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ENERGY RESOURCES

Mr. Samuel G. Lasky

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Reviewed by Col E. J. Ingmire, USA on 6 December 1963.

INDUSTRIAL COLLEGE OF THE ARMED FORCES

WASHINGTON, D. C.

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Energy Resources

3 December 1963

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Reviewed by: Col E. J. Ingmire, USA Date: 6 December 1963.

Reporter: Albert C. Helder

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COLONEL BLACKWELL: Gentlemen, we are fortunate to have today as our speaker, Mr. Samuel G. Lasky, the Assistant Director of the Office of Coal Research in the Department of Interior. He is going to talk to us on the subject, "Energy Resources." As is indicated in his biography he has had a wealth of experience in energy resources, both from his regular assignments as well as the many other assignments he has had. He is also distinguished by the fact that he's an ICAF graduate.

Mr. Lasky, it's a pleasure to welcome you back to ICAF.

MR. LASKEY: Thank you, Colonel Blackwell.

Admiral Rose; General Stoughton:

Probably by now in your reading assignment you've heard that the length of an introduction is inverse to the speaker. Do you remember that one? Well, having been a student here and knowing something about the mission of the college, and something about the dedication of the faculty, I can say with complete sincerity that it is an honor to be up here. The first time that I talked to the college was 11 years ago. At that time I appeared here as an expert on non-ferrous metals. And now today I show up here in the guise of an expert on energy. There must be something in Shakespeare like, "What kind of stuff are these experts made of?"

Part of my admiration and respect for the college stems from the fact that as I've watched this course over the years it has seemed to me always that the curriculum has been one step ahead of history. And

I think this lecture today is further evidence of that. Because, the scope given to me for my lecture reads, "First a survey of world supplies of coal, oil, natural gas and hydro-power; the significance of nuclear energy; the availability of energy supplied to the United States and the possible need to import energy into the United States; and finally, an appraisal of the economic factors and technologic progress."

Well, this covers the waterfront. Moreover, it's the only lecture, I am told, that you're going to have on energy resources, or energy at all. Not so long ago, you remember, there was a worldwide concern that the world was going to run out of energy pretty soon unless a crash program was started - an international crash program - to develop atomic energy. Here and there we still hear those kinds of fear expressed. Do you remember the report from the National Academy of Science, only a year ago, on energy resources? It contained the recommendation that something be done about population growth and be done in a hurry because the world was running out of energy resources.

Only last October, at a conference in Paris, I heard a high official of the Coal and Steel Community, and men of equivalent rank around the conference table with us, make the statement that Europe was going to run short of oil; that oil was going to dry up in Europe by 1980. And yet, here your faculty, in making up its program in the summer of 1963, relegates the subject of resources to one single lecture in the curriculum. And I think they're quite right in that judgment.

The energy resource problem is not one of preparing for and adjusting to scarcity; it's a problem of how to decide best in an economic

sense, to allocate abundant resources; allocation of one energy resource with respect to another, and allocation of these resources geographically.

Now, my assignment begins with reference to world supply. Supply is never an independent action; supply is reaction to demand. And so, if you don't mind, I'll spend a few minutes talking about demand first. Colonel Blackwell told me that part of your reading assignment was an article by Sam Shore in the September issue of Scientific American. At the mast-head of that particular article there appears this summation by Shore:

"The supply of fuel appears to be almost inexhaustible. A high level of fuel consumption is not a prerequisite of development, but a result of it." Yet, the October issue of Challenge Magazine, which is a magazine of economic affairs, published by New York University, has in it a review of the National Fuel and Energy Study by Professor William Peterson, who is Professor of Economics at New York University. Professor Peterson says, "The Lasky report confirms the correlation between United States' economic growth and energy consumption. Clearly, economic growth requires an abundance of dependable energy and of inexpensive energy."

These are two opinions by two eminent economists, and yet 180 degrees apart; one of them, that economic growth requires cheap energy and that consequently the problem facing mankind is to provide it in abundance and cheaply; and the other opinion is that energy is not really the prime mover; that there is plenty of it available and it will

be supplied as needed. I side with Mr. Shore, despite all the nice things that Mr. Peterson said about the Lasky report.

Now, there are two schools of thought about how you measure the future. In the present case one of them would like to see the energy demand of every country broken down into its separate parts, with each part projected off to some point in the future, and then adding together all these little sums to give you a national total, and then adding the several national totals together to give you a world total. I disagree with this school because it piles one assumption on top of another assumption, indefinitely.

An example of how careful one has to be in this kind of projection is given by the projections of energy for the United States; 11 different projections by 11 different persons of equal competence and equal reputation; and 11 different answers; the top one just about twice the size of the smallest estimate. I'm reminded here of the man walking down the street and in front of him he noticed a drunk staggering and muttering. He stopped every person he came to and asked the time of day. He'd hear the time of day, stagger along, shaking his head until he came to another person, and then he'd ask the same question. Finally, the man behind him got tired of watching the performance, so he walked up to him, touched him on the shoulder and said, "Friend, what's this business of asking everybody the time of day?" "Oh my," said the drunk, "all the time different answers."

The other school of thought about making estimates for the future is that if there's a long-enough history of the past, you can then make

a growth projection of trend and do it satisfactorily. The only assumption here, you see, is that the past is a guidepost to the future, the present day simply being one mile-post along the entire course. Well, unfortunately, no analysis has been made in the detailed way that the first school would like to have, and unfortunately there is not a long-enough historical record to satisfy the second school of thought.

Sam Shore accepts the figure made by Milton Searl of the AEC, which calls for a consumption five times as big in the Year 2,000, as in the Year 1960; that is, 22 billion metric tons of coal equivalent as against the present 4¼ billion tons. But for our purposes today for your lecture, and for your purposes as you pursue the subject further here at the college - and perhaps even in later assignments - we can accept the AEC estimate, the one by Milton Searl - if only for the reason that it is so high. In Sam Shore's words, "It makes a good measuring stick against which to test the projections of demand," or, to project the adequacy of the resources.

Well, now to come down specifically to supply. Sam Shore does point out that the estimates of supply can be almost as filmy and gossamer-like - insubstantial - as are the projections of future demands. No one can see into the earth, of course, but we do know considerable, both about the geology of coal, oil and natural gas, and about the geology of the regions in which these materials occur. We can say categorically that some regions are highly favorable for the presence of one or the other of these, or for all, even though none may yet have been discovered there. And with equal certainty - maybe even more certainty -

we can say that some areas of the earth can't contain any substantial quantities at all. And on the basis of that scientific knowledge, the discipline by past experience, geologists can make reasonable estimates of the volumes and tonnages still remaining in the ground to be discovered. But history might prove them to be quite wide of the mark. If so, I'm quite sure that they will be on the low side, because it's in the nature of geologists and engineers to be conservative.

Now, in the art of resource estimation the first step is an estimate of working inventory, or inventory investment. And may I suggest to you at this point that you are the first persons to hear this term "inventory investment." I'm trying to put across an idea. At any rate, the first step is an estimate of what we call a "working inventory," the quantities known with investment certainty that can be produced at a profit under the conditions of cost and sales existing at the time of the estimate. These are what are technically known as the "reserves." And using this bench-mark it becomes reasonably possible to estimate what added quantities can be produced if the producer can cut his cost of if he can sell his product at a higher price; also, what added quantities remain yet to be discovered; what I'd like to call respectively, in order to maintain the analogy, "inventory enroute," and "inventory on order."

For petroleum the proved world reserves are estimated at 280 billion barrels. But please note that the information on areas outside the United States and Canada is disorganized, sketchy, and in many instances based on very loose criteria. So, even regarding our proved inventory

for oil, the working inventory of proved reserves, the available information indicates only what parts of the ball park we are playing in so to speak. Or, let's say, what part of the infield we're playing in. So that, we may say that the world knows of some 300 billion barrels of oil that it can produce under today's conditions of operation; under today's conditions of cost and inventory.

With respect to the reserves enroute and on order, here we really get into speculation and into judgment. We're no longer in the infield here; the figures may be way out in left field, or they might be close in to short stop. For myself, I think they're much closer on in to short stop. That is the estimates are nowhere nearly as good as the estimates of proved reserves, but certainly they are far from being guesses.

The latest estimate of oil that ultimately will be recoverable from the ground, is about 4 trillion barrels. This is also the highest estimate. I'm not an expert on world oil resources, but I'd venture the opinion that this figure will turn out to be much better than the lower estimate of 1¼ trillion.

As for gas, the proved reserves total 3,000 trillion cubic feet. The amount that is estimated currently to be ultimately recoverable is roughly about twice that. The figures, like the substance itself, are much more insubstantial than those for oil because there being no market for the stuff outside the United States, there has never been any real incentive to estimate how much there may be.

Now, one more caveat about estimates of oil and gas, before I pass

on to coal. All such estimates as these are transitory. Continuing discoveries of oil and gas continue to push the figures upward, and there is substantial solid and professional opinion that the quantities ultimately recoverable may be, oh, some ten times as much as what we presently estimate. And before I offer you any figures on coal I want to clarify one muddy point for you that I'm pretty sure has been bothering you. I'm certain it has been bothering you because everywhere I go I run across it.

I'm referring to estimates of coal reserves. Until our group on the fuels and energy study began its own inquiry and delved into this matter, reserves of coal were reported as coal in beds of a minimum specified thickness and a maximum depth down below the surface. Now, these estimates are quite all right within the limits of the definition assigned them. But the definition doesn't have the very rigid, practical and economic limitations that the definitions for proved reserves of oil and gas have. And it's not proper; it's down-right misleading, and I think sometimes, deliberately so, to compare the figures for coal with those for oil and gas, and then to say, "Look, the reserves of coal are X times as much as are the reserves of oil and gas.

Under the definition used for oil and gas the proved reserves are those quantities that can be produced under today's conditions of cost, price and investment, and above all, that are known with enough certainty to justify additional investment to get them out of the ground. The proved coal reserves of the United States total some 20 billion tons of coal. Now, this is the figure that came out of the fuels and energy

study. Being the first such estimate ever made, and there being incomplete response to our inquiries, it doubtless has a large margin of error. But in any event, the proved reserves of coal of the United States are not 100 billion tons of coal; not 50 billion tons of coal; but something like 20 billion tons of coal.

At the recent coal symposium at the University of Kentucky at Lexington several months ago, a man came up to me and said, "Mr. Lasky, that estimate of yours was 20 billion tons of coal reserves in the United States has to be dreadfully wrong. There's more than that," he said, "along the right-of-way of the Northern Pacific Railroad." "Well, that's fine," I said, "where do you sell the stuff." "Oh, we don't sell it and we don't mine it; it costs more to mine it than we can sell it for." Well, I replied, "Then, by definition the stuff is not a reserve."

An economist said to me recently, "Well, what difference does all this make so long as we have the stuff in the ground?" Now, to me that's a queer question to come from a man whose profession is grounded on precise definitions. It makes a difference because government policies, commercial decisions - money - are spent on the figures that are used.

On the basis of which I speak, then, I judge that the published figures for world coal reserves should be discounted to something like 40 billion metric tons. The total quantity estimated to be ultimately recoverable, making due allowance for the amount that has to be left in the ground,totals some 1.2 quadrillion metric tons.

Placed on a common footing, these figures for oil, gas and coal, add up to a proved reserve or inventory of near-term availability, of

200 billion metric tons of coal equivalent; and to 2,200 billion tons of coal equivalent ultimately recoverable out of the ground. And if to this total we add the potential of tar sands and of oil shale the figure approaches, let's say, some 3 trillion metric tons. Now, there is no point in going through the arithmetic exercise comparing these figures of supply with the projected figures of demand. I see some of you gentlemen taking notes on the figures.

By now you've made up your own minds as to what these figures mean. If you're inherently skeptical; if you're doubting Thomases, you most surely have said to yourselves, "These figures are pretty guessy and the situation can't be anywhere near as good as some people want us to believe." On the other hand, if you're just naturally optimistic you've said to yourselves, "Now, these figures are pretty guessy; they sure are conservative and certainly there is nothing to worry about."

But however you interpret these figures, surely the coal, oil and gas resources of the world add up into a long and substantial future supply. And, in any event, just hold onto your judgment for a few minutes. And again in any event, whichever way you do view these figures, let me point out that projections of future use are usually based on projections of population.

The demographers, as you know, are no more skilled in their profession than are the resource experts in theirs. And sometimes when sleep comes slowly to me I imagine a demographer somewhere in the same plight, worrying about this problem, pondering on how he might prove his projections. And I imagine him saying to himself, "This is a pretty

tough business I'm engaged in. But those resource boys, they know their stuff. So, why don't I just take their figures of future projection of energy consumption and divide by their estimate of per capita use, and lo, I've now got a good projection of future population growth." You laugh, but I'm half serious about this.

Another point in this regard is that projections of future energy demands usually assume a per capita consumption that is the equal to that used in the United States. The trouble with this assumption is that it overlooks the fact that energy use patterns depend upon the culture of a country, upon its geographic features, and that it differs widely from country to country. Now, I acknowledge that if one wants to take this approach of population and per capita consumption he has no other alternative but to make this kind of assumption. But, in doing so he ought to be aware of betraying himself into forgetting all the maybes, in his answer.

Now, nature has been quite kind to man in the way in which she has distributed the fossil fuels around the world. Apart from the grand totals of coal, oil and natural gas that I have quoted to you, one or the other of these is present in every region of the world. Almost everywhere, supplies of one or the other are reasonably available to any nation that passes the wood-burning stage in its economy. The problem, then, becomes not one of supply but of deciding which supply to use. I'll take this point up a little more fully, later.

Up to now, and may I suggest that some of you who are geologically inclined take a good hard look at that map and maybe you can bug me with

a question later - up to now I have presented energy demand as being met solely by the fossil fuels, ignoring hydro-power. The growth in energy demand will, of course, be met largely by the fossil fuels. But there will be a substantial base of hydro-power, which, because it is renewable, can be counted on as being permanent. The extent to which the hydro-power has been developed in individual countries, varies, and varies quite widely. Some countries like Sweden are completely developed; others have potential hydro-power, but having no need for it up to now are undeveloped.

In 1958, which is the latest year for which I have dependable figures close at hand, there were no installations at all in 20 of the countries having potential hydro-power. For example, 99 8/10% of the hydro-power for Africa is undeveloped. In contrast, nearly 30% of the hydro-power of Europe is developed. For the full Free World the total hydro potential amounts to 10,200 billion kilowatt hours, which is equivalent, roughly, to 3 billion metric tons of coal. And about 95% of this is still undeveloped.

Secretary Udall's trip to Russia, of about a year ago, brought out the information that Russia's hydro potential is equal to just about 1/5 of the hydro potential of the total Free World. And only 3% of it is developed. About 8/10 is in Siberia where there are seven great rivers that traverse the full width of the country from the China-Mongolian border on up to the Arctic Ocean.

I have no figures on China or other parts of the Communist Bloc, but we can say that the total hydro potential of the world - only 5%

or even less - is equivalent to perhaps 4 billion metric tons of coal equivalent. This is not very much in comparison to the nearly 3 billion tons of coal equivalent for the fossil fuels, but still that's a respectable quantity. And, as I say, it is inexhaustible.

No discussion of energy, of course, is complete without some consideration of atomic energy. And my instructions specifically make reference to the nuclear fuels. The most up-to-date figures are those turned in by the AEC to the President in June of 1962. According to them, these are the figures for the United States: 175,000 tons of U-308 mineable at a price of $8 a pound, and additional tonnages ranging up to perhaps as much as 5 million tons at $50 a pound. Here, incidentally, we have a good example of the proper application of the definitions of the concept of reserves. I wish we had some equivalent figures for coal, oil and gas. It would make your and my jobs easier.

For the total Free World the reserves of uranium are estimated at 1,100,000 tons of U-308 at $10 a pound, ranging through various depths on up to 10 million tons of U-308 at $40 a pound. Figures have been published on the uranium reserves of the communist countries, but they are in such terms that I don't know how to interpret them. The amount of energy derivable from this raw material depends, of course, upon the efficiency of the reactors - and by now you know more about that than I do. The more than 1 million tons of U-308 available at $10 a pound could be the equivalent of from 65 billion tons of coal to more than 3 trillion tons. The lower figure is the equivalent of present proved reserves of oil in the whole Free World.

The upper figure is half as much, again, as all the coal, oil and gas now estimated to be ultimately recoverable. At the higher prices, I'll let you do your own arithmetic. These figures refer to uranium reserves, and because of their magnitude I never bothered even to read the figures on thorium reserves. When, and how, and at what rate these resources are going to be put to work, is a matter of economics and of national policy.

Here and there, up to now, I have referred to the figures for the United States, and now let me address myself specifically to this part of the assignment. Part of it, you remember, was the availability of energy resources to the United States and the possible necessity for imports. Because, the United States does import fuels. The question is whether we import fuels because, like Japan, we must because we don't have enough at home, or whether we do it because for a variety of reasons we just want to do it.

One of the findings of the Fuels and Energy Study was that the United States can be self-sustaining if it has to be, or even if it wants to be. The nation's resource base is quite strong enough to support the demands that we may reasonably expect to be put upon it. The 20 billion tons of coal that I mentioned that is even now commercially available, are great enough, of themselves, to support comfortably for a long while any demands that one may realistically contemplate. And, while this coal is being mined additional coal naturally gets developed to create a continuing capability.

There is plenty of oil in the ground, even though one or more steps

may have to be taken to realize it. The rate of exploration, for example, may have to be stepped up or we may have to place more attention on secondary recovery. But so far as the resource base itself is concerned, in any event any shortage of oil could be made up by coal if the demand is for electric power generation, or be made up by oil derived from coal or derived from oil shale if the demand is for liquid fuel.

For gas the domestic supply is quite safely well above projected requirements. In addition to the resource base, of course, there has to be a physical capacity to produce; the capacity to transport; and the necessary investment capital. And both capacity and labor at present are well above needs.

As to transportation, one unexpected finding of the fuels and energy study was that the concern over the number of cars available to transport coal was exaggerated. The shortages of hopper cars that developed as a result of management decision as to the rate and conditions under which they were going to repair the cars was studied, and a good economic case could be made for other conditions of repair that will not lead to a shortage. If, for some reason, production or transportation capacity should fall short, the industries involved have a financial capability to take care of the matter, and not only that, they have the capability to take care of it out of their own resources.

The railroad and coal company officials, I'm sure, would tell you something different if you had them up here, but what I'm reporting to you up here is one of the findings of the Fuels and Energy Study. But

the fact does remain that the United States does import energy. It imports this energy because here and there the imported energy is cheaper than the equivalent domestic supply. Were it not for national policies that limit the import of oil we would import even still more oil. The energy may be cheaper here for strictly economic reasons, or because of subsidies by the governments of foreign producers, but we import it because it is cheaper at the point of use than is the domestic counterpart.

Thus, the United States, with our tremendous reserves of resources of coal, we still import a little coal from Canada on into Maine and New Hampshire. We import a little electricity from Canada and from Mexico, and a little gas from both Canada and Mexico. The big United States imports, of course, are of oil, both crude and refined products; about 6/10 of it coming from the Western Hemisphere, mainly from Venezuela, and the rest from the Middle East; secondarily from the Far East; and more recently from North Africa.

Residual fuel oil constitutes about 8/10 of all the refined products that are imported. And this is an East Coast matter. The West Coast is an energy surplus area. On the East Coast almost all that comes in/is from Venezuela and the Netherlands West Indies. The imports have been rising quite steadily for some time, filling up the gap between a slightly rising demand on the East Coast and a somewhat more sharply declining supply from the domestic refineries. The domestic refineries find it more profitable to make the higher quality products like gasoline and distillate, so that, little by little they have a

lesser and lesser quantity of residual fuel oil to sell.

You will have recognized in these passing references to oil import policies that national policy as well as economic matters influences the use and shapes the details of importation. The policies of foreign governments in allowing the exportation, or in subsidizing their production, also are at work. Some persons believe that here at home in the United States, policy is much more effective in its economics even here in the United States. And that is surely true elsewhere in the world. Western Europe is willing to pay a big fuel bill for the sake of protecting its domestic coal industries; so are Canada and Japan. Coal mine employment is a top problem in almost every coal-producing region in the world; political and sociological. And such problems as this were at the root of the creation of the Coal and Steel Community.

Perhaps you'll remember that Article III of the Coal and Steel Community instructs the community to promote the improvement of the living and working conditions of the labor force in each of the industries. The high authority for the community controls the price of coal and the conditions of operation. It levies charges on production and it grants subsidies. In the United Kingdom and France a government agency is the only authorized importer of coal. And I'm told that in Germany communism becomes an additional problem; that communism is popular among the coal miners of the Ruhr.

Coupled with these matters is the matter of a secure source of supply. Because, fully 1/4 of Western Europe's energy supply is in the

form of Middle East oil. You remember the Suez crisis, of course, and now the problem of supply is aggravated and intensified, added to by the exports of oil from Europe. When Governor Herter was here a month or so ago you remember he mentioned the difficulty of getting a common agricultural policy for the Common Market. And there is even more difficulty in getting a Common Energy Market developed.

The Treaty of Rome specifically says that there shall be a common agricultural policy, but it says nothing about a common energy policy. And not until a common energy policy is developed will there be any such thing as a common trade policy, because energy policy is wrapped around imports of oil and of ooal. Policy matters operate at the consumer end also, but at the consumer end the control on wholesale and retail prices is much more widespread on petroleum than it is on coal, either directly or through taxation. Almost all the countries of Latin America exert some kind of price control.

In a number of countries oil production is a government monopoly, and in some other countries the governments have a financial interest in the operations. So that, policy gets inserted into supply almost at the very outset.

By now in the course of your studies you've heard of OPEC, the Organization of Petroleum Exporting Countries, consisting of the Middle East producers. Venezuela originally, and now some more, banded together for common action in prying a higher share of the profits out of the producing companies, a maneuver that certainly has considerable leverage on petroleum economics.

You are more up-to-date on communist philosophy than I am, but let me quote to you from a speech by Chairman Khrushchev. This was a speech in November 1959 at the All-Union Conference of Power Industry Construction. Mr. Khrushchev explained the move away from reliance on hydropower and more toward reliance on steam power. "When you tell me," he said, "that you can produce a kilowatt of power cheaper from a hydro station, but you will get it five years later than from its thermal counter-part, now that's something to think about, because we can lose five years in our competition with the Capitalist countries."

Now, I want to close my monologue with some discussion of technology. And let me introduce this element of technology by one further economic reference. If energy were much cheaper, with the demand for it increased so much, even those who are as sanguine as I, would conceive of some possible shortage; or, if it were much dearer, would that reduce the demand within the limits of reasonable supply? One way to approach this matter is to ask how much the use of energy would grow if it were free, if it didn't cost anything - what the economists call a "free good." The cost of energy is said to be let's say a minor part of the final cost of anything; that it doesn't control any decision whether to use the energy or not to use the energy.

Cost controls the use of one energy with respect to another, but not the total use of it. On a national basis the cost of energy surely isn't a burden. Manufacturers, for example, spend only 1½% of their total income on the purchase of energy. In all manufacturing in the United States, only ½ of 1% to no more than 3% or 4% of the cost of energy

of that small fraction of the total cost of all other things that are being purchased. The other point of view is the one expressed by Professor Peterson; that production in a modern economy is dependent on low-cost energy. Not being an economist I can venture the opinion that each of these points of view is correct so long as one avoids the extremes. I don't believe that any moderate change in the cost of energy will ever influence its total use.

Yet, if it were much cheaper, this surely would constitute an invitation to greater investment of capital in those directions that use the energy, with a consequent increase in productivity. And because there is a correlation between productivity and capital investment and national welfare, if the circumstances were widespread enough, energy could accentuate a nation's economic growth.

But the same argument can be applied in the opposite direction. If the cost of energy became greater there would be a pressure on management to invest more capital on technology in order to overcome the cost. This is precisely what happened with the coal industry in the United States when the cost of energy in the form of labor went up. And that is what has happened in South Africa in the building of the Saiso Plant to make gasoline out of coal.

Now, while all this is true, there are still some areas in which the cost of energy is a substantial part of the total; steel-making, all smelting, chemical manufacture, chemical production, cement, aluminum; and where such industries are major producers of wealth in a country, any considerable reduction in the cost of energy can have an effect and

materially increase that nation's competitive position, its balance of payments, and then its total use of energy. Should there be any savings in the use of energy, that money would, of course, be spent on something else. And it would be the equivalent of that much extra capital infused into the economy. The energy bill of the United States is about $25 billion a year, and if we were to achieve a saving of 10% in the cost of energy this would be another $2½ billion infused into the economy.

Many economists, as you know, feel that a small reduction in tax rates, or a small reduction in interest rates could be a great stimulant for the economy. And assuming they are right in that view, we can get some perspective on this by observing that the proposed income tax legislation will call for a reduction of some $11 billion in income taxes. Bank credit totals about $315 billion. So, a reduction of one percentage point in the interest rates would then be a little more than $3 billion into the economy.

But the most profound effect of technology lies in the fact that it works two ways; it works both on demand and on supply. There is no question that petroleum geologists and geophysicists are going to be able to find oil and gas pools much more cheaply. There is no question that the oil industry is going to be able to drill holes deeper and cheaper; that they'll be able to get oil out of the ground cheaper than they do now, and that they'll be able to transport it to market more cheaply than they do now. But no matter what improvements might happen in this direction, the delivered cost of this kind of energy is going to seem pretty high to the users in the coal field.

And so, the pressure to convert coal to liquid and gaseous fuels is going to continue in order to try to get them more cheaply. While the cost of energy may not control its use or non-use, a little saving here and there can make all the difference between profit and loss to a particular user. And it is this kind of thing in our economy that is the prime stimulant for technology.

You and I, were we living in the coal fields, would someday - and perhaps not too long from now - be using gasoline in our automobiles, which was made out of coal, or be using gas in our kitchens, which was made out of coal. And when similar local economic circumstances dictate it, the same sort of thing will happen with oil shale. These efforts are going on; they're going to continue going on, despite all the heavy investment in atomic energy research. They will go on because the technologic progress that I talk about is a day-to-day economic and commercial requirement, whereas economic nuclear energy remains something for the speculative future.

Nuclear energy is a fact today, but it is local and it is subsidized. No one has any good idea when nuclear energy will be a common day-to-day part of the energy economy or the energy complex. You will notice that I make a distinction between having a good idea and making projections about it.

Only six weeks ago the OECD in Europe authorized a task group headed by J. A. Jukes of Great Britain, of whom you may have heard, to analyze the future of atomic energy in the absence of subsidy. One direction of subsidy, surely, will be in the direction of the disposal of the atomic

wastes, which is a political and technical as well as an economic problem. Speaking as a geologist I don't dispose of this matter as easily and blithely as does the Atomic Energy Commission.

Cheaper energy, if it is cheap enough, can drastically change the technology of use even though it doesn't change the totality of it. And this can have a ripple effect whose ultimate influence is impossible to predict beyond the first one, two, or maybe three ripples. Extremely low-cost energy would lead to new ways of finding it, getting it, and the manufacture of new techniques and new products would be introduced. For example, with the cost of power cut drastically the price of aluminum and its competitive relations with copper, zinc, lead and steel would be drastically changed; and with them, the inter-fingering use patterns of all of these metals. And then, changes in these use patterns would induce changes in design, in manufacture, and in construction. The refrigerator in your kitchen wouldn't occupy that little spot it occupies now; it would be something either larger or smaller.

Steel would cost only a fraction of what it does now, and the user could then invent and design tools that he doesn't even dare contemplate now. Now, there is one technologic change that titillates me particularly. It doesn't have the glamor of atomic energy, but it can have a truly extensive influence. And I refer to "extra-high voltage transmission." In the United States, Scandinavia, Russia, and parts of Europe and elsewhere the various electric transmission systems or grids are inter-connected in varying degree, so that the demand for electricity at one place may be met by electricity generated at some place else and

perhaps at a considerable distance away.

As it becomes possible to move power at higher voltages, then an even greater inter-connection becomes possible. And fruition of long-distance DC transmission makes doubly possible the economic transmission of power at the ultra-high voltages. Russia, which has been moving power at 400,000 to 500,000 volts against our 325,000, only last October energized an 800,000 volt DC line - a test line - from Volgagrad, almost 300 miles down to the Donetz Basin. Here in the United States Congress has authorized a five-mile test line, 1,100,000 volts at Bonneville.

I foresee the day when the whole of North America is inter-connected. And all of Russia may very well be inter-connected even sooner, with central dispatching of power, and given the proper political environment, in due course all of Europe. And why not, in due course, continent-wide inter-ties so that wherever energy is wanted it can be supplied cheaply? Now, I appreciate the political obstacles, but my assignment had no reference to political realities. My talk is confined to a discussion of resource availabilities, economics and technology. And I won't quibble with you over the relationship between economics and politics.

Now, when I add all these various factors together - resources; their widespread distribution; the technology of discovery; and the technology of use; I just ponder on how anybody can ever become alarmed over our supply of energy and the possibility of a shortage. Surely the world's supply of fossil fuels and water power is great enough to satisfy demand for a long time. And surely by the end of that long time, some

uncertain but significant number of generations from now, atomic energy will have moved into its own.

So, as I said at the outset, I'm quite sure that your faculty was correct in relegating this subject of energy resources to one lecture and to a couple of seminars.

Thank you.

QUESTION: Mr. Lasky, with reference to the green area on your slide would you elaborate a little more on just what this represents? When you talk about the green sedimentary basin, does this mean that it's a place where we could logically expect to find energy resources, or does it mean that they are actually there?

MR. LASKY: No, that's the place where you could logically expect to find them. Certain parts of those green areas are very good; other parts are less good; and still other parts are less good. The non-green areas are the places where you won't find it except a few barrels here and there where there has been some kind of leakage. The non-green areas represent the basement rock or volcanic rock.

QUESTION: What progress is being made in the development of solar energy as a possible future source?

MR. LASKY: Experts are made by accolade and one time I was an expert on this thing; I'm not as good as I was. If there is progress, mainly through the United Nations' efforts; in some particular areas of the world they think they can use solar energy and use it effectively and cheaper than any other kind of energy. But that seems to be for

some distant future well even beyond atomic energy; the same thing for wind and tidal energy and all of these unconventional forms. There may be places where they turn out to be applicable. But they will be special circumstances and they won't have any kind of leverage on world supply and demand, as to whether we should or shouldn't worry about.

QUESTION: Mr. Shore mentioned that nuclear energy might possibly be the solution to energy requirements in the fuel-poor underdeveloped countries. Would you comment on that, please?

MR. LASKY: If they don't have any coal there. Or, if they have coal and can't mine it at a reasonable price. And if they don't have any oil there or if they can't transport it from where we do have oil, and you have one of those local circumstances where you can build an atomic plant, under circumstances like that there is no absolute measure as to whether something is cheap or expensive. If you have to have it you pay. What you need is much like saving water. We have a plant down in California that used to bring in their water in a tank-car, and they'd pay $1 for 1,000 gallons. If you have to have it you pay for it.

But the underdeveloped countries I don't think are going to develop as a result of getting nuclear energy, not as long as you and I are worrying about it, because nuclear energy is costly. And the present indication is that it's going to stay costly if it becomes truly competitive. The only way it will find any kind of substantial place will be by subsidy of one form or another, and the underdeveloped countries can't subsidize it. Maybe we'll get to the point where the United Nations will subsidize these plants in the underdeveloped countries.

But take your pick. Read the literature and make up your own mind about these things. Almost rarely does anyone talk about these subjects completely objectively; they usually have some kind of little ax to grind; Shore doesn't, but most people do.

QUESTION: You mentioned that hydro-electric power was not too important. For certain areas, according to your talk, or your chart, which are relatively poor power supply areas, such as Australia, how about the snow in the mountains being used there?

MR. LASKY: This is a place where I'm not an expert even by accolade. I was addressing myself in the lecture, of course, to energy across the world. And certainly, the Scandinavian countries depend upon it quite heavily. But even they find not enough of it. Sweden, for example, the report issued only last year jointly by the government and the commercial agency, recommended that they move rapidly toward supplementing their hydro-power by imports of oil. It will differ from each one of these countries which has hydro-power. But I can't answer your question, really.

QUESTION: Sir, I realize your subject is energy. However, what about the uses of petro-chemicals or synthetics; were they used in your projections of use?

MR. LASKY: Oh yes. You can make an awful lot of petro-chemicals out of one barrel of oil or one ton of coal, and all that you would ever need would not have any effect on total consuming supply. Every once in awhile I have a conversation with an economist at the German Embassy, who recommends that the United States stop trying to send coal over to

Europe and try to conserve it here at home because, "The day is going to come, Mr. Lasky, when you're going to need that coal for chemicals." Baloney.

QUESTION: You stated that the hydro-power available was equivalent to about 4 billion tons of coal. Is this per hour, per year, or what is the basis of this?

MR. LASKY: This is potential. You can put any tag on it. This means going on, and on, and on.

QUESTION: I assume it would be on the basis of an hour.

MR. LASKY: Call it continuing as of any particular time that you estimate it. I haven't thought of this point and I'm doing some quick mental arithmetic. At any point where you calculate it the hydro-potential of the world adds up to this figure.

QUESTION: So that, every hour you would add this up?

MR. LASKY: Well, you don't multiply this figure by the number of hours in a day and the number of hours in a year on into infinity, as if to say that any time you calculate it you have that figure. Because, it renews itself; it's never more; it's never less. Except, sir, you might get another figure if you used another factor for the conversion. You either use the BTU content of the amount of coal that it requires to make a kilowatt hour of energy, or you can use the textbook conversion factor of the equivalent between kilowatt hours and BTUs.

QUESTION: What is the future outlook for political parties in the energy projects?

MR. LASKY: I belong to the Department of Interior. I don't know.

It's a political problem here. This is certainly a place where policy is going to enter. If you leave it alone it will be one heck of a long time. These halls are sacred and I can say what I want - the last report on this was one put out by the Department of Interior, put out by the Bureau of Reclamation, or rather, a team, Bureau of Reclamation, Bonneville and Lucknow, who painted a glowing picture. Maybe they were right; I don't know. I'm not a power engineer.

But I suspect that their enthusiasm was handed to them as part of their assignment, you see. There are some fellows from the Department of Interior here now and I remind them that these halls are sacred.

QUESTION: With reference to nuclear power and your estimates or your figure you gave on U-308, of course there is a very little amount of U-235 in this, and of course it's a very limited amount of time when we're using U-235, what are your comments with reference to pushing further technology in reactor power, using the thorium or natural uranium at this time in the face of ample sources of energy?

MR. LASKY: Well, this was part of the thing I had in mind when I talked about reactor technology; either go the reactor route or using poor raw materials. I'm no more of a nuclear engineer than I am a power engineer. But whatever direction technology seems to be available, these fellows will follow it out. And in due course we'll have nuclear energy. But I'm quite certain that it won't be in a period of time that will worry you fellows in any of your assignments. Does that answer you?

QUESTION: With reference to the subsidy, AEC has estimated over a billion dollars went into it and now they're asking for more. Should

this be pushed in this rapid progress at this time? You tend to indicate that it should take a more even course.

MR. LASKY: Is this a rhetorical question, or are you asking me?

QUESTION: I say should it be pushed as AEC indicates?

MR. LASKY: If you're asking me I say no it shouldn't be pushed; not for this kind of money. AEC has to live and these fellows do as every other bureau does, and they make work. I'm quite sure that they're building up a story that will get them an appropriation. I think the fossil fuel position is not so precarious that we have to have this kind of program that they have. Now, you'll have some other opinions on this pretty soon because the Wiesner report will be out one of these days and it will have something else to say. I don't know whether or not they will agree with me.

QUESTION: Mr. Lasky, I remember reading some time ago about burning coal underneath the surface in order to generate power. Could you tell me something about this process?

MR. LASKY: What you have in mind, I think, is the burning of coal underground to make gas. This has been tried out. I think actually it is in operation in Russia. But here you run into that special circumstance where they have their own kind of economics and their own kind of bookkeeping. And if they want gas energy at some particular place where they don't have a lot of coal, they can do this. I've seen movies on this subject of the operation in Russia.

A little bit of experimental work has been done here in the United States, but it's costly as heck. But once you set fire to the coal it's

almost an impossible job to put it out. If you create the proper control after you set fire to it, pick off the gases, tear them apart and put them back together again, you can get some high BTU gas. But it's an awful costly thing to do and I'm quite sure that we will have what we call coal refineries making oil and gas out of coal long before that.

QUESTION: Mr. Lasky, we've heard it said that shale oil was close to a breakthrough with regard to competitive costs and that from a security point of view the federal government should adopt a push program. Would you comment on that?

MR. LASKY: Shale oil technology is marginal. Union Oil, had it not been for the recession of '57-'58, Union Oil would have gotten into the business. But the recession came along just at that time and they decided they wouldn't do it. If there's an outlet for it - and that stuff has to be sent out to the Pacific Coast, the gas or oil being made from it being sent on down there to be refined.

An oil company that has its own pipelines and its own refineries can probably make oil and gasoline out of oil shale right now. Somebody else can't do it because they can't stand the cost of a refinery and pipeline.

As to the security angle, oil up on the Colorado Plateau is not as good, let us say, as oil back here in the East. And I think we'll be getting synthetic oil out of coal before we'll be getting it out of oil shale.

QUESTION: But there is no federal program?

MR. LASKY: No. The Department of Interior has broadcast an appeal

to the public for some kind of guidance as to what it should do about leasing the oil shale lands, those that are still under federal control. But, there is no program.

There are three different companies that have processes. The Bureau of Mines has a process - we call them a company. There's an outfit in Denver that has a process; and the Union Oil Company. And it's almost impossible to find out what their costs are. Each one uses a different kind of bookkeeping and they won't come clean. But the story is that it's marginal in the economic sense.

QUESTION: Sir, you mentioned the benefits that would accrue to our economy if the energy costs were reduced for several large manufacturers of metals and the like. Are you therefore advocating that the government should include these reductions in its policy?

MR. LASKY: No sir. If you don't mind my correcting myself, I didn't want to say that these benefits would accrue. I said that economists say that savings of that magnitude would be a great stimulus to the economy. And I said if we accept their point of view, then we can get some measure as to how big the lift might be by comparing it with the possible income tax savings, and with the big credit bill. I'm not an economist, and therefore I can say that I doubt that that kind of saving will have much effect, except for those countries that have steel mills, chemical refineries and other smelting operations.

The United States has these things, but we have so much of something else that I don't think a little energy-saving would help us. But all of the coal and steel community countries do insist that an

energy-saving will help them. This is gospel for the people who are trying to get a common energy policy. And what they want in a common energy policy is a gradual shutting down of the European coal mines at a rate at which they can keep the sociologic and political problems under control, but gradually open themselves up to more and more imports of oil and to coal from the United States. Their credo is that they want this because a saving in energy will stimulate their economy. And they developed this credo because of the heavy steel, chemical and smelting industries that they have.

But I think this applies only to those countries that have that kind of industry where energy runs pretty high. Energy in steel-making is about 25% of the total cost, and probably that's true for other smelting. In chemical and cement manufacture it runs down to about 10%. So, for an industry that large and where that kind of industry is a major source of income to a country, as it might be in Germany and France, a saving of several percent can be something. Does that answer you? I hope it does.

QUESTION: In your fuels and energies studies, Mr. Lasky, have you considered the influence of the effects of closing military demands on a non-nuclear fuels policy?

MR. LASKY: Yes, we did. But I can't conceive of any circumstance where those demands will be so big that we can't meet them. There is a section, I recall, in the Fuels and Energy Study, on peacetime demands and then on emergency demands. We broke the emergency demands down into several categories, the continuance of the cold war which is a synonym

for peace; and then an all-out war, a nuclear war, and mobilization short of war. And we found no cause for any kind of alarm at all, within the time limit we set for ourselves, which is 1980.

You see, I myself can't get alarmed about this because I must confess that I was on the opposite side of this argument quite some time ago, but little by little I've educated myself and changed my mind.

COLONEL BLACKWELL: Mr. Lasky, on behalf of all of us, thank you very much for being with us this morning.