

Preliminary Remarks  
 by  
 Vice Admiral H. G. Rickover, U. S. Navy  
 at the  
 Annual Membership Meeting  
 of the  
 Pensacola Area Chamber of Commerce  
 Pensacola, Florida  
 Thursday, June 8, 1972

Before starting my speech I would be remiss if I did not acknowledge the contributions of a distinguished Floridian and one of the great men of our Congress, The Honorable Robert L. F. Sikes.

I have been privileged to know Congressman Sikes officially and personally for more than 20 years. During the numerous contacts I have had with him in connection with my work on our atomic Navy I have found him kindly, perceptive, hard-working; a man who is always thinking and acting in the public interest.

I speak from personal experience when I say that without the support he and his Committee have unfailingly given, conversion of our fleet to atomic energy would have been delayed and might have come too late to be of use to the United States.

I consider him as fine a politician as there is in Congress. In using the word politician, I do so in the sense that politics is the highest calling in which a human being can engage. This is so because it is through politics that we get things done; that the world is kept moving. To be a good politician one must possess far more than intelligence; he must also have the human touch, the innate ability to know how people think and how they feel. He must have their confidence and he must know what is necessary to do for their basic needs and for their welfare.

Mr. Sikes is that kind of politician. In our form of government the basic function of a Congressman is to represent the people of his district and of his State; he also has a duty to the United States as a whole. Balancing these two interests can present a difficult task for a legislator, but Congressman Sikes has handled this task with wisdom and integrity. He has looked out for his district and State and for the United States.

One of the things that has made the deepest impression on me in my half century of service in the Navy is that things in this world get done by people and not by an organization or a system. Yet the present tendency in the United States is to seek improvement by concentrating on organization changes and on management systems. These efforts are doomed to failure because human beings, having free will, cannot be organized into systems and treated as inert atoms. Mr. Sikes' work in Congress is proof that he understands this fundamental fact.

With his 32 years of service, he is the ranking member of the House Appropriations Committee as well as the senior member of the House from Florida. His foresight, wisdom, judgment, and common sense have allowed him to make major contributions to our national welfare and security.

Now to the topic of my speech: "ENERGY--A DIMINISHING CAPITAL RESOURCE"

SPEECH REFLECTS THE VIEWS  
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## ENERGY—A DIMINISHING CAPITAL RESOURCE

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Vice Admiral H. G. Rickover, U. S. Navy  
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In recent months a great deal of attention has been focused on the rapidly developing shortage of energy resources in this country. This is a matter that has been of deepest concern to me for many years. In 1957, I delivered a speech, "Energy Resources and our Future" which became a chapter in my book Education and Freedom, published in 1959. I can think of no public issue confronting us today that will touch the lives of our children and grandchildren—if not ourselves—more closely than the ability of the U. S. to command the energy resources that are needed to sustain our economy.

The public's current awareness of this shortage of energy is a result of a series of recent Congressional hearings on this subject. To try to secure these resources is, of course, one of the oldest, most basic of the responsibilities of government, equaled only by its obligation to protect the Nation against foreign aggression and to maintain domestic peace by administering efficient and even-handed justice to those who violate the law of the land. None of the other tasks

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which our government—as well as all other modern governments—have added to these traditional responsibilities is as indispensable to the welfare of all our people than preservation of the economic base which sustains our civilization.

In a democracy such as ours, government can act only if it has the support of a majority of the electorate. There can be no effective national resources policy unless the American people acquire a clear understanding of our resources position. They do not have a realistic picture of our position today. How can it be otherwise when every time a new fossil fuel deposit is discovered, a flood of optimistic statements fills the air, and the press deprecates the severity of the energy crisis against which disinterested experts have warned?

I vividly remember the exaggerated claims made eight years ago when new energy resources were discovered in and around the North Sea. The pattern of world politics, it was predicted, could alter; the consequences, once the find was exploited, would be staggering. Europe would become wholly independent of the Near East; Russia would no longer obtain foreign currency to buy wheat and machinery by selling her oil at marked-down prices.

The production of oil in the North Sea has now begun and intensified efforts have been made to find additional deposits in offshore areas of Europe. Yet the latest projections supplied by Undersecretary of State, John N. Irwin, II, indicate that the production from the North Sea area is expected to reach only one million barrels per day by 1975, and perhaps three million in 1980— a small percentage of the 24 million barrels Europe is expected to need by then.

Most of the studies of the past 25 years projecting future energy needs have consistently underestimated the consumption needs of Europe and Japan. Certainly, no one foresaw that by 1980 Europe's demand would equal our own of 24 million barrels per day, and Japan's would be ten million barrels—almost half as much again.

That our resources position is precarious has been attested to by experts during the past months. There are however a few points I should like to make.

I, myself, have been aware that we were facing shortages only since the end of World War II. Previously, I shared the profound conviction of most Americans that ours was a country of limitless space and boundless resources. The whole of our past history seemed to support this conviction. When I was young, free homesteads were still available. And up to the 1940's we were still exporting metals and fuels in quantity to the rest of the world. The war was the turning point. So vast were the inroads we made into our stock of metals and fuels that for the first time attention among experts focused on the adequacy of our remaining metal and fuel resources. A number of important studies appeared, examining our probable reserves and projecting future consumption demands. All of them warned that we were living high on resources capital which—no matter how large—was bound eventually to be exhausted.

Having just been entrusted with the task of developing nuclear power for naval ship propulsion, my attention was naturally drawn to these studies. One

of the most comprehensive of these was the Report of President Truman's Materials Policy Commission on Resources for Freedom, published in 1952. It was shocking to read that—almost overnight as it then seemed—we had changed from being a net exporter of metals and fuels to becoming a net importer. "There are today only two metals (magnesium and molybdenum)," the Commission wrote bluntly, "for which we are not partially dependent on foreign supplies." (Vol 1, p. 6) And further on, ". . . the remaining reserves of gas and oil that are known to exist in the United States are no match for the demands of the next 25 years." (p. 104)

There is a saying that the British Empire was acquired in a fit of absentmindedness. One might say this, too, of the shift in the 1940's from an economy still based largely on renewable resources, to one depending almost entirely on nonrenewable resources. In 1850—to give an example of the magnitude of this shift—fossil fuels supplied 5% of the world's energy; men and animals 94%. By 1950 the percentages had reversed themselves, 93% coming from coal, oil and natural gas, 1% from water power, and only 6% from the labor of men and animals. By 1970, the energy required to give the U. S. a gross national product of just over a trillion dollars was derived 95.9% from fossil fuels; 3.8% from water power and 3/10th of 1% from nuclear power.

Through nearly all his history on earth, man has lived almost entirely on renewable resources. These left him energy poor but fairly secure in the little he had. We are energy rich today but find ourselves in the unenviable

of the prodigal son who lives luxuriously on his inheritance but after a brief  
moment of glory is left with nothing to his name.

The shift has come about so suddenly that it is difficult for most Americans to change their outlook. Yet change it we must and quickly, for we are faced with the fact that while it took 600 millennia to create the earth's deposits of fossil fuels, we are using them up in a time span measured by decades. Half the coal ever mined has been taken out of the ground in the last three decades or so; oil production did not begin until 1900, but more than half the world's production has occurred in the last 15 years.

The excellent study entitled Resources and Man put out in 1969 by the National Academy of Sciences and the National Research Council concludes from the data available that "the steady rates of growth sustained during a period of several decades in each instance cannot be maintained for much longer periods of time." Its prediction that U. S. oil production will peak near the end of the 1960 decade proved accurate. Gas, as we now know will peak within a few years. The Fossil Fuel Age may well prove to have been one of the briefest major epochs in man's long history on earth.

We did not deliberately choose to build our economy on the uncertain foundation of resources that are finite and must therefore run out unless we devise complex technological alternatives. We did not take into consideration how long ago our present inventory of energy resources was formed--4.5 billion years ago in the case of uranium for example! When we discovered how to unlock Nature's treasure trove of fossil fuels we lost all the instincts for carefully husbanding Nature's bounty that we acquired during millennia of living frugally off renewable energy sources. Prudence would have dictated that we regard this as a one-time windfall, and not go on a wild spending spree before we had some assurance of finding man-made alternatives once the treasure had all been dug out. Instead, we took the continuance of fossil fuel energy for granted and did not exert ourselves sufficiently to prepare for the time when it will be gone.

Psychologically, most people have difficulty grasping that the earth is finite, and that therefore any part of it taken out and destroyed by usage—as are fossil fuels and uranium—diminishes by that amount what is left. The experts moreover have added to the confusion. Too many of them treat energy reserves not as the finite capital they are, but as something that can be increased by exploration and better technological utilization. To be sure, exploration is needed to find energy deposits, just as technological advance was needed for man to make use of these deposits. But it should be made clear in any public statement that the cause of our energy crisis is neither lack of exploration nor lack of technical research, but simply the fact that consumption proceeds at geometric progressions and supply is finite. Assertions that our resources are ample and we need merely to put more effort into exploring and improving our technical utilization of these resources blurs the real problem: fixed assets, limitless consumption demands.

I blame many of the experts, too, for failing to make clear to the public that Nature is impervious to human demands, to assertions that we have a "right" to live in the style to which we have become accustomed since the Fossil Fuel Age began some 30 years ago. There are no "rights" that government or anyone else can enforce against Nature. I blame many of the experts, too, for serving the public such absurd bromides as that the population explosion does not require us to change our family habits since surplus people can be settled on other planets in the solar system, or, lately, that we shall mine the moon for scarce resources. These are pipe dreams that should not be

peddled, for they prolong the time when the public will be ready to take stock of the consequences of current profligacy and accept the necessity of taking steps appropriate to the reality of our situation.

Secretary of the Interior Morton, during recent Congressional testimony, attempted to illustrate how unrealistic the public's position is with respect to a national energy policy. I would like to quote from Secretary Morton's testimony where he is discussing the public's conflicting demands:

"Give us an energy policy that is intelligent and concise and, above all, responsive to the interests of the Nation as a whole. Give us a policy that can apply to the short-term and to the longer term as well."

So far so good. This is a reasonable request. But then the public adds the following additional requirements:

"Give us an energy policy that will provide the consumer with the type of fuel he wants, in the amounts he needs, at the time he must have it, and at the lowest possible price. Assure us this energy will be from secure and reliable sources."

In the light of our supply position and the present state of technology in regard to alternative energy resources, the government of no industrial Nation, not even the government of this comparatively resources-rich Nation, could devise such a policy today. As if this were not enough, the public adds strings to tie the hands of the government:

"Don't drill offshore of my coastline, don't build any pipelines across my land, don't strip mine any coal, don't build any refineries or storage facilities in my area, abolish the oil import program, don't move oil in by tanker" --and so on.

The magnitude of the rise in consumption during the last few decades is also not easy for the public to visualize. Most people are not familiar with geometric progressions. This, I believe, is why the nature of the population explosion—evident to demographers years ago—remained incomprehensible to the general public for such a long time. Indeed, it is difficult to understand that a change in the normal family pattern from two to three children—given today's low death rates—should account for our own recent growth figures. Energy needs have doubled since 1950, and are projected to double again by 1985 and to triple by the end of the century. Even today, in spite of our brownouts, economists and other experts take great pride in our rising consumption pattern: indeed, they measure our success as a Nation not by our intellectual, artistic, or humanistic record but by per capita consumption of telephones, refrigerators, cars, etc. We still seem to pride ourselves on consuming one-third of the world's resources, even though we make up but 6% of the world's population.

To sum up, what needs to be generally understood is that Nature is completely unconcerned with man, his needs, or his desires. We are in a period of painful adjustment to a world which we can neither escape from nor control. I hope that, just as our space explorations have helped arouse general awareness that we have but this one small planet to live on, so perhaps the recent Congressional hearings on the energy crisis will help dramatize the energy problem which—to repeat—is simply finite resources vs consumption moving in geometric progression.

It is possible, of course, for man to manufacture certain energy sources such as uranium or oil artificially. However, this in itself requires the exploitation of other existing energy sources.

Too many overly sanguine statements have been made about the prospects of replacing fossil fuel energy with man-made alternatives and natural minerals with man-made substitutes. I mention the latter because invariably these substitutes require large amounts of energy to produce, again aggravating the energy problem—though this is rarely spelled out clearly. How well is it known that to produce the aluminum in a medium-sized cooker requires 72 kilowatt hours of electricity? Nuclear power is a man-made alternative, but unless practical fusion power (using deuterium) is developed—which it is not yet—even nuclear power has a finite capacity, depending as it does on finite uranium resources. It is true that if we could count for certain on developing hydrogen fusion before our fossil fuels are gone, the energy problem would be far less severe. However, comparatively little is known about this potential source of energy. To develop it will be the most difficult technological enterprise ever attempted by man. I will mention merely that extremely high temperatures will have to be produced. Moreover, we simply do not know what potential danger to man there may be in its use.

You will remember that when atomic power was first generated, extravagant claims were made by many that this would solve our energy problem.

There are other potential sources of energy not now being effectively used. Hydro power could be increased somewhat, though not much in the industrial nations—more so in the underdeveloped part of the world. Power could be derived from the wind, the earth's thermal energy, tidal energy, electrostatic energy, gravitational energy, and solar energy. Many difficult

problems would have to be solved before these sources could be effectively used. Whether or not these problems will be solved only time will tell. However, it should be recognized that some of these sources have but limited power output capability. For example, the energy available in lightning strokes, if it could be directly used to produce electrical power, would provide only .01% of the current requirements for electricity in the United States. If all of the volcanic heat of the earth could be captured, it would provide only one-tenth of the world's energy needs. Potential tidal energy sources are of the same magnitude as the volcanic heat sources.

As for solar energy on which many pin their hopes, the drawback here is its enormous cost.

It is estimated that if the sunlight falling on 14% of the western desert regions of the U. S. were efficiently collected, it could supply the additional power needed between now and 1990. But solar energy requires a tremendous amount of equipment. One scheme for obtaining the energy equivalent to a 1,000 megawatt generating plant—the size of modern generating plants—would require collecting systems covering more than a square mile and a capital cost of more than \$1.1 billion—four times the cost of a nuclear power plant. To this vague estimate must be added the cost of all the necessary development work.

A realistic assessment of our energy resources position would stress the fact that it is not important exactly when our fossil fuels give out. We may find better ways to extract oil and gas from coal, tar sands, shale; we may

discover more resources than we know of at present on the Continental Shelf surrounding our country or elsewhere in the sea. What is important is to comprehend that some day the fossil fuels will be gone; that renewable energy sources are unlikely to provide more than a small percentage of our needs; that even atomic energy, since it requires uranium, is finite; and that we cannot be certain that some man-made alternative as yet undeveloped will arrive in time—or ever—to supply our energy needs. We share this situation with all the industrial nations; in fact, we are better off than the rest of them. We still have very large coal deposits, most of them do not. Something like 70% of the world's oil reserves are in the Middle East, which will make access to these reserves the biggest international problem before long.

It is interesting to note that in all the resources studies of the 1940's and 50's, the possibility of not being able to fill in our energy gap with imports was never considered. We now know that imports are no panacea. The costs of building tankers and port facilities if gas were to be imported from abroad are just one part of the transportation problem. Our present balance of payments problems point up the financial difficulties. The unexpected rise in consumer demands in Europe and Japan foreshadow the competitive bidding for Near East oil that we must expect. The status of energy resources in this country—or in any significant world power—is more than just a domestic concern. Future energy demands in the technologically advanced nations, and their efforts to meet that demand, will have a considerable impact on international relations. For example, it is not inconceivable that the major powers—the

large users of energy resources—might come to a "sphere of influence" arrangement—formal or informal—vis-a-vis the net producing countries.

Russia, it would seem, has a keener awareness of the fact that access to energy resources is becoming the primary national interest for all industrial countries. Compare her policy of courting the Arab oil countries with our policy of continuing to export enriched uranium for the sake of improving our balance of payments position. Russia's new naval strength in the Mediterranean poses a very real threat that she might succeed in controlling the Middle East and its oil.

Pressures are exerted on the government to cut down armament expenditures and use the money to solve domestic problems. The Navy is thought of as merely an instrument to wage war—entirely adequate if it is strong enough to act as a preventive force against nuclear aggression. But for the United States, which is a continental island, the Navy's function, besides acting as a primary means to deter nuclear war, is to prevent forcible interference with the flow of international trade to and from our shores. For this purpose it must at least be the equal of any other navy.

No sensible person can look at war as anything but a disaster to be avoided if at all possible. But if a truly vital national interest were jeopardized, I believe most nations would still fight to protect it, provided always there were any chance

... that they could win. I believe that most of those who totally reject all war are influenced by the fact that for hundreds of years European wars have been fought, not to preserve vital national interests, but for religious, dynastic and imperial objectives—objectives which are rejected today by the free peoples of the world. Our own wars during the 19th century—with Britian, Mexico and Spain—were also fought for objectives we would no longer seek to obtain by force. But history would indicate that any major industrial power, faced with exhaustion of its energy supplies and feeling itself strong enough to win would, I think, risk war to keep its economy functioning.

Curiously enough, the wars we may not be able to avoid in future are likely to be the kind of major wars fought in antiquity. Homer sang of the Judgment of Paris, the abduction of the beautiful Helen, and the thousand ships that were launched to destroy Troy and bring Helen back to her husband. But historians are well aware that the underlying motivation of the Greek attack on Troy was economic. Troy stood athwart the trade routes between Greece and the Black Sea and was thus able to keep vital imports from reaching Greece, and lucrative exports from reaching their Black Sea destinations. To control these routes was of overwhelming importance to the Greek economy. Hence the Trojan War—the most cataclysmic event of the Maecenean epoch.

Or take the Punic Wars. Disregarding the eloquent rhetoric of Cato and the noble sentiments voiced by other Roman apologists, historians agree that the real cause of the war was Rome's determination to break Carthage's hegemony over Spain and the rich grain producing regions of North Africa. Unhampered grain imports were as vital a national interest to Republican Rome as adequate energy supplies are to today's industrial Nations.

I bring up this point only to emphasize the importance of facing the truth about the energy crisis and taking steps to insure that our Nation has the means to protect its sources of energy. All experts agree that in a few years we will be importing half our oil—importing 12 to 18 million barrels a day. If we do not have a Navy adequate to insure the safety of our oil sources and the means of transportation, we could risk our industrial capability.

The need to conserve energy resources in this country is clear, but how can it be done? The subject of energy utilization reminds me of the Möbius strip, a simple geometric figure found in topology, a specialized field of mathematics. This figure has no end and only one side. This is also true of the increase in demand for energy: it apparently has no end and there is only one side to its justification: "It's good for you."

Specifically, I would suggest the following:

- a. The American people should recognize the vital importance of the energy resources we now possess. Action should be taken at once to discontinue exporting these resources. This action should not be limited to the more obvious sources of energy such as coal or enriched uranium, but should also be directed toward services provided by this country which require large energy inputs. For example, providing uranium enrichment services to foreign countries should be prohibited. Ten thousand kw hours of electricity are required to enrich to 3% one kilogram of uranium as presently used in water cooled reactors. In other words, if the U. S. provides enrichment services for a large foreign water cooled reactor this requires 600 million kw hours of electrical energy. This means that we are exporting about 2,000 million kw hours of our energy resources for each reactor core we export. In return, we receive money.

b. Obviously, population expansion is an important consideration in the growth of demand for energy. While I recognize it is an unpopular subject, serious consideration must be given to eliminating tax deductions for dependent children beyond some set number, perhaps three. Possibly a tax penalty should be added for any children in a family after the first four.

c. The price structure used by utilities is so structured as to encourage the use of energy. The cost per unit of energy decreases as the quantity used increases. This creates exactly the wrong incentive; it encourages energy consumption rather than its conservation. A minimum level of use should be established. Any energy use above the minimum should be more expensive, and an upper ceiling of allowable use should be established for commercial and noncommercial uses.

d. Inefficient uses of energy should be discouraged. My office is located in a new building which is heated, cooled, and lighted by electricity. It is not possible to open the windows, and the building arrangement is such that artificial lighting is required, day and night. Such wasteful applications of energy should be prohibited. Take space heating by electricity. The maximum total system efficiency for electrical heating is less than 50%, but there is no theoretical limit on system efficiency for obtaining heat directly from the combustion of fuel. Hence, the use of electricity for heating should not be permitted unless the situation uniquely requires it.

Artificial lighting uses about 6% of the country's total energy, or about 24% of its electricity. The efficiency of converting electricity to light is about 4%. This indicates the incentive to utilize natural light wherever possible.

Furthermore, greater effort should be made to utilize the waste heat generated from energy conversion plants. We cannot afford to continue throwing away 60% or more of our energy resources when converting them to electricity. I recognize that the present siting requirements for nuclear power plants are inconsistent with this suggestion, but some intermediate storage media should be developed—to use like a battery—so as not to waste this heat.

e. Motor fuel represents the other large consumer of energy in the United States. The demand for high-powered, heavy cars represents not only a waste in the energy required to propel the vehicle but also a waste in our nonrenewable mineral resources for their construction and maintenance. Undoubtedly, the public will complain if the government takes action which restricts their choice in automobile styles. Yet, this is certainly a lesser evil than to have these more powerful vehicles and no fuel to run them. I suggest that automobiles be taxed by weight and engine displacement and that upper limits be placed on allowable limits for them.

f. Action should be taken to prohibit the deduction for tax purposes of any expense incurred by utilities as a result of their efforts to expand their market. Also such costs should not be passed on to the consumer, but should come from profits; this would include advertising and other promotional expenses, such as installation allowances, etc. The growth of energy requirements in this country is far too great already; it needs no artificial encouragement.

Another important consideration is that protection must be provided against the development of unnecessary energy converters. The profit a utility is allowed is related to its capital investment. This provides an incentive for a utility to

and its capital base in order to obtain higher profits. It also means there is an incentive to expand its market, whether or not there is a real need.

g. Other large nonproductive uses of energy such as air conditioning must also be controlled. These controls should seek to minimize use and also to achieve greater efficiency. Taxes relating to energy consumption would achieve this goal. For fairness, an upper limit of allowable energy should also be established; otherwise only the poor will feel the effects of such a control.

h. Unpopular as this will be, other controls are also necessary: prohibit air conditioning except where required for industrial or medical purposes. Currently about 16% of the increase in electrical generating capacity is used to meet air conditioning requirements. High excise taxes should be placed on luxuries which require high energy inputs either to manufacture or use. For example, the second car, clothes driers, etc.

The purpose of the proposed actions is to gain time to find practical solutions for the overall energy problem. The minor inconveniences and necessary changes in our habits these would entail pale into insignificance compared to the distress, dislocations and general misery that would follow a rapid loss of our major energy resources. The brownouts we are told to expect in the near future will give us but a faint inkling of what such a loss would mean.

I am aware that our tendency in the past has been to let problems alone until a major crisis is already well developed. But in the world of today there is less and less chance that what is casual will be adequate.

The fact that living off energy capital has lasted for so short a time should make it not too difficult to adjust ourselves to the realities of the supply and demand situation. After all, life in America was very pleasant before we had automobiles, jet planes and electrified homes.

What I said in my 1957 speech still seems to me to sum up correctly where we stand:

"High energy consumption has always been a prerequisite of political power. The tendency is for political power to be concentrated in an ever smaller number of countries. Ultimately, the nation which controls the largest energy resources will become dominant. If we give thought to the problem of energy resources, if we act wisely and in time to conserve what we have and prepare well for necessary future changes, we shall insure this dominant position for our own country."