Bureau of Mines, was associated with a major mining disaster. There was a rising tide of public opinion against the coal mining industry. This is a deeply held resentment and to a degree justifiable. The coal industry has been cavalier with both people and with land. It is unwilling to reform itself.

There is a strong feeling among the elite that a one-to-one relationship exists between the production and use of energy and degradation of the environment. No doubt energy producing industries, concerned primarily with cost, have permitted some bad practices, particularly those related to air pollution, which have raised questions in people's minds. In Santa Barbara we had the outpouring of public indignation at the oil spill. The Alaska pipeline fight had to be resolved, not in the courts, but through the efforts of Congress. All the forces of the administration and all the forces of the oil industry were turned loose on this. A nuclear moratorium is now being proposed by environmentally oriented groups.

There is a feeling that energy is somehow dissociated from our day-to-day living. When the fellow who says, "Let's have

no more Santa Barbaras," goes into the service station to fill up his gas tank, I do not think he sees the relationship at all. There is a disassociation in people's minds between the energy industries and turning on the light switch, using amplifiers, or starting a car.

There is also a school of opinion that equates energy use and the resulting environmental degradation with growth, and holds that growth is therefore not desirable. Those who hold this opinion say we are too materialistic. They advocate zero growth, or less growth at any rate.

This whole complex of emotions are among the raw materials which you as understanders and proposers of policy must work with. Some major education efforts about our policy problems are probably going to be required to get us over the hump.

A task which must be undertaken soon is to extend into land use the work that we have done in developing understanding of broad policy issues affecting other resources. We have made notable strides in the past ten years in developing water policy, for example, and over the next five years I think we will pretty well have developed a total national policy of ethics on how we will handle water as a public resource.

We are about in the same stage now in our air quality standards. The battle that is now being waged between the automobile industry and the bureaucrats in Washington and between the local utilities and the state regulatory people is leading to considerable public debate. We should have pretty well laid out a national policy on air quality within the next four or five years.

But we are not even into the beginning of developing a policy with regard to land use. Here we have the most difficult institutional customs to face. We are dealing with very strong traditions with regard to private property rights. We also have extremely strong traditions in local zoning. Township and county zoning have been the rule. The states are moving very slowly into that field. We are heading now for some sort of federal regulations for key facilities, and this must continue or we will have a morass.

The difficulties associated with a nuclear plant now being built on the Chesapeake Bay pretty well exemplify our situation in land use policy. The citizenry there woke up one day to learn that a nuclear plant was under construction. On inquiry, this turned out to be a typical smoke-filled room type of deal. The utility, Baltimore Gas and Electric, had dealt with the county officials. There had been little in the way of public notice. The Atomic Energy Commission did not have the full environmental responsi-

bility it now holds; it was not provided an opportunity to hold public hearings. The citizenry was therefore presented with virtually a *fait accompli.* And naturally it reacted as best it could. It hired an attorney who happened to be a very competent young fellow. About that time the National Environmental Policy Act was passed. Reaction against the way the plant got started, a smart attorney, and the new legislation set back that particular plant about four years. Similar setbacks have occurred with other plants.

The National Environmental Policy Act put the nuclear industry behind in its otherwise attainable schedules by a good year to a year and a half, which is very costly. In the present energy situation we cannot afford such delays. We must develop some way to guarantee earlier public participation in decisions on siting of key facilities. I am thinking here of refineries, large generating plants, and other facilities that have a major public impact. To accomplish this we will probably have to look to a federal framework similar to that within which our air and water quality standards are being developed.

We will also have to develop an energy conservation policy. During the past few years, there has been much talk about conservation from the administration and other sources. But there has been no action. We really do not know how to do it. We do not know whether we can develop a conservation ethic that will lead to voluntary reductions in energy use or, conversely, whether a major regulatory effort is required to force people to curtail their energy use.

It is very easy to give lip service to conservation but most difficult to achieve it. The elected official who tells us that we cannot use air conditioners on the hottest summer day, although it is all right on a cool day, is not going to be re-elected. The Consolidated Edison Company made a concerted advertising effort to get people to turn down their air conditioners during the summer. They found it worked beautifully on days in the 80's but on that very hot day everybody pushed his thermostat all the way over. Consolidated Edison Company's peak demand day, the one they feared would exceed their capacity, was untouched by their conservation efforts.

Finally, I think we must take a very careful look at reduced growth propositions. Should we, as a nation with 6 percent of the world's population, continue to consume 35 percent of the world's energy, sufficient to drain in a generation the Arabian and Siberian holdings of oil? Should we allow ourselves to knock off our coal resources in about eighty years? We talk about them as

being good enough for several hundred years, but this is on the basis of current use and does not take into account that exponential curve, which is still going up. If we were to shift all our demands to coal resources as we know them now, we would begin to peak after about two generations, or about eighty years. Can we afford to do that? Can we find solutions that are more conservative?

What are our alternatives, and what are their environmental consequences? If we shift the bulk of our demand to coal, we will use up land in a destructive way and we will kill people to get the coal. If we get the bulk of our energy from oil imports, we will have spills, and also some very heavy debits from the standpoint of foreign policy.

Consider our commerce situation. Our present oil imports are about $4 billion a year. By 1980 imports will be up to $20 billion a year on a straight extrapolation of where we are to where we are going. That means that net cash flows will be going into countries that do not have a strong incentive for more money. The Libyans, for example, do not want dollars and are doubling the price of their oil. There is a question whether we can continue to import oil from this source. If we could import to 1980, could we import to 1985? If we could import to 1985, could we import beyond 1985? At any rate, there are extremely high costs in going the import route. It has the potential of disrupting our monetary flows and reducing our mobility in handling some key foreign relations.

Can we go to solar energy? Electrical energy needs alone, which are about 25 percent of our total energy requirements, would require the dedication of about a quarter of the State of Arizona for solar collectors. I do not think that is an acceptable cost.

Do we want to go to geothermal energy? Probably we can achieve some additions to our energy supplies through geothermal, but here again we will be paying a price in terms of environmental damage. It will require the development not only of conversion plants but also of pipeline systems to move the steam around.

No matter what direction we go, our energy dilemma exacerbates our environmental problem, given even the best of technology. This brings us back to the chief environmental policy issue of the 1980's and 1990's—the limits of growth itself.

I recently heard a debate between Jake Forrester and Hermon Kahn on this subject. Forrester, as you may know, is sort of the progenitor of the Club of Rome book, *The Limits to Growth,* published about a year and a half ago. Based on an extrapolation

of world resources versus world population and the standard of living, the book's conclusion was that we could not sustain further demographic or economic growth without disaster. Kahn's futuristic approach, on the other hand, tends to be extremely optimistic. He thinks that we need to set absolutely no limit for ourselves largely because we can apply ingenuity to our broad resources base and just continue up the exponential curve forever.

As the debate proceeded Forrester, not surprisingly, took the view that development meant environmental damage while Kahn maintained that if we applied enough ingenuity we could come up with energy developments which would actually result in less environmental damage in the aggregate in the year 2000 than we have now. This would come about at a price; increased energy consumption, of course, being the price. Then Forrester took the view that with increased technical complexity society became more vulnerable. He mentioned in that context the exposure of the United States to the hijacking of airplanes. Kahn contended that increased complexity made society more flexible. He mentioned the primitive society of the Irish potato famine days and the complete destruction of that society when one thing went wrong. Probably, we have to score a point for Kahn on that one. And finally they got to a point where they could not reconcile their views. In Kahn's view, the world is not overcrowded, in Forrester's it is.

That is sort of the beginning of a debate that ought to go on.