The Role of Electric Power
in
National Security

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GENERAL STOUGHTON: As you've noted from the biography of our speaker this morning, Mr. Edwin Vennard has had a most impressive record of service in the public utilities field. Therefore, it is obvious why he occupies the position that he does today as the Managing Director of the Edison Electric Institute. I'm sure his remarks to us this morning will be most helpful as he discusses "The Role of Electric Power in National Security.

It's a pleasure to welcome Mr. Vennard back to the Industrial College and to present him to the Class of '64. Mr. Vennard.

MR. VENNARD: Thank you, gentlemen.

Your interest in electric energy, of course, is understandable. To keep the nation safe and secure you want to be assured that there is enough energy available to run the machines to make the things you want made to keep it secure. The use of energy is very likely the best index of the productive capacity of a people. All modern societies are run by machinery. In our country, as you know, 98% of all of our work is done by machine, and every worker has working for him the equivalent of some 400 helpers. That is a primary reason why America has the highest living standard and why the productive capacity is the highest of any nation on earth.

The next competing nation in productive capacity, of course, is Russia. And Russia also uses machinery to make the things they need. Therefore, you are concerned that the machine power of America will stay ahead of Russian machine power. Therefore, you are interested in how the Russian use of energy compares with our use of energy. We have been there three times, to appraise the Russian power system - by we, the power company experts. In exchange, the Russians have been here. The Russians are just as much concerned about our productive capacity as we are about theirs, believe me. In fact, they're a great deal more anxious to get here to see how we do things, than we are to get there. Fortunately,we go first. And the understanding is that what they show us we'll show them; if they hold back, we hold back. They understand that and they are therefore anxious to show us everything they have. They do that and there is no holding back.

We have been able to appraise the Russian productive capacity for the next 10 to 20 years. We know how fast they are growing; what they are building and what their potential is.

In this lecture I should like to, No. 1, describe for you the energy production of our country; how it was built; where it is; how efficient is it; how well prepared are we to supply energy? - because these things you need - what are the planners for the future in developing energy for our country? And then, lastly, how do we compare with the world, and especially how do we compare with Russia? I want to illustrate this with a number of slides, and if you will, I'll have the first one.

This chart shows the growth in use of electric energy in our country from 1930 through 1962. The yellow bars indicate the energy growth in kilowatts of capacity. The blue bars with the red bar at the bottom indicate the capacity to supply that load or demand. The blue portion of the bar is the capacity that has been financed in the free market and the red portion is the amount financed by government. The free market financing is about 80% and government about 20%.

The two interesting features there are these; that the energy growth is doubling every ten years. That is, the energy used is doubling every ten years. That's about twice the rate of growth of the whole national economy as measured by the gross national product. The second point of interest is that the capacity has always been ahead of the demand during periods of war and peace. Notice there during the period of World War II there was always sufficient capacity to meet all of the demands, both civilian and war needs during World War II.

Some years back - five, six or seven years ago - as you know, the Congress urged all manufacturing concerns, and gave certain credits for doing it, to build capacity beyond their normal needs so as to be prepared in case we happened to get into a war. That is one reason we have today 25% reserve capacity when actually you don't need but maybe 15% reserve. The next slide, please.

I thought you might like to see how the systems were built by evolution, because that will give you some hint as to how it's going for the next 10 to 20 years. Power plants were first built in the towns, each town having a separate plant, and therefore small ones. Beginning in about 1908 it was found that you could transmit power over fair distances thus enabling one power plant to serve more than one town. By 1918 there developed a certain pattern. And by 1928 you see quite a few transmission lines having been built. In 1950 there were power lines covering I'd say most of the country. That's just after World War II, as you know.

You might recall that during World War II there were pools of power supplying the war needs of the country. During that period most of the generators were used by the Navy to build ships. We could not buy generators or turbines during the war and therefore we had to do more pooling of our facilities by transmission lines to supply the war needs. There was a shortage of power in the Southeastern Area during World War II, but all the war plants were served with power coming from as far North as New York, as far West as Chicago, and in the Southwest, as far as Abilene, Texas, moving into the Southeastern Region.

And so, we had pretty well developed inter-connected pooling systems during World War II, some 20 years ago. Well, that pooling concept has grown since then. That's the way the map looked in 1960 (slide portrays map). During that evolutionary period you notice that the steam turbines that make the power have increased in size markedly. In 1920 there were 45,000 kilowatts; in 1928 90,000; in the '58-'60 period, 500,000 kilowatt units; and as you know, recently the Consolidated Edison Company in New York has bought a single unit of 1 million kilowatts of capacity.

Now, that's of interest because the larger the unit, generally speaking, the higher the efficiency of production, and therefore the lower the cost. But you can put in these big units only if you can inter-connect your systems one with the other. For example, Con Edison could not put a million kilowatts of capacity in and be safe, without having big inter-connections with their neighbors. Because, when that unit fails or is shut down for maintenance they must draw power from their neighbors.

Also, we have found that efficiency goes up in a steam turbine with steam pressure and temperature. Temperature has risen from 650 degrees in 1916 to now 1,200 degrees - which is common - and pressures have increased from 350 pounds per square inch to 5,000. Those three factors are the primary ones bringing about the improvement in efficiency and the holding down of costs. As a result of the improvement in efficiency we have found that the energy used per kilowatt hour has gone down. The energy referred to here is the raw energy in coal. Now, these generators use coal, gas or oil, the predominance being coal. The next in order is gas, and the next in order is oil. And all of the plants in the country have been reduced to the coal equivalent.

Where back in 1890 it took somewhere around eight pounds of coal to make one kilowatt hour, the new turbines now being installed take about 2/3 of one pound of coal per kilowatt hour.

This chart more than any other has a bearing on the efficiency of production; that is, the holding down of the cost of making electricity. The top line shows what is referred to as the Handy-Whitman Index. That is simply the cost index in making power facilities. It reflects the cost of materials, supplies and labor. Notice that that has about doubled since 1949. The bottom line shows the price per kilowatt of capacity that power companies have paid for steam turbines - and generators. Note that in 1961 the price per kilowatt that we paid for a machine was about the same as it was some 20 years ago.

Now, those two factors, the holding down of the investment cost per kilowatt - in spite of inflation - and the improved efficiency in production, have enabled the lowering of the cost of electricity to the public, and to industry to make the machines, the guns, and the other things that you want them to make. This chart illustrates the consumer price index from 1913 through 1962. Notice the sharp rise during the '20s; the drop during the big depression of the '30s; and the gradual rise since then. So that, the cost of living is now 300% what it was in 1913, or three times as high. But the cost of 100 kilowatt hours of electricity in the home is about 70% of what it was in 1913. But because of increased use - and as you know, the price goes down with use - the average householder today pays only 30% of what he paid in 1913. It's the only commodity that I know of that has that kind of price record.

Well, that isn't all due to the great brilliance of management of utilities, although I have to confess that there has been some of that also. But, you see, there has been the opportunity, the built-in economy of operation; you can inter-connect your systems and go to bigger and bigger uses at higher and higher pressures. Now, fortunately management saw that and the regulatory bodies of government saw that, and they said, in effect, "Let's adopt the sole supplier principle; we won't duplicate these systems. We'll substitute government regulation for competition among companies." And so, we have regulation today. The regulators see to it that the investor makes a fair return, but no more than a fair return, and the public pays a fair price. The system has worked pretty well.

Here now is the way the transmission line system of the whole country looks. You see the lines there covering the whole country. It's a simplified map of the main transmission lines. So, every corner of America is now covered with electricity. People have it anywhere they want it, in the quantities they want. And that's the purpose of getting energy out there; all they want and where they want it, economically.

Today there are six major inter-connected systems or pools of power. That chart illustrates those six pools. The one in red there, of course, is the largest of the six pools, extending from the Rocky Mountains to the Atlantic; Canada to the Gulf of Mexico. 97% of all the energy in the country comes from one of those six pools. The balance of the 3% comes from some isolated municipal plant, cooperative, or the like. But most of the municipal plants and co-ops tie into this major inter-connected system. This pool here is a large one. It has a capacity roughly 1 2/3 times the whole Common Market of Europe. It is three times the capacity of all of England. It is 1 2/3 times the capacity of Russia - in the one pool there.

I showed this chart in Russia when I was there last and they were astounded that we had reached the inter-connected system that they have plans for reaching in 1980.

They're a strange people. They like to brag you know; it's part of their - well, Americans like to brag too. They're very much like us in many respects. I was glad my wife was along anyhow, because in Russia the women do most of the hard work; they pave the streets; they drive the streetcars; they build the buildings; and the men do most of the office work.

My wife is a good Catholic, by the way, and she tried to convert these Russian guides there. You know they brag about the fact that they are 98% aetheist. I have my doubts. I happen to be an Episcopalian. You know, you Episcopalians down there, in case you don't know it, the Methodist right next to you thinks you are a Republican Catholic. I know I found that out. It may be so, I don't know.

Shortly after I got married I went to the church of my wife and it was my first time in a Catholic church. Now, don't get me wrong, you Catholics out there, I think you're doing the finest work there is in the world to beat this communism. But I couldn't help but be amused at - well, they have an entrance fee when you go to church; you pay before you go in. But I said to myself, "Now, Vennard, what's so strange about that? After all, they want to keep the chancel holy, keep the money affairs out, and so you pay before you go into the church." I thought that was a pretty good idea and so I paid to get in.

But, before long the plate came around. Well, "all right," I said, "Vennard, they need some extra money,"and so I put some money in the plate. Then, before long came a second collection. This was unique. I put money in the second time and then bells began to ring and things became very quiet. Then the plate came around a third time and I began to leave. My wife said, "Honey, are you going home?" I said, "No, I'm going to get a check cashed; I'm going to see this thing through." She did not convert those Russians, I'll tell you that.

I recall having said to one of those girls there, "Are you married?" "No." "You have no children, then?" "Nope." I said, "Wait until you have a child; you'll have something to parade to."

By 1966 the plans are that the whole country can run in synchronism as we're running in synchronism here. Now, those who are not engineers might not know what running in synchronism means. In this interconnected system here there may be hundreds of power plants. They're all rotating with their generators at maybe 3,600 revolutions a minute or 1,800, with some multiple of 60. As you know, we have 60 cycles per second, and therefore energy pulsates 60 times per second. Well, these machines are all pulsating in unison, 60 times per second. They're all together; not out of step, you see; all of them the same. So that, if a failure occurs in Minneapolis, we'll say, the people there don't know it. Because, energy flows at 186,000 miles a second. And some plant around here (pointing to chart) might pick it up. It's all connected. They may even get some from down here by displacement. And we expect in a few more years, I'll say, to have it all connected in syncrhonism.

Now, here's how the system is expanding, and here's how the evolution now goes on to the future in stepping up to still higher voltages. In the Southwest, the companies in Arkansas, Oklahoma, Louisiana and Mississippi, are connecting up with TVA - if I may mention the name. After they're built, you know, you may as well connect with them; they have a good physical plant and it's all giving energy to the people. I'm giving it a good word so I'll just pass over that one fast.

You see, TVA in Tennessee has a big load in the wintertime because their peak, you see, is in the winter, for house-heating. About half the homes are heated electrically at 4 mils a kilowatt hour - at your expense and mine. The peak there is in the wintertime. Now, over here the peak is in the summertime with the air-conditioning, because we can't make power for 4 mils per kilowatt hour. There are 1½ million kilowatts of diversity there. And so, TVA engineers - who are good engineers, by the way, and good fellows - as good as we are; and that's saying a lot - they found they could save by connecting those two and I'll show you what that looks like.

The yellow line shows the peak load at TVA from '61 to '70. Notice the peaking there in the wintertime. The black line shows the peak of the investor-owned companies neighboring TVA. See how they fit together, to give 1½ million kilowatts of diversity, that can be saved for the benefit of the people of both systems. In Texas they're building a 345 KV network from Houston to Dallas to Fort Worth. A big mine-mouth plant is being built in West Virginia - the coal mines there - and power is being shipped through plan; it will be through there in a year or so - 500,000 volts to the Washington-Richmond area.

There is another mine-mouth plant being built in Western Pennsylvania with 500,000-volt lines being built now into Philadelphia and New York. In Connecticut they're building a network of 345,000-volt lines. There a system is being superimposed upon an existing system in the North Central part of the country at 345-KV. The California companies are about to build a 500-KV line extending from the Northwest, to get Bonneville power down to the Southwest.

In New York City Con Edison is giving consideration to getting power from Newfoundland - up in Goose Bay there in Labrador - about a thousand miles down to New York. They speak in terms of 700 KV possibly.

And they're studying DC as a possibility of getting it down there. The black lines show the major transmission lines as of now, and the red lines are the new lines being built between now and 1970. So, combining those two, this is the way the map will look in about 1970. Parenthetically, plans are pretty well made through 1980. Our people must plan 10 or 15 years in advance. Now, they adjust these plans from time to time, and they have to because economic conditions keep changing.

For example, atomic power is coming in more rapidly than we had thought possible. You see, power people were able to deal with atomic energy in 1954 for the first time when the Atomic Energy Act was passed. Up to that time the government had all the use of atomic knowledge and research. Well, since 1954, all over the country manufacturers and utilities have been dealing with atomic power plants. We now have 23 power plants built, or building, for some 2 or 3 million kilowatts of capacity. The program is the most exhaustive on earth, with the greatest number of types of reactors. But we have found two types that have progressed more rapidly than we had thought possible.

We have predicted that by 1970 we'll be able to make energy from atomic fuels as cheaply as we can from coal and oil. We have some now in New England that are running as cheap as you can build from coal or oil. In fact, the one just announced - "Yankee No. 2" - in New England; it's a big plant, 500,000 kilowatts; but the companies there made that decision because it is cheaper.

Now, recently in New Jersey a plant was announced down there. I can't give the figures yet, but they are the lowest thus far. And when you see those figures in a couple of weeks you'll find that the atomic power plant being built in New Jersey will be about as economical as you can build anywhere - in New York, New England, the Middle-Western states, or California; not as cheap as the Southwest or Southeast, or the Pennsylvania or West Virginia coal mines. That is hitting something that we look for in about 1975 or '80.

Now, one reason for that is that we find the competition among manufacturers to get that business is great. Westinghouse has been getting most of the atomic power plant and GE didn't like that at all. And so, there is great competition there to get that New Jersey plant. So, you find both of them striving to make them better and cheaper. Well, both of them are pretty close together on price and both of them well below some coal plants.

Now, some of my coal friends are getting uneasy. They say it might interfere with the sale of coal. That's a long ways off, fellows. By 1980 coal will still be the predominant fuel. Just keep in mind that this energy thing is growing so fast - doubling every ten years. The lowest we have on paper now for the next ten years, they're building a plant equal to everything they've built before. And after that they'll do it over again in another ten years.

Well, now, here are the plans for the future. First of all, we can't see any let-up at the moment in this long-term trend. It may be by 1990 or 2,000 that this thing might level off a bit. But that's so far in the future, you see. You can't figure quite that far ahead. But by 1980 we think it will still be doubling every ten years.

Now, how accurate are these forecasts? Well, pretty accurate. For example, we made a very exhaustive study in 1959; in fact, the most exhaustive ever made of the energy requirements of our country. We asked each of the 200 companies that are in the Edison Electric Institute - that is, they belong to the association; and 97% of all the investor-owned companies belong to the association; it is simply a means of meeting, one with the other, to exchange ideas; there's no control by the Institute; it's composed of 2,000 men on 300 committees, who meet and discuss their common problems. They plan and work together, but still maintain the local initiative, you see, local design, which is the key to America. It's not a central plan.

I came back from my last trip to Russia, through Poland. And in Poland, as in Russia, we were asked to give lectures on how we do it - as they give lectures to us on how they do it - and I was giving this kind of lecture in Poland. I was describing our system and a fellow said, "Tell me this; why is your system so much more efficient than ours and Russia's system?" Well, I began quoting these figures on our B.T.U. per kilowatt hour; our investment cost per kilowatt; etc. He said, "No, you misunderstand me; I know that; I know it's lower and more efficient, but I want to know why." He said, "I want to know why it is." "Well," I said, "fellow, you just asked me a question. You're getting down to the basic root of the thing we're all talking about around this world, as to which of these two systems is more efficient."

I said, "I don't have an official answer because we don't have an official position such as the communists have." This was all friendly;

we weren't angry at all. And I said, "Here's my own viewpoint as to why." I said, "I think it's more efficient because we don't have any central plan. Somebody down there in Arizona might think of some new way to transmit this power from here to here. I might think he's wrong. But he thinks he's right. But he isn't told 'no' by anybody; he does it. And he may be wrong; if he is, we'll all learn. But he might be right and we'll all learn something new. We have 10,000 engineers thinking for themselves out there.

"You people have a central plan. You might be right and you might be wrong. But when you're wrong, boy, you've made a dilly."

And, you see, they've made a dilly. I came back here and testified before the Joint Economic Committee of the House and Senate, after 1959. I said, "Russia is putting too much of its gross national product on war production." I estimated then about 22% of GNP on war production. How high can they go? I don't know. In World War II you hit 35% of the GNP on war production. But you've got to eat; you've got to travel; and you've got to have clothes. Back then we had 18% of our workers on the farm to feed us. By the way, there are 8% now to feed us and food is running out of our ears.

Russia then had - in '59, and they still have them - 50% of its workers on the farm to feed them. They weren't putting sufficient resources - materials, supplies, brain-power - on building farm machinery. And I said back there then - which came true last year - that they were going to suffer the consequences. And they have; they ran short of food. Instead of burying us, if they starve, who buries who then?

I must tell you one Russian story that came to me as a true story. It may or may not be, but it's harmless and a pretty true story anyway. Mikoyan was here, you know, for the funeral, and he wanted to look the country over. He wanted to go to Detroit to see the production plants of General Motors. Well, they had a hard time getting someone to be his host. Walter Sessler who runs the power company in Detroit is quite a fellow. He has put quite a lot of time in going to India, Japan and Russia, for the government, and he generally heads up our missions to Russia. So, they called from the State Department to see whether Sessler would entertain Mikoyan. He's next in line to Khrushchev, as you know, and he, Sessler, said he would.

Well, Mikoyan wanted to go through a plant of General Motors and Sessler was showing him through. Mikoyan said, "May I speak to this worker?" It was agreed and he spoke to one of the fellows. He said, "What's your name?" The fellow told him. He said, "What are you doing?" And the fellow told him. "How much are you making?" The fellow told him that. "How do you progress?" He told him that. "How do you like your boss?" "I like him fine." "Well, how do you mean 'you like him fine'?" "Well, he's a nice fellow; that's all; he's a nice guy."

"Give me an example. What do you mean he's a nice guy? Illustrate that." "Well," he said, "I'll tell you. I live out near where he lives and I can be standing on a corner waiting to go home, waiting for the bus, and he'll pass by in his Cadillac and he might ask me to get in and drive me home." "Well, go on." "Well, he might even ask me to stop and have a drink with him. He's a nice fellow. He may even ask me to dinner. As a matter of fact, he might ask me to spend the night with him. Has that ever happened to you?" "No, it didn't, but it did to my sister." It may or may not be true; I don't know.

This is the forecast of the kilowatts that we expect to have in 1970, the capability and peak load. Notice it's about doubling between '60 and '70, and doubling again by 1980. And plans have been made to supply that. It takes lots of capital to do this. In 1940 the investor-owned segment of the industry - that is, the 80% supplied by free market financing, had $13 billion;in 1950 $19 billion; in '61 $48 billion; about doubling every ten years; in 1970 $88 billion; in 1980 $168 billion. Parenthetically that capital represents 12% of all capital of all industry in Ameaica. It's the highest of all industry - railroads, telephone, communications, automobiles, steel - 12%. About 10% of all personal savings of people in America have their savings here either through life insurance policies indirectly, or directly as 4 million stockholders.

There is nothing to indicate that it all can't be financed in the market. There has been no difficulty thus far in raising the capital to finance it. The new capital is now running around $3½ billion per year, which is about 10% - by the way - of all new construction now going into business enterprise to create jobs, to create work, to build the economy. We think that will continue into the future. We see no end to that. Because, you see, beside the natural desire of people to utilize the most convenient form of energy there is, the power people have been sales-minded and therefore they keep promoting this kind of energy; they keep selling it. And it's that sales effort, I think, that keeps this thing doubling also.

Now, the more the people use, the cheaper you can make it, and therefore that works well in keeping the price down. The big drive on now is for house-heating because most of our peaks are now running in the summertime for air-conditioning and we want to balance that out with house-heating. It might get to the point ten years from now when that will be the peak and we'll push more air-conditioning to keep that balanced out, you see. But there's a drive on now to get the total electric home.

We're doing research on quite a few new things to come. We're about to start a major research project to try to get the battery to be more efficient. There's a tremendous amount of energy being used to drive automobiles. A tremendous amount of energy is being used there. Now, we have the electrical automobile with the ordinary battery. We bought 100 of these cars a few years back. But the battery just didn't have the stamina; the pickup power; the lasting power. And the idea is, you can make a battery as we have in these cars here, and to be able to plug them in at night to be charged during the off-peak hours at a very low price. And they'll run all day.

The calculations show that this is the cheapest way to drive the car. But the battery would play out; it wouldn't do. And so, we have had a committee of people for the past year, going to every manufacturer who does anything with batteries, and we have found one who has made some strides on a new battery. It's a different concept; not the old lead battery, but a new one - a new concept. They think that with the proper financing in a couple of years they can develop this thing so that we'll get enough energy per pound of battery to make an automobile that you can use in the daytime and plug this thing in at night. It will stop some of the fumes going into the cities and make it much more convenient.

The prospective load there is equal to all the house-heating there is in the country. And so, we're looking forward to that also.

Notice the way the transmission line voltage has risen over the years. And the number of miles of lines have gone up over the years. That is one of the other reasons why we expect the price to keep going down. Our calculations show that for the next 10 or 20 years we can see that despite a gradual inflation which I'll predict, and perhaps you will also, of some 2 to 2½ percent per year, continuous, we think the price of power will keep on going down; our forecasts indicate that. Because, we can so far see no end to this going to bigger and bigger units and more and more pooling.

Now I want to make a few comparisons as to the world, because your concern is, "What about these Russians? How good are they? How big are they? What's their capacity? Are they going to cross us?" Well, we've examined that and I'll give you a brief summary of our examination. We have been able to bring this up to date from time to time. Here's the way it is now.

We have here in this country more power capacity, more electric energy being used, and capacity, than the next five countries in the world combined; the second being Russia, the United Kingdom, West Germany, Japan and Canada. And, we have three times that of Russia. The gap, by the way, is widening; it is not crossing as so many people have predicted. It has been widening for the past five years. You have in this country 314 thousand miles of transmission lines as compared to Russia with three times the area and 71,000 transmission lines. Their plans call for pooling the systems in Siberia with the systems in European Russia by 1980, the way ours are pooled now. We went out to Bradsk. Bradsk is here in the middle of Siberia, getting its water from Lake Bakal, here. This is a fresh-water lake, by the way, and has more water in it than all of our Great Lakes combined.

This feeds water into Angara to a hydroelectric project now under construction here at Bradsk - 4½ million kilowatts. Bonneville is now the biggest in the world, at 2½ million kilowatts, but this one will be 4½ million kilowatts. It's a beautiful job. I said to the Chief Engineer when I was there a few months ago, "Why are you doing it? If you fly over Labrador you'll see the same kind of country that you see in Siberia - big,open spaces - and here they're building the biggest power plant in the world."

"Well," he said, "we expect to move industry into Siberia. We'll put a limit on the population of Moscow - and that's 3½ million - and when we get above that we'll just move people into Siberia." I said, "Well, suppose they don't want to come out here? It's cold and there are knats here." "Oh, they'll come out; they'll move out here." Well, they can do that; it's easy to move them.

I noticed a few weeks ago that Khrushchev now has stopped construction on Bradsk and he is now putting more of his energy, manpower and materials into building chemicals to better his farm production, which makes sense. Well, in every country there is a certain amount of manpower, brains and resources, and they put too much here. And also, you see, the theory up until now has been from the Napoleonic days, in case of war they'd back up into Siberia proper. So, since World War II, after the Germans invaded, they've been backing up into Siberia. That's the theory of that.

Well, I think the realization of the awful effects of a missile war may have changed that. Because, Khrushchev is learning now that it is pretty expensive to move people out into open country here when they want to live over here, and to move industry back from out here to the places where they want to live. Now he's saying let's put our resources into bettering our existing farms rather than try to develop more land out here.

Here is the energy used per capita in Russia as compared with the U.S.A. We are running now almost 5,000 kilowatt hours per capita, and Russia about 1,500. Here is Russia's - not forecast; they don't forecast like we do. Our forecast is what we expect it to be; not a goal.

We made our forecast on energy - I forgot to mention that - in 1959, with some exhaustive calculations. And I just had our man check the actual results now, because we forecast five years ago what it would be now. The error is .0001% in energy forecasting. So, you can do this thing provided you have no major disruption in your economy, you see. A war would have changed that, or any major inflation change. We put 2½% inflation in there and the energy use was forecast pretty accurately.

These are our forecasts for 1970, and that's Russia's goal. By the way, they're running under this goal right now, but the gap is widening by 1970. A year ago I was asked to give a paper on this subject and to give my view as to whether or not Russia would cross us in productive capacity. If that is measured that is energy use. So, I attempted to forecast Russia's energy use as compared to ours. Our actual is shown here; in 1910 - a dip during the depression - and again in 1960. Here is Russia's actual growth to World War II - no statistics there. After the war this has been their growth (referring to chart). That's our forecast to 1980.

The dots show Russia's announced goal in all their public statements, by 1980. Well, my question is, "Will Russia hit its goal?" You'd like to know that. I can just give you an expert opinion on that. Now, don't get angry with me; as I said, they're ordinary fellows.

One more story. I'll tell you one more story and then I won't tell you any more. There were two boys who went through college together and both were Grade A students; very bright. They were so jealous that they hadn't spoken in four years of college work. One graduated into the military. After 40 years he became a four-star General, with a snappy uniform; braids of gold; stars; no tummy at all; and broad shoulders.

The other fellow became a Cardinal; a little short fellow; stout; with a big tummy; a long, red robe and a red hat. They were so jealous they hand't spoken in 40 years. They eyed each other at a railroad station near New York City. The Cardinal said to himself, "This is terrible; we shouldn't do this; I'm more important than he is, I'm a Cardinal; I'm of the cloth; I should speak first. I will go over and address myself to him." He walked up to the General and he said to him, "Conductor, what time is the next train to Cincinnatti?" The General didn't bat an eye. He said, "Madam, anyone in your condition shouldn't be traveling in the first place."

Back here in the '20s the power industry in America was new. Many towns had no service. We were extending service to towns not having it, to electrify industries that were using coal, oil and gas. This is our rate of growth back here; it was about 12% per year. We had assumed in 1930 that we would have continued at 12% growth per year, that to electrify all our customers and industry we would have been somewhere near 2 trillion kilowatt hours, and we're hitting now in 1964, 1 trillion. That trend would have made it 2 trillion - twice as much. That difference there between 1 and 2 is the same difference as between 1,000 and 0.

Russia is now running at a 12% growth, because Russia is now electrifying towns that had no service, and industry, with that continuum as they electrify all the towns and farms.

During World War II you ran the country on forced draft. But what about selling the tanks and guns you built? You make up for this; you run day and night. We did. And when you do that you don't worry about selling them to anybody. We ran 12% again during the World War II period. As we assumed after World War II, this will continue. We're going to hit double the amount again, that we actually hit.

Russia, you see, for the past ten years has been on a forced draft war economy. Now, here's Russia; what will happen there? My judgment is it will drop down to something like a 7% increase per year, like ours, when they reach our saturation of things.

I'll close on a new study that has just been made by a man named Pealings, on this same subject. I can't make it public yet because he wants to make a speech on this at the American Power Conference in Chicago in March. After that you can have copies of it. But there it is; his basic study is this. He examined every country in the world on the basis of electric energy used per capita. Here are kilowatt hours of energy consumed per capita in 1961. And over here the kilowatt hours increase per capita; the total use per capita and increase per capita. The dots you see are 155 countries of the world in that pattern. You see where we are up here; that's the USA right about here, because we are using about 5,000 kilowatt hours per capita, and our use increase would be as high as that of other countries using the full amount.

The highest on here is Norway in total use. As you know, Norway has very little coal or oil, and most of their power is electrical. They have a lot of chemical industries up there using electric energy. England is there; France here; the USSR is there; and Japan there (pointing to chart). Now, the lowest use of energy in here is Ethiopia. But the point is that it's a pattern. You can draw a line through those countries indicating the pattern they're going to follow. This will help you to make a forecast. Back here is the pattern of the previous line.

Here it shows the kilowatt hours of electric energy consumed per capita, as before, but over here I've put the percent increase per year; meaning what? Those countries having a low use per capita now have the highest increase. And those having the highest use now, have the lowest percent increase. The more energy being used, the lower your percent increase per year. There is Ethiopia, Nigeria, India, Turkey, Lebanon, Hungary, Japan, the USSR, France, West Germany, the United Kingdom, the USA, Canada and Norway. That kind of a pattern you can forecast. When Russia is using this percent increase; when Russia gets to this use per customer, that will be the percent increase. And when it gets to 30,000 we'll both have this percent increase, as our forecast based on forecasting this trend. I mean, you can forecast that trend there to get what you get.

The top line shows the USA in five years. The value in 1960 gives '65 and goes to 2,000. Here we are right now between '60 and '65 and we see we have the 5,000 kilowatts per capita. Taking that curve on a previous line we make our forecast per capita based on the trend. I give Russia the same trend. Here they are now in 1963 using 1,500 and they will follow that pattern. I take the population of Russia and the trend per capita and get Russia's total energy. In 1963 that's the way it will be, based upon the pattern. Here is ours now and there is where it will be based on the pattern. And my judgment is that the productive capacity will follow that trend.

My time is up, so I'll close with one story. It has no bearing on the lecture at all. If you've heard it don't stop me, because I like to tell it. You might be able to use it sometime.

I guess you know that Hal March is back on TV with the $64,000 question despite all the trouble he got into before. The man whom he had up there had gotten up to the $64,000. March said to him, "Your category when you come back next week will be 'The Art of Making Love.' And since you have $64,000 involved you may bring an adviser." Well, of course the guy racks his brain for an adviser on the art of making love, and naturally he thinks of a Frenchman. Maurice Chevalier was in town and he said, "Would you mind being my adviser?" Chevalier said, "I'll be glad to do it." So, they went to the show and Hal March said to him, "Are you ready? Are you ready, Mr. Adviser?" Yes, they were ready.

"Your question, now, is in three parts. You must get all three right. Part No. 1. Where is the first place you kiss a girl?" It didn't take him very long - "On the mouth." "You're right on the first part." Now for the next part: "Where is the second place you kiss a girl?" "On the neck." "You're right again on the second part, but watch the third though. Where's the third place you kiss a girl?" "May I speak to my adviser?" "Yes."

He turned to Chevalier and Chevalier said, "Don't ask me; I'd have been wrong on the first two parts."

QUESTION: Sir, would you say a few words, kind or otherwise, about the Passamaquoddy Project?

MR. VENNARD: I apologize for the unkindness that I might use in referring to it, but you gave me the privilege. Passamaquoddy has been under discussion, as I recall it, for some 30 years. I'll give you the basic power facts about Passamaquoddy, and you can appraise whether you'd like to see it built. The power in Passamaquoddy will be, roughly, 1 million kilowatts of capacity. The cost will be, roughly, according to the Department of Interior report,$1 billion. That's about $1,000 per kilowatt. That report says the power will be available one hour a day for peaking. As an expert in the power business I think that one hour per day is not economically sound power. We can't use it. To use peaking power as we're doing in the Southwest, and as government power uses it, you have to have from four to six hours per day to carry the peak. It's too short to have one hour per day.

The second comment is that you can build peaking capacity in New England by any number of means including topping units on steam plants, or pump storage plants. And pump storage plants are the nearest thing to hydro; the nearest thing to Passamaquoddy. We've employed engineers to pick out four sites in New England, on which there can be developed a million kilowatts for four hours per day. And the cost will be about $100 million per million kilowatts as compared to $1 billion. In other words, we can build power capacity of the same kind in New England at about 1/8 to 1/10 the cost of Passamaquoddy.

In our opinion as power experts, Passamaquoddy is not economically sound and should not be built.

QUESTION: Sir, there is a continuing controversy about TVA. Is it losing money or making money, or could it be operated more efficiently by private industry?

MR. VENNARD: That's a good question. When my daughter Catherine was in high school in Winnetka, one of the most rock-ribbed Republican cities, I guess, in America, she came home one evening and said, "Daddy, we have a subject tomorrow about TVA. Do you know anything about TVA?" I said, "Cathy, you just came to headquarters; I know all about TVA." And boy, I really let her have it. I wrote this thing out and gave it to her, and figured she'd make 100% on the test. She came back and said, "Daddy, this thing was a bust; you don't understand it at all. I told my story like you said and they all laughed at me. The teacher said, 'Does your daddy work for a power company?'" She said "Yes," and they all laughed again.

Let me give you TVA in a nutshell. If you will forget for a moment the ideology involved. Forget for a moment that TVA is basically a government-financed power enterprise. And whether or not we want to engage as Americans in government-operation of the economy, forget that for the moment. As a different subject let me give you first of all the economic facts about TVA. And I'd like to have you write for the analyses and reports in support of the summary of the facts.

TVA began in 1933 as a flood-control navigation project, as you know. Because, the government can build navigation flood-control projects. It was also designed to help build the economy of the area. And when you build a dam to control floods you might make some incidental power. And so, the TVA Act says that TVA can sell the incidental hydroelectric power to the people of Tennessee. Now, TVA has done all of that by the evolutionary process. TVA has gone through a change; we all do.

TVA now is primarily a power enterprise. 80% of the roughly $2 billion of investment is in power. Some $1.2 billion is in power investment and 75% of all the energy is steam. Therefore, TVA is similar to any big investor-owned power company, such as the Southern Company; Con Edison Company; Pacific Gas & Electric Company; Thomas Edison Company. They're all about the same size and are all about the same; the same kind of people; the same turbines; the same generators; the same characteristics.

TVA is different in three major respects. No. 1. TVA is not required to pay the cost of capital that you and I must pay for capital at the market price. Parenthetically, the market cost of capital is the only measure of the cost of capital. The cost of capital is the same whether you finance in the market or finance by government. If government taxes people to enter business, government then takes from people those dollars they could invest in the market. The value of those dollars to a person is what he can earn on those dollars.

No. 2. TVA is not required to pay any federal income tax. Well, we pay federal income tax, as you know, but we're tax collectors. The taxes that we pay are more than the cost of labor; more than the cost of all capital. But you have to collect that from people. It's in our bill; the customer pays those taxes. Therefore, the people in Tennessee are not required to pay in their electric bill the taxes that our customers have to pay.

No. 3. Investor-owned companies are regulated by government, and they should be, as I mentioned before. You have to have an impartial body fixing fair return on fair value, and a price to the consumer. Well, I have undertaken to adjust TVA's earnings, having formerly been a rate expert all of my life before coming to my present job. I adjusted

TVA just as you would analyze any company before the Federal Power Commission. I simply said, "Let's charge TVA the market cost of capital, the same taxes a power company pays, put them under the Federal Power Commission, and then fix the rates the way the Federal Power Commission would fix them under regulation. I raised TVA's rates 56% for it to break even.

I then raised all the rates up to 60% and I took those rates down to Atlanta, Georgia, and applied them to the Georgia Power Company. I raised the bills of the Georgia Power Company a little bit; not much. I found that the efficiency of TVA is about the same as ours. The rates are about the same when you adjust them, and therefore there is no, what would you say, public benefit by having government finance as distinguished from free market financing.

I would not do as Goldwater suggested and sell the thing out to somebody. I don't think you can sell it unless the earnings get up to the proper amount. What would I do with TVA? I would simply put TVA under independent government regulation and let the experts on power fix the rates so that the American people get a fair return. After you do that there are many things you could do with TVA. First of all, you must separate out the power from all the other good things that TVA does - the flood-control; the navigation; malaria abatement; all of those things are good ends and should be continued to make the power a separate enterprise, and regulated.

QUESTION: Can you tell us the possible advantages of using direct current for a long, high-voltage transmission line, instead of alternating current?

MR. VENNARD: Yes sir. In fact, we have just completed a rather exhaustive economic analysis of that. We found that the Russians were doing a great deal of thinking and studying on DC. DC is not new, as you know. We've kept pace with it for 25 years. It's being used modestly in some parts of the world now, but there is no big use of it. And so, we had EBASCO Service give us an economic analysis and it showed this; that where you are transmitting power in very large blocks, around a million kilowatts, over very long distances such as one, two or three thousand miles - as the Russians plan to do in going from Bradsk to European Russia - they'll transmit some 8 to 10 million kilowatts.

On those long distances, in big blocks of power, DC is cheaper. The cross comes somewhere around 700 miles, and around a million kilowatts or less, and it's cheaper to have AC. Now, in this country, as you know, we have plants at closer distances than every thousand miles, for example. You don't find people building a big steam plant at Detroit to show to New York, as it were. So, we haven't thus far felt the need of the economic feasibility of DC. It is being considered now by Con Edison because we have a thousand miles from Northern Canada to New York City. But they are finding that if they tap that line at Montreal or two other spots along the way, you must convert back and that destroys the economic feasibility. It has to be a thousand miles or so with no tapping of it.

But you get benefits by tapping it at Montreal, or supplying the New York power authority - hooking in with that, you see. And so, the economics of inter-change might offset the savings by DC.

QUESTION: Would you discuss the fair return on investment? In other words, is it the same for all of your areas; for all of your interests, etc?

MR. VENNARD: The Federal Power Commission regulates the rates of companies where energy flows between states. State regulatory bodies regulate intra-state business. Now, most of the regulation is by individual states. Opinions vary among state commissions as to what is fair value. Most of the commissions today take what they call the net plant as the fair value. That is, they take what is on the books. And all the companies now keep their books as the Federal Power Commission prescribes; the original cost of putting property on the books; and they've gone back to the date when the things were bought, and every item is on there at the cost, as I say, when it was built. So that, every 5 KVA transformer, some put in there last year and some put in there 20 years ago, are on the books with the price paid.

Therefore, the original cost is the original cost of every item on the books. And from that original cost they deduct the depreciation reserve. That's called net plant. Some commissions add to that the material and supplies - the working capital - and call that the "fair value."

Other commissions say we must take into account the present value of property. That is to say that a transformer out there that cost $5 back there 20 years ago, costs $10 now. And fair value - that is, reproduction cost - is worth something more than what is on the books. I know of no commission giving full value to that, but some weigh that in establishing a value.

The fair return is determined primarily be measuring what is the cost of capital in the market. And so, they have experts on money cost. They will testify that this year you can sell bonds for blank percent; you can sell stock for this percent; you can sell common stock for this; and therefore the average cost for capital is 6%. They'll say, "Here is your value and you're allowed 6%." Now, those vary within 10 to 15 percent limits over the country; no more than that. And usually it comes along at about 6%. It has been rising lately because the cost of money has been going up, as you know.

Once in awhile you get a good commission that will say that good management is entitled to an incentive and they'll give a little bit more than just the bare market cost of capital. Because, if you charge every company the market cost of capital, then what's on the books is a formula. Shoot. I can sit back and say, "Why should I work so hard? Hell, I'll get a fair value and fair return." But if I want to watch my expenses, sell, and work efficiently, I can get a little bit more. And so, frequently a commission will say, "You're entitled to 6.5% return for that." And, we like that, of course.

QUESTION: Mr. Vennard, would you give us your views on the Rampart Dam Project in Alaska? Is it really needed? Or could we spend our money better elsewhere?

MR. VENNARD: The Rampart Dam is a good project. And by the way, that is an economical hydro; not like Passamaquoddy. All up through there there is good hydro, and it's good cheap hydro. But as you know, there is no load in Alaska that can absorb that for the moment. Now, we have found that for economical power development you should develop power as needed. We find that it is not economically sound to build great capacity in advance and hope to attract industry into that. We stay 25% ahead and if it keeps growing we'll build onto that.

Some people say that it is economically sound to ship the Rampart power into low centers like Chicago. Our calculations indicate that that is too far for it to go. We have not seen any studies yet, showing economic feasibility of Rampart Dam. Now, in commenting on that I should mention this, and that's one of our problems with the government financing power. As you know, the government can borrow money at, say, 4%, and the market cost is, say, 6%. And frequently, in appraising Rampart Dam, for example, I'd use 4% or sometimes less. I've seen some calculations such as on Passamaquoddy, using 2½% cost of money.

Well, you see, that to me as an economist is not economically sound. I think money costs about 6%, and therefore with the American people putting their money into Rampart Dam, for example, that's government financing and the American people should get a return on the value of that capital to them. And that value is what they can invest that money in in the market. Therefore, they ought to return to government 6%. And furthermore, the government needs taxes; needs income; and therefore in weighing the economic feasibility of Rampart, or any government dam, I think the government should put on that dam the same taxes that they would get if they financed in the market.

Now, one of the best tests of economic feasibility is some group of people on their own with their own savings or savings raised in the market, who develop that dam. If they will, that, then, likely has economic feasibility.

Now, if the government needs flood-control there, that's something else again, you see. Or if irrigation is needed, that becomes a government project then. My calculations show, though, that when the government builds an irrigation dam or flood-control dam as a government function, the government makes the most money by licensing someone to put the power in with free market financing, selling foreign water to that project, and taxing it. There is more income from that than from the government going in directly and building the power.

QUESTION: My question concerns computer control dispatching of power. Recently a group from the school observed the Early Bird control device at the Southern Company. Would you comment upon the significance of this development to the industry, and particularly to flood-control?

MR. VENNARD: Yes. This computer control is really growing fast and it's very significant. These big pools of which I speak, like the Southern Company, they'll cover Alabama, Georgia and parts of Mississippi. There may be 100 power plants controlled from one center. And the object is, with a big pool where the load over the whole country varies hour by hour, to bring those machines on in the order of their greatest efficiency; taking into account the cost of fuel out there in Western Alabama as opposed to transmission distance.

Well, you can calculate that thing mathematically and it takes you about three or four months to make one calculation. You can give the load dispatcher a chart showing how to bring these units on. But you can put that into the brain and the brain does all the work. Every hour that electronic computer brings those machines on in the most economical fashion, and the dispatcher sits there and watches the machine work. If it forgets or goes wrong he takes over there. That's a growing thing now in this country.

The second thing is the automatic operational power plant. The Little Gypsy power plant in Southern Louisiana is the first power plant with 1,500 valves; all must turn a certain way to get that plant started. And if a valve fails you have to go around that valve or do something else. It is controlled by an electronic brain; there isn't a man in the power plant. It's run from Sterlington, Louisiana. It's the first completely automatic power plant. That's coming.

It's the same on billing now, by the way. We have those machines doing our billing. And it cuts our costs, by the way, also. It cuts the cost and so you can cut the cost of commodities so that people have more money to buy other things and create jobs.

EVOLUTION OF ELECTRIC POWER IN AMERICA

An Address by

Edwin Vennard
Vice President and Managing Director
Edison Electric Institute

Before the

Industrial College of the Armed Forces
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The armed forces of the United States have a clearly defined goal -- to provide our nation with the best defense possible. Electric Energy plays an important part in this effort, for in the modern world, no nation can survive economically or militarily without an ample supply of electric power. We depend on it for war and for peace.

Because of this, it is important for us to understand how electric energy is provided in this country, what the plans of the power industry are for maintaining an adequate power supply in the future, and how we compare with other nations -- and particularly with the Soviet Union -- in this important area. I would like to discuss these matters with you during the next few minutes, but in doing so I want to emphasize some of the ways the electric light and power industry is working to increase the efficiency and economy of the service we provide.

The Growth of Power Systems in America

In this country, the goal of the electric utility business is to provide electricity in such a way that everyone will have all the power he wants whenever and wherev he wants it, reliably and economically. To achieve this goal we begin our planning at the bottom, in our districts and divisions where there is a close understanding of the customers' wants and needs. We try to build economics into our systems at the base, and to maintain our operations efficiently from the ground up. Our approach has been realistic, and the record shows that it has been effective. Power plant and transmission capability has always remained well ahead of demand.

In 1963, the total output of electric energy in the United States was estimated to have exceeded one trillion kilowatt-hours. By the end of the year, the generating capability of the total electric utility industry in the contiguous United States reached an estimated 209.6 million kilowatts -- providing a margin of reserve of 25.1 percent over the estimated annual peak demand. About 80 percent of this capacity is in steam plants, most of the rest is in hydroelectric stations -- although atomic power plants are now beginning to provide a notable fraction of our total capacity.

Today, about 80 percent of America's electric power customers are served by investor-owned electric utility companies. The remaining 20 percent are served by government-owned and government-financed power suppliers.

The two primary objectives of the electric power companies in this country have been good service and economy of operation. Everything that is done is measured against these standards. It has been that way from the beginnings of the industry, little over 80 years ago.

At first, small plants were built to serve the needs of their immediate areas. Naturally, these tended to be in the more densely-populated areas. As the demand for electricity increased and technical knowledge grew, electric service spread. It became possible to build larger and larger generating units and to interconnect them with lines of higher and higher voltages. Little one-station companies combined with others to form more efficient operating units. And as the process of consolidation went on there was a continual expansion of transmission lines so that in a relatively short time the companies had established the beginnings of today's backbone transmission system.

Later, whole areas were interconnected. Through the 30s, 40s and 50s transmission line development continued as the population grew and as the demand for power increased.

In developing their power systems, the companies, with the help of equipment manufacturers, have continued to bring larger and larger generating units into service. One company now has a unit of one million kilowatts on order. At the same time, the companies have been making use of higher temperatures and pressures in their generating plants, resulting in greater and greater efficiencies.

This engineering progress has resulted in substantial improvements in fuel economy over the years.

Technical knowledge and engineering abilities have advanced rapidly, enabling the companies to hold down the unit investment cost per kilowatt in their power plants. Since 1950 power plant construction costs have about doubled, but the cost per kilowatt of adding power plants in 1960 was about the same as it was in 1950.

Improved efficiency in construction and operation has been an important factor in lowering the average cost of electricity to the customer. The promotional nature of electric rates, which lowers the price per kilowatt-hour as more electricity is used, has also played a part, as have diversity in use of power, good government regulation, and the industry's encouragement of new and wider use of electric power as a result. Since World War I the average revenue per kilowatt-hour has declined, despite the fact that the cost of living has about tripled during that period.

By keeping prices low, the companies encourage wide use of electricity. The value of this multiplies through the economy. Effective use of electric energy saves manpower and time. It means more machine production, lower cost goods, and more income for individuals and enterprises.

Where We Stand Today

Today, nearly all the major electric power systems in the country, providing 97 percent of the nation's electric energy requirements, are members of one of six principal interconnected groups. Two additional interconnected systems operate in the less populated Southwestern portion of the country.

The largest of these groups, extends from the Rocky Mountains to the Atlantic Coast and from Canada to the Gulf of Mexico. During 1962 several interconnections were completed that permitted this Interconnected Systems Group to operate continuously in parallel with the Pennsylvania-New Jersey-Maryland Interconnection and the Canadian-U S Eastern Interconnection. The United States' portion of this combined group had a generating capability of 154 million kilowatts, which is about 1-2/3 times Russia's entire electric power capability, and 1-1/2 times the total capability of the six European Common Market countries. It is by far the largest interconnected power system in the world.

The major interconnected transmission lines in the country form an intricate network that covers the entire nation.

The network can be seen more clearly when only the principal lines are shown. Today, all the major power systems east of the Rockies are interconnected. West of the Rockies interconnected operation has been an accomplished fact for a number of years, both in the Pacific southwest and the Pacific northwest.

Developments in interconnection and pooling are coming at a rapid rate. Let me mention just a few recent examples.

Eleven southwestern companies have proposed an intertie with the Tennessee Valley Authority. This will be the largest exchange of power ever made between systems in this country. By 1968 it is expected to reach 1.5 million kilowatts annually.

The exchange is made possible by the fact that TVA has its annual peak demand in the winter, while the companies find their peak demand occurring in the summer.

In Texas, investor-owned companies are building a network of lines at 345,000 volts to strengthen their existing transmission systems.

Virginia Electric and Power Company is building a line of 500,000 volts to help meet the power needs of consumers in its area. A 350-mile loop will carry electricity from a new one-million-kilowatt generating station in West Virginia, to the suburbs of Washington, to Richmond, and on to the Shenandoah Valley.

Just to the north, the companies that make up the Pennsylvania-New Jersey-Maryland Interconnection, the Allegheny Power System, and Consolidated Edison Company of New York have recently announced plans for building more than 600 miles of 500,000-volt transmission lines. These lines will help carry power from two large new generating plants being constructed in coal-producing areas to load centers in the east. This system and the VEPCO systems will then be connected with a 500,000-volt line.

Moving farther north, construction has begun on a 345,000-volt line that will tie power companies in New York with power companies in New England.

In December, 1963, four New England companies announced plans for CONVEX -- the Connecticut Valley Electric Exchange -- which pools one-third of New England's electric resources. The plan includes construction of 345,000-volt transmission, for joint-planning of new power plants, and for joint operation of a dispatching center.

In August, 1963, 22 Midwest power suppliers announced plans for new lines and interconnections now being planned -- much of which are to be rated at 345,000 volts -- will be to make one giant power pool of the existing pools in the Midwest area. According to this group, by 1980 about $280 million will be invested in a 5,400-mile network which will link key cities in Illinois, Wisconsin, Minnesota, North and South Dakota, Iowa, Nebraska, Montana, Wyoming and Missouri.

Earlier in the year the Pacific Gas and Electric Company announced its plans through 1980, which include building 1,200 miles of transmission line of at least 500,000 volts.

Most recently, in January of this year, Consolidated Edison Co of New York announced that it plans to purchase hydroelectric power from Canada and bring it 1,100 miles over 700,000-volt transmission lines to New York City.

I could cite other examples in other regions of the country that are just as important as these. By 1966, all the major power systems in the nation will be capable of operating on an interconnected basis.

Plans for the Future

Planning in the power industry must include three major considerations: the service to be provided, the economics of providing the service, and selling.

The service must be the best possible. That is basic. And the importance of such economic questions as possible alternative methods of providing the service, of cost, and of financing can be recognized by people with little knowledge of the power industry. But the third consideration, the sales effort, is often overlooked.

A company designs its sales programs with definite goals in view. It tries to increase the volume of its sales. At the same time, it tries to increase the diversity in the use of electricity among its customers in order to achieve the most economical use of its equipment. It sells with an eye to increasing its load factor, so that the demand for power will remain as even as possible throughout the year.

The direction and vigor of a company's sales program can affect the total demand for power, the characteristics of the demand, and, in the final analysis, the economy and the quality of the service. In our system, the sales function and the planning function are closely intertwined.

By basing our planning locally, within the companies, we can be sure that local needs and local differences are taken into account. We do not depend on a small staff in some central location to forecast our needs, we rely on the combined wisdom of thousands of engineers in every part of the country. We allow them freedom to try out new ideas, to test new techniques, and to tailor power development to the consumers' requirements. Through the committees of the Edison Electric Institute -- which represents some 97 percent of the investor-owned electric utility industry -- companies are able to trade the benefits of their experience. Through these committees they achieve the maximum interchange of information, the best degree of coordination, and the maximum local planning -- all under government regulation. The hundreds of company plans that grow out of this process form our national power plan for the future.

The Edison Electric Institute has published the industry's plans through 1980. These are not goals, but the product of the best judgment of many people as to what will actually occur.

The EEI forecast was made on the basis of components of the Gross National Product that show positive correlations with electric industry data. For example, reasonably good correlations were found between disposable personal income and domestic kilowatt-hour sales, between service consumption expenditures and kilowatt-hour sales to small light and power customers, and between the Federal Reserve Board Index of Industrial Production and sales to large light and power customers. This forecast was compared with the companies' plans for the future, and showed a high degree of correlation. When two so different approaches bring so similar results, we can be reasonably confident of the forecasts they provide.

By 1980, electric companies expect to have nearly quadrupled their 1960 capability, reaching a total of 492.6 million kilowatts that year.

The investor-owned power industry represents the largest net capital investment of all the industries in America. The companies average about 10 percent of all the money spent for new plant construction by all American business. The huge amounts needed to finance our growing power systems are accumulated through voluntary investments by millions of people throughout the country. In fact, about 6-1/2 percent of all Personal Savings will go into the investor-owned utility industry for new electric plant construction during the 1960's and 1970's.

An important part of the economic management of the power business is to make sure that earnings are sufficient to keep the industry attractive to investors. To expand their power supply systems, the companies will need to nearly quadruple their investment by 1980. Between 1960 and 1970 some $8 billion for transmission alone. They are confident that the sums needed to build the power facilities of the future can continue to be raised in the free money market.

Problems in Planning

There are no easy solutions to the problems of providing power supply. The criterion must be to provide the best service in a particular locality in the most economical fashion, but one of the complicating factors is that as technology advances, the economics of power supply can shift and change.

For instance, there is an evolutionary process in transmission voltages. Thirty years ago 200,000 volts was considered to be very high. Now we have lines of 460,000 volts in regular operation. We are building lines of 500,000 volts, and planning lines of 700,000 volts. And the idea of a million-volt line does not seem far-fetched.

Today there is great interest in building power plants at the mine mouth and transmitting power at high voltages to load centers. But the further development of atomic power is having an effect on present problems of transporting fuel and other concepts may be developed in the future.

In planning power development the companies begin by forecasting the economies that can be built into their systems through use of larger generating units, increased pooling, improved load factor, and the like. These economies are taken into account in finding the cost components for rate-making purposes so that power can be priced as low as possible in order to increase use. Predictions of demand can then be made on the basis of the low prices.

Some people tend to confuse the relationship between the rate of growth of energy use and the rate of growth of the economy as a whole. Energy is developed to meet the needs of the economy; it does not boost growth of itself. Of course, a shortage of energy can hold back economic growth, but over-capacity can be an equally serious drain.

Electric power is not something that can be squirted into the economic machine to make it run faster. Too much power capacity can be a drag on the economy, for if there is no demand for the energy, valuable resources may be wasted by building over-capacity.

Our system of power development provides the flexibility and awareness of demand that are required to maintain the abundance of energy we need, now and in the future.

Comparison with Russia

Any comparison of power systems is difficult, and comparisons between nations should be handled with particular care. But there are certain points which clearly define the relative effectiveness of the Russian power system and our own.

We have three times the power-producing capacity of Russia.

Although we are about one-third the size of the Soviet Union, we have about four times the miles of transmission lines.

The vital comparison lies in kilowatt-hours per capita. Here we have about three times the production of electricity per capita of Russia. For 1970, the

Russians expect their per capita production to be about 3,000 kilowatt-hours. Ours will then be about 7,500 kilowatt-hours.

Rates of Growth

With this background, let us examine the trends in the rate of use of electricity in the two countries. From 1930 to 1960 the energy growth rate in Russia was 10.4 percent per year.

But Russia is now extending service to customers who previously were without it and going through a process of mechanization and electrification of industry much as we did during the period of 1915 through 1930. During that time our growth rate averaged about 9 percent per year. If in 1930 we had used that 9 percent growth trend in making a forecast we would have predicted 1,582 billion kilowatt-hours for 1960. As our system grew, its characteristics changed. Such change is an inevitable mark of progress in the evolution of a comprehensive power system.

Over the past 10 years the Russian economy has been operating on a basis similar to the way ours was in 1938 through 1944. During that period, our rate of increase of energy use was 12.5 percent per year.

During this period Russia has been concentrating on the construction of goods that can be used for defense or war. For obvious reasons we have felt it necessary to match Russia in such production; but because of our greater productive capacity, arms production takes a much smaller percentage of our total output.

It has been estimated that 20 percent of the Russian Gross National Product now goes for arms and defense. What will the ceiling be? Of course we do not know, but possibly we can get some idea from our own situation during World War II. For the sake of all-out war production we temporarily gave up part of our freedom, and the economy was run in much the same manner as a government-planned economy. We had government wage and price controls, production controls, allocation of materials, and restrictions of the freedom to change jobs in certain essential occupations. We were then devoting about 35 percent of our total productive capacity to arms production. If we could have produced more arms, we probably would have; but we also had to produce food, and clothing, and other non-defense items.

Is Russia's top limit 35 percent? It may well be something less. About 40 percent of Russia's workers are employed on farms. During World War II about 17 percent of our civilian labor force worked in agriculture. Now about 8 percent of our workers are agricultural workers. In the light of our own wartime experience, it seems reasonable to say that Russia is somewhere near her maximum in arms production.

The question is can Russia keep her over-all economy going on the present footing? The answer seems to be no -- at least not if, as seems the case, she is reaching the outer limit of what the total economy can stand in terms of percent for arms production. This view has been supported recently by testimony before the Senate-House Economic Committee. Experts have told the Committee that the rate of growth of the Soviet economy is beginning to slow down. From 1950-1958 the Russian Gross National Product grew at a rate of about 7 percent per year. It has now dropped to about 5 percent per year.

In forecasting Russia's rate of use of energy based on her 1945-1960 record, let us not make the same mistake we would have made if we had forecast United States' use based on a 1938-1944 trend.

Russia's trend line will probably change after service has been brought to existing households. The trend line will change further when Russia has managed to reach the same level of mechanization of industry and agriculture that we have attained. With these considerations in view, it does not seem possible that Russia will overtake us in power production in the foreseeable future.

Conclusion

The power supply system that has evolved in this country is efficient and effective. It provides the power we need in ample amounts when and where we want it. The Russian system, on the other hand, seems to have serious flaws. Recent statements by Chairman Khrushchev and the current attempts to re-juggle administrative methods and to redirect capital from some of the large hydroelectric developments planned for Siberia to the chemical industry indicate that the Russians themselves see a need for improvement.

Chairman Khrushchev has urged that the Soviet economy "use anything rational and economically advantageous that the capitalists have to offer." This attitude is a long step from the traditional Marxist position, and it is a sign that the effectiveness of our approach to industrial development is becoming increasingly clear to the Russians. It may even be a sign that the Russians are gravitating slightly toward our system.

We should never underestimate the Russian threat, nor close our eyes to the potentialities of the Russian economy. But we should also remember what our system has accomplished. We have in the United States the finest, most advanced power system in the world. We should do our best to see that the elements that have made it effective are not changed.

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