01929

THE ELECTRIC POWER INDUSTRY

6 March 1956

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INDUSTRIAL COLLEGE OF THE ARMED FORCES

Washington, D. C.

Mr. Philip Sporn, President of the American Gas and Electric Company and its subsidiaries, was born in Austria in 1896. He was graduated from Columbia University, School of Engineering in 1917 and received the M.S. degree from Columbia in 1918. Stevens Institute awarded him an honorary degree of Doctor of Engineering in 1947 and he received the degree of Doctor Honoris Causa at the University of Grenoble (France) in 1950. Mr Sporn is a scientist, engineer, and administrator, who has devoted his entire life to the advancement of the electric power industry and is noted for pioneering work in this field. He is responsible for the design, construction, and operation of the Twin Branch Power Station which operates at a boiler pressure of 2,300 pounds per square inch, the highest pressure regularly used in an operating station in the United States. He has many responsibilities in developing the techniques of operating all the power systems of the eastern United States as one unit during World War II. This vast network was governed by the Philo station of the Ohio Power Company which was designed and constructed under Mr. Sporn's direction. He is the moving spirit in the development of the "heat pump," which may completely revolutionize all present concepts of residence and commercial heating. He has been the directing head of many experiments now being conducted in the art of electric transmission. He has written many papers for technical and scientific societies, and has received many citations for his contribution to the industry. Most of his professional life has been spent with the American Gas and Electric Company and its subsidiaries, where he has risen from an engineer through all grades to his present position of President.

THE ELECTRIC POWER INDUSTRY

6 March 1956

ADMIRAL DEUTERMANN: For the past week we have been studying production. Yesterday we had an analysis of our production as compared with that of our probable allies. The heart of production is energy or power, and the most flexible type of power is electricity.

This morning I know you are in for a special treat. This is our speaker's fifth visit here. I have read what he had to say on his previous visits, and I know that this morning's discussion will be very profitable.

I want to be brief in these remarks, so as to give our speaker the maximum time possible. In passing, however, I want to mention that we in CRIB get around the country and see industry on its home grounds. This year I have been through plywood mills, knitting mills, steel, gas, and petroleum; and while in the Northwest I spent several days "diving" the hydroelectric industry.

This (indicating) is a one-foot sample of a high-tension transmission line that I picked up at Bonneville. It carries thousands of horsepower. When I showed it to our speaker today, he said: "That is a small filament compared with what we use." The transmission of electrical power is in itself fabulously interesting, but I want to get on with this introduction.

The person who made the transmission of alternating current possible in its present-day flexible form was the late Dr. Steinmetz, of General Electric. He was a great teacher and mathematician, and applied his mind to the problems of transforming alternating current. The Steinmetz formula for transformers broke the bottleneck in this problem, and as a result today we have the great flexibility possible in our high-tension lines.

In this connection, next Sunday evening General Electric will honor Dr. Steinmetz on its Sunday evening television program. I mention Dr. Steinmetz here because our speaker today knew him well and attended some of his classes.

You have our speaker's biography and know that this is his fifth visit. He is a very busy man, and is a recognized leader in his field in the country. Certainly we are honored by his visit. It gives me great pleasure to introduce to this year's class the president of the American Gas and Electric Company and its subsidiaries, Mr. Philip Sporn.

MR. SPORN: General Hollis, Admiral Deutermann, members of the Industrial College of the Armed Forces: It is a great pleasure and a privilege both to have this opportunity again to appear before you and to tell you something about power, and particularly the place of electric power in national security.

I have again resorted to a technique that I have used on other occasions, and that I hope to find effective here. There have been handed out to you a series of printed charts or diagrams, which I will refer to in the course of my remarks. The series is complete except for three charts, two of which I was given permission to use by the Atomic Energy Commission but not to reprint, and the last, which is one of my own, but is premature to release.

The place of electric power in the economic life, and therefore in the security, of any industrialized society, in the life of the United States, for example, is critically important. It is particularly important when it is absent. Without power today the functioning of all of our commercial establishments, all our farms, our homes, our commercial buildings, and our industry--all of them are utterly inconceivable. Functioning for all of them would almost be impossible, and certainly would go down to a much lower level of activity. Certainly high level production and productivity both are impossible without resort to tools and to the electric power to drive them.

In the production of electric power the United States has held a commanding position for a long time. With something like 6 percent of the world's population, we have had 40 percent of the world's production of electric energy for close to thirty years. We hold such a commanding position today.

The breakdown of such use in the last decade and a half is shown clearly in chart 1, page 3. I would like to call your attention to just a few points in connection with it.

Note, for example, that in the decade 1940-1950 electric energy production has more than doubled--from approximately 180 billion to 389 billion kilowatt hours. Again note that the rate of growth between

CHART 1

ELECTRIC ENERGY CONSUMPTION BY VARIOUS CLASSES OF CUSTOMERS 1940, 1950, 1954 AND 1955

CLASSIFICATION	1940	1950	1954	1955 [1]
	Millions of kilowatt-hours			
RESIDENTIAL OR DOMESTIC	23,317	67,030	108,645	120,500
RURAL	1,991	7,400	10,176	10,700
SMALL LIGHT AND POWER	22,373	50,446	73,373	80,500
LARGE LIGHT AND POWER	59,557	139,065	200,155	249,000
STREET AND HIGHWAY LIGHTING	2,048	2,976	4,042	4,400
OTHER PUBLIC AUTHORITIES	2,720	7,163	9,423	10,100
ELECTRIC TRACTION	5,910	5,881	4,701	4,500
INTERDEPARTMENTAL	727	578	569	595
TOTAL UTILITY SALES	118,643	280,539	411,084	480,295
LOSSES	23,194	48,601	60,705	66,209
TOTAL UTILITY PRODUCTION	141,837	329,140	471,789	546,504
PRODUCTION FOR SELF USE	38,100	59,533	73,036	78,497
TOTAL UNITED STATES PRODUCTION	179,937	388,673	544,825	625,001

[1] Preliminary

Source: EEI

March 1956

1950 and 1955 is an even faster rate than in the preceding decade. And, still again, you will note that residential use has almost trebled in the decade 1940-1950, and again in the period 1950-1955 it has almost doubled.

I want you also to note that the production for self-use, which at one time was a dominant element of the energy picture of the United States, was still 21 percent of the total in 1940, but by 1955 had dropped to 12-1/2 percent.

If you go on to chart 2, page 5, I would like to point out one or two things. Here I have shown the rate of growth of electric energy production in the United States as compared with most of the leading countries of the world. You will notice by the slope of the curve--this is on a logarithmic scale--that so far in this 35-year period, 1920-1955, we have been fully holding our own against other countries.

A very interesting curve to look at is the Russian curve. You will notice that for the last five years, in fact, for the last ten years or so, we and the Russians have been operating on about a parallel slope. Those of you who have been reading the details of the recently announced Russian Five-Year Plan may have seen that the 1960 goal for Russia was some 320 billion kilowatt hours. This is an 88 percent increase over their 1955 figure. Personally I question whether they can make it. But it is a formidable objective; and, if they do achieve it, it will certainly be an achievement of no mean order.

In chart 3, page 6, I have shown the backup data for chart 2. There is nothing here except substantiating data, but I thought you might like to have it.

Now, looking forward toward the future, it seems to me that this conclusion is quite clear out of our general experience and out of our close study of the whole energy problem: For a dynamic and healthy economy, all classes of use must expand.

Take, for example, residential use. It is a recognized fact that the domestic servant has practically disappeared; the few that still remain in American homes are certainly on the way out. So some substitute has to be found, and that substitute is electric energy. Automatic cooking, which means electric cooking, will have to come with the disappearance of the servant. Automatic washing, again electric cooking, even electric heating, which solve a great many

CHART 2

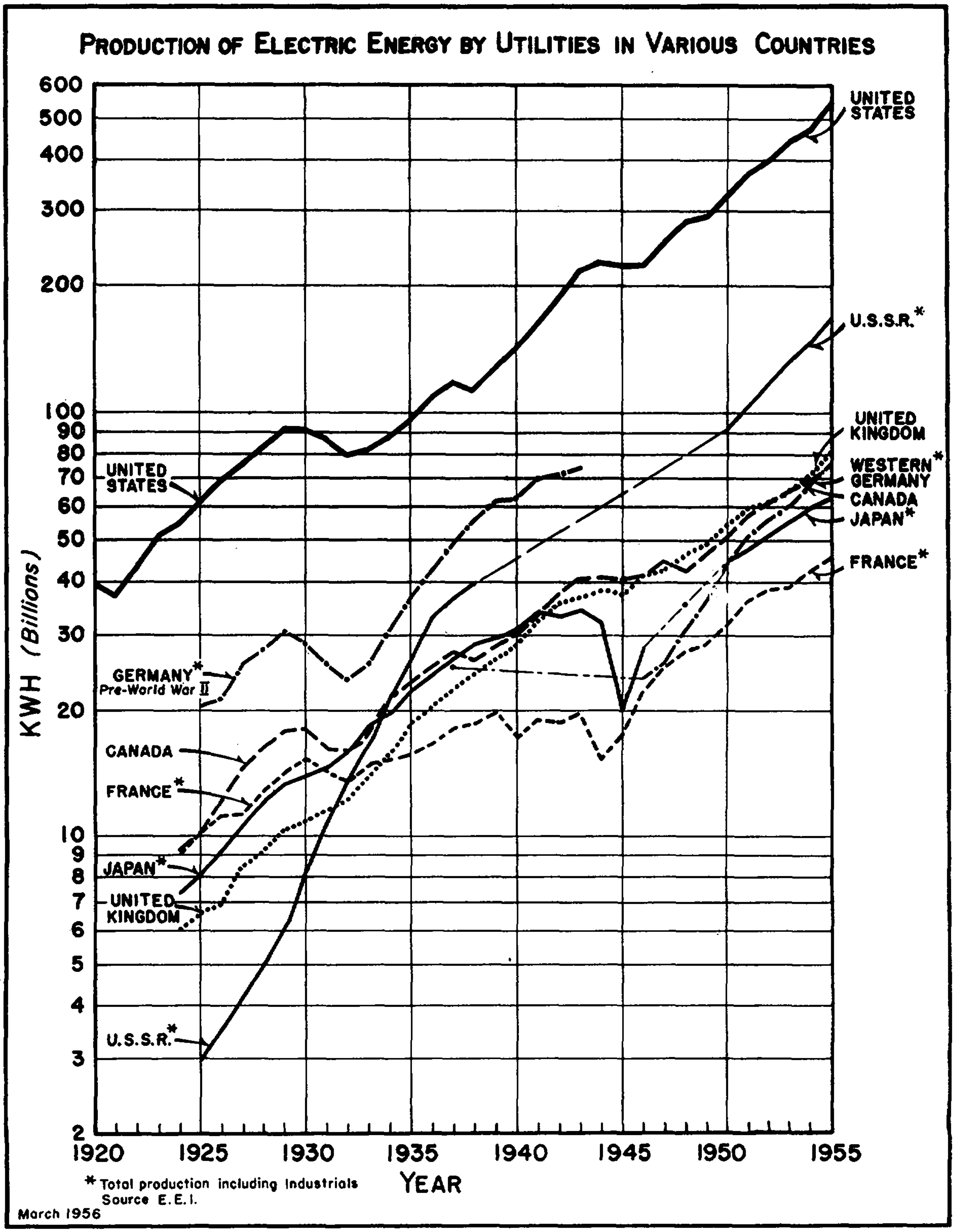

PRODUCTION OF ELECTRIC ENERGY BY UTILITIES IN VARIOUS COUNTRIES
KWH (Billions)
YEAR
UNITED STATES
U.S.S.R.*
UNITED KINGDOM
WESTERN* GERMANY
CANADA
JAPAN*
FRANCE*
GERMANY*
Pre-World War II
* Total production including Industrials
Source E.E.I.
March 1956

CHART 3

PRODUCTION OF ELECTRIC ENERGY BY UTILITIES IN VARIOUS COUNTRIES IN MILLIONS OF KILOWATT-HOURS

YEAR	UNITED STATES	CANADA	UNITED KINGDOM	FRANCE[1]	U.S.S.R.[1]	GERMANY[1]		JAPAN[1]
						Pre-World War II	West Germany	
1920	39,405							
1921	37,180							
1922	43,632							
1923	51,229							
1924	54,662	9,315	6,022	9,066				7,331
1925	61,451	10,110	6,619	10,222	2,925	20,328	-	8,172
1926	69,353	12,093	6,992	11,268	3,507	21,218	-	9,313
1927	75,418	14,549	8,452	11,388	4,173	25,135	-	10,559
1928	82,794	16,338	9,324	12,976	5,007	27,870	-	12,036
1929	92,180	17,963	10,401	14,352	6,224	30,661	-	13,312
1930	91,112	18,094	10,947	15,339	8,368	28,914	-	13,910
1931	87,350	16,331	11,533	14,232	10,687	25,788	-	14,402
1932	79,393	16,052	12,347	13,602	13,540	23,460	-	15,950
1933	81,740	17,339	13,915	14,906	16,357	25,654	-	18,160
1934	87,258	21,197	15,587	15,172	21,016	30,662	-	19,900
1935	95,287	23,283	17,971	15,818	25,900	36,697	-	22,348
1936	109,316	25,402	20,524	16,659	32,700	42,487	-	24,312
1937	118,913	27,684	22,908	18,162	36,400	48,969	25,200	26,714
1938	113,812	26,160	24,372	18,576	39,600	55,238	-	28,896
1939	127,642	28,344	26,412	19,716	-	61,380	-	29,484
1940	141,837	30,108	28,776	17,376	-	62,964	-	30,972
1941	164,788	33,312	32,364	19,044	-	69,999	-	33,444
1942	185,979	37,356	35,652	18,924	-	71,500	-	33,072
1943	217,759	40,476	36,948	19,956	-	73,943	-	34,284
1944	228,189	40,596	38,364	15,384	-	-	-	32,580
1945	222,486	40,104	37,284	17,568	-	-	-	20,064
1946	223,178	41,604	41,256	22,164	-	-	23,820	28,152
1947	255,739	44,988	42,576	25,128	-	-	25,660	-
1948	282,698	42,384	46,488	27,564	-	-	30,910	35,580
1949	291,100	46,668	49,056	28,560	-	-	35,700	-
1950	329,141	50,904	54,960	31,476	91,080		44,028	44,892
1951	370,234	57,420	59,964	36,048	103,560	-	51,360	47,724
1952	399,324	61,788	61,992	38,455	118,560	-	56,208	51,648
1953	442,014	65,484	65,508	38,916	133,680	-	60,456	55,704
1954	471,686	69,132	72,900	42,768	149,400	-	67,872	59,604
1955	546,404*	76,447	80,148	46,548	170,000*	-	75,800*	63,300*

SOURCE: E.E.I., U.N.

[1] Total Production including industrials

* Preliminary

problems of manpower or womanpower or the lack of them--all of them lead to an extensive increase of electric energy use in the home.

On the farm, without going into a detailed series of discussions, you will find that we have had for many decades a continuing decline in the farm labor force. But equally clear is the fact that we have had with it an increase in production on the American farm. And farms are certainly an indispensable element in our economy, because we all have to eat.

A good deal of the increase in productivity, it is true, is not the result of the utilization of electric power, but is, rather, due to tractor power. But it is significant that the electric power portion of the total power used on the farm is increasing.

If you will examine in this connection the curve in chart 4, page 8, you will see what has been happening to the use of electric energy on the American farm. This curve, incidentally, shows a 7.8 percent long-term trend for growth in electric power use on all farms in the United States. But I believe that we are definitely approaching the period when the accepted trend line will have to be changed. It is probably much closer to a ten percent trend line at the present time than 7.8 percent.

If you are wondering about the peculiar shape, the V-point, in the curve for the period 1926-1940, that was brought about during the period when a very large farm acreage was brought in on an irrigation basis; and pumping, which theretofore had been a significant item in energy use, temporarily disappeared. But that trend too is reversing itself.

Now, in manufacturing, which I have shown on chart 5, page 9, I want to point to a few fundamental, basic factors. I want you to note first the curve of the annual kilowatt hour use per worker. That is the dotted or broken curve, the middle curve. It seems to me that this curve, as you notice it on a log scale, is particularly impressive when you consider that the weekly hours of labor have progressively gone down. Yet this curve has a strong upward trend in spite of that.

If you take a look at the long-term trend curve and examine, for example, the figure for 1928, let us say, and compare it with the projected figure for 1968, which I think is quite clear now, you will find a ten-to-one increase in the total energy use in manufacturing.

CHART 4

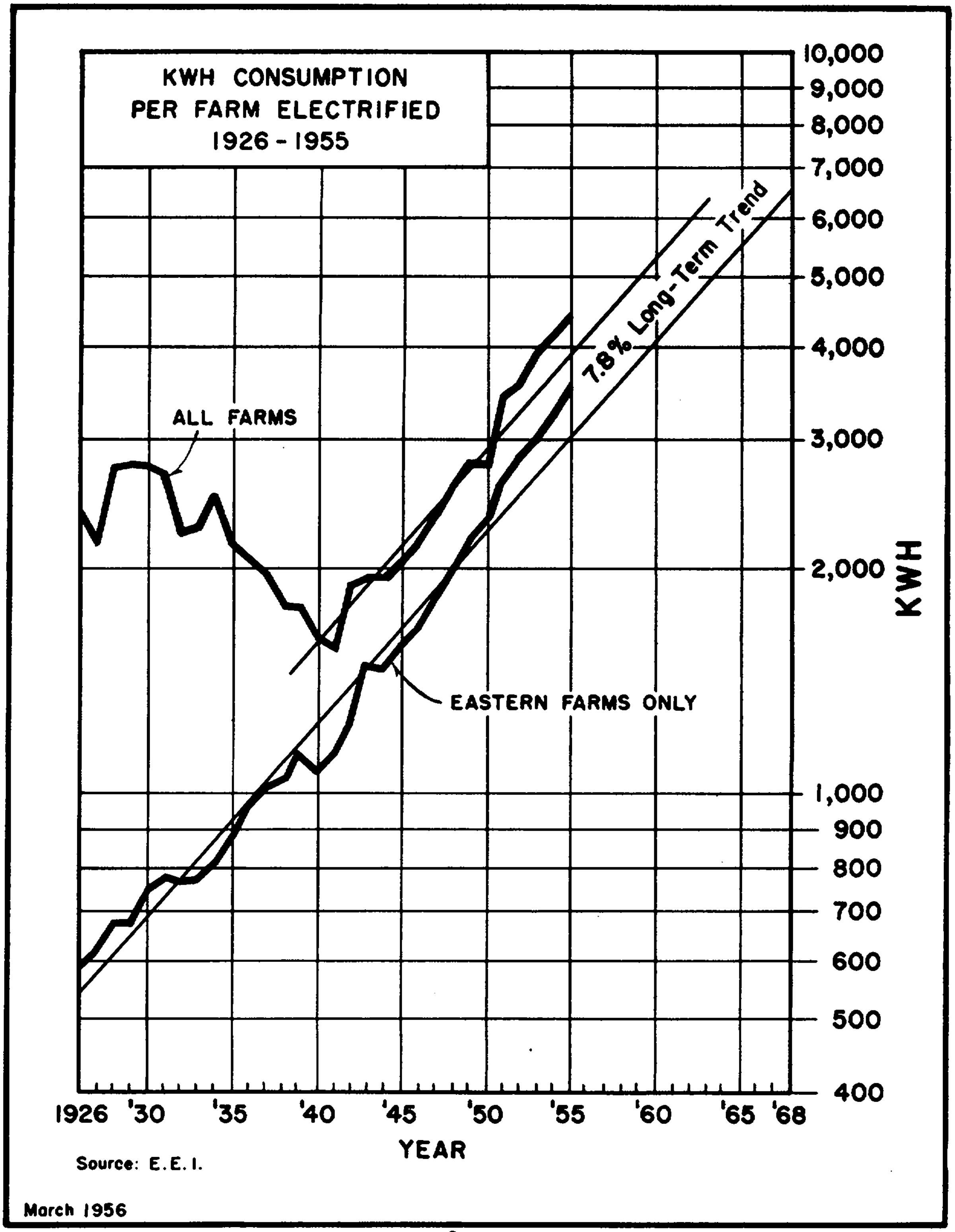
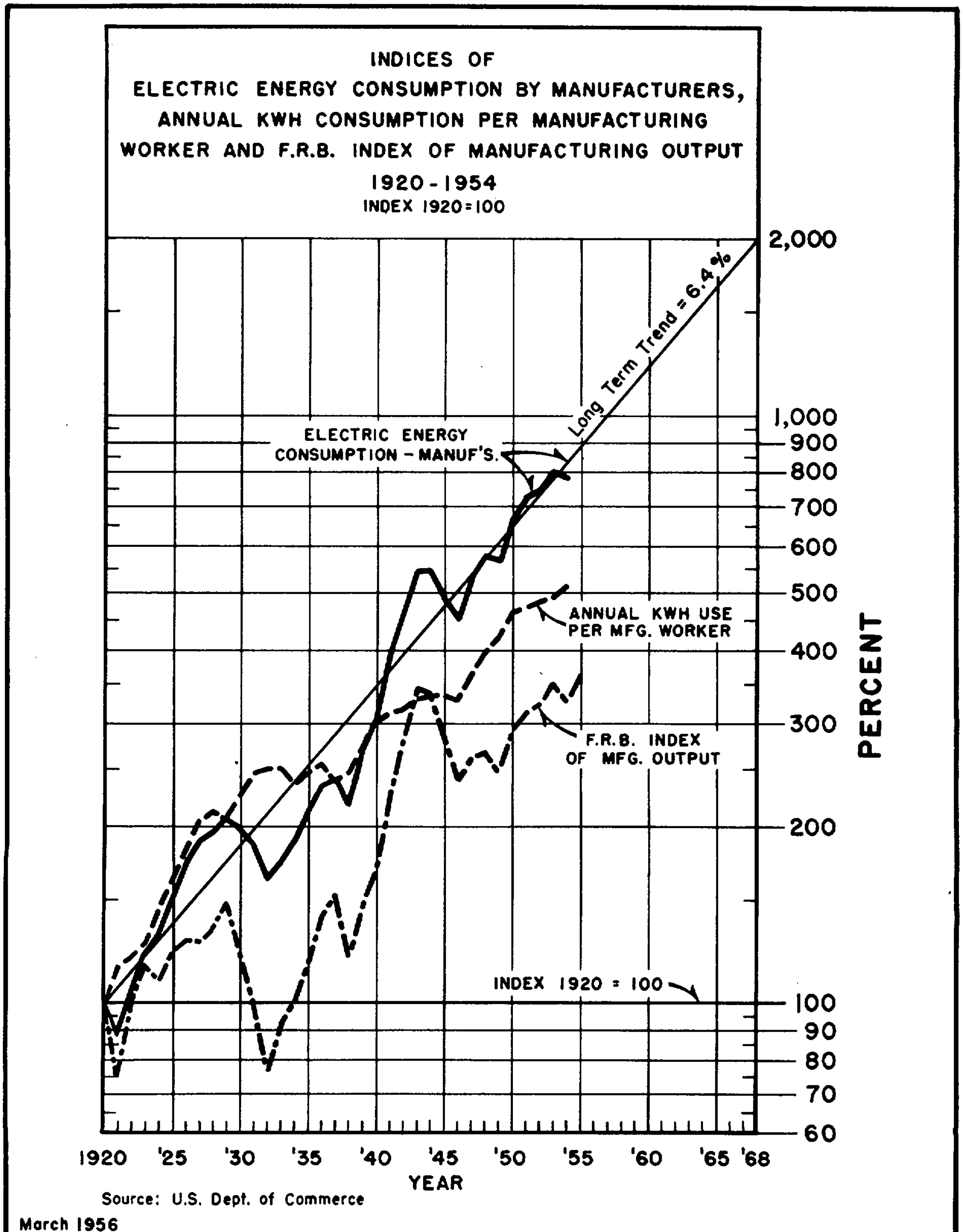

KWH CONSUMPTION
PER FARM ELECTRIFIED
1926 - 1955
ALL FARMS
EASTERN FARMS ONLY
7.8% Long-Term Trend
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
900
800
700
600
500
400
KWH
1926
'30
'35
'40
'45
'50
'55
'60
'65
'68
YEAR
Source: E.E.I.
March 1956

CHART 5



INDICES OF
ELECTRIC ENERGY CONSUMPTION BY MANUFACTURERS,
ANNUAL KWH CONSUMPTION PER MANUFACTURING
WORKER AND F.R.B. INDEX OF MANUFACTURING OUTPUT
1920 - 1954
INDEX 1920=100
Long Term Trend = 6.4%
ELECTRIC ENERGY
CONSUMPTION - MANUF'S.
ANNUAL KWH USE
PER MFG. WORKER
F.R.B. INDEX
OF MFG. OUTPUT
INDEX 1920 = 100
2,000
1,000
900
800
700
600
500
400
300
200
100
90
80
70
60
PERCENT
1920
'25
'30
'35
'40
'45
'50
'55
'60
'65
'68
YEAR
Source: U.S. Dept. of Commerce
March 1956

Actually, as we all know, productivity can come only from more tools and energy per worker. There is just one way, either today or in the years to come, in a society like ours--it might be different in a slave society--but in a society of free men there is just one way to bring about an increase in productivity, and that is by making each human being, each worker, produce more through the use of a greater amount of energy in the form of tools driven by electric power.

I think this same factor is shown even more clearly in chart 6, page 11. If you will examine this, you will see that what we have here, plotted from 1936 and projected to 1970, is the kilowatt hours per man-hour. I believe that kilowatt hours per man-hour is a true criterion of what it is that we are really getting in the way of productivity.

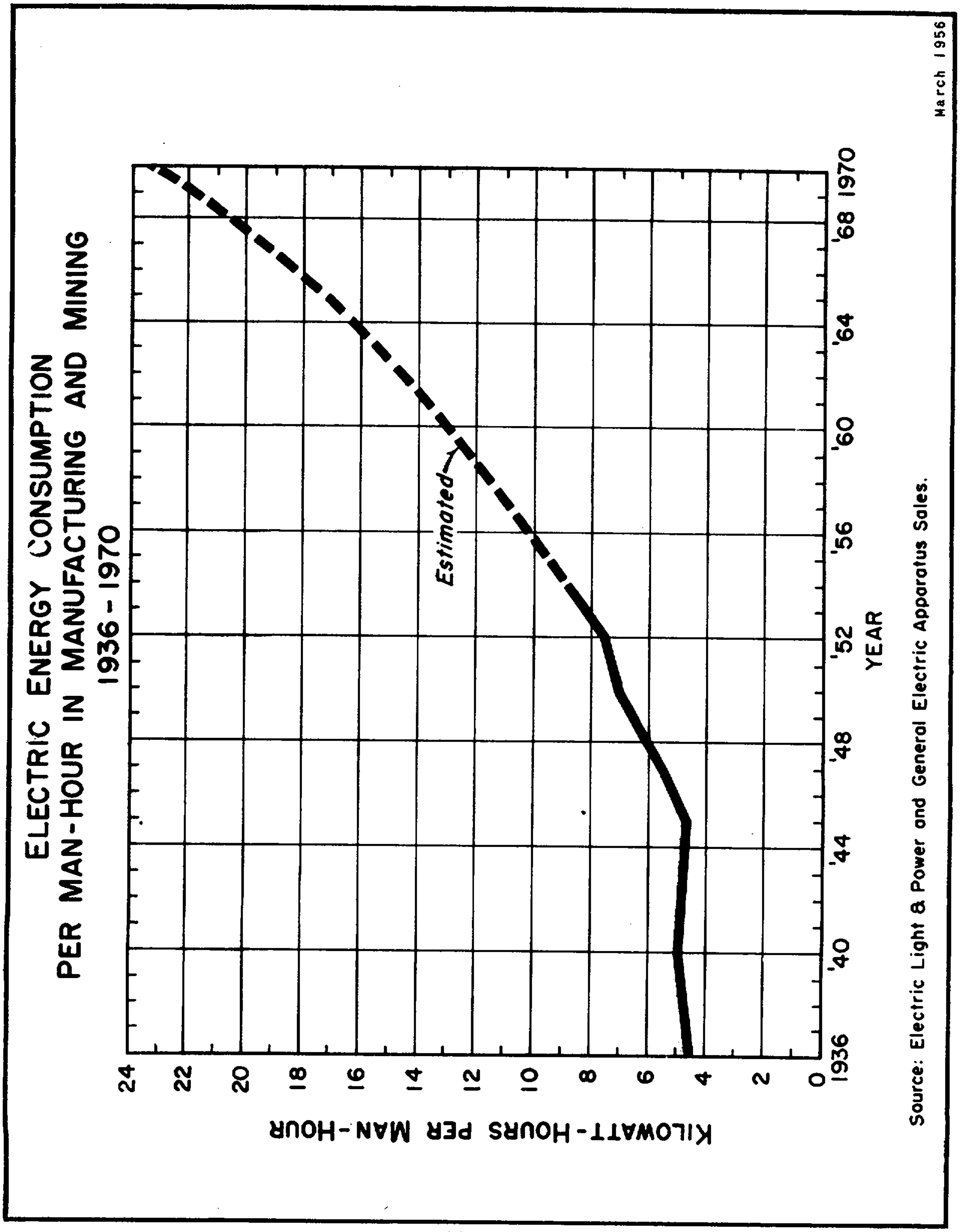
As you would expect, and as I pointed out to you a moment ago, the kilowatt hours per worker have got to go up; and the kilowatt hours per man-hour have got to go up even more sharply than the increase in production, because of the decline in the hours worked by each man in the labor force. If productivity is to climb up, then we must have that kind of a trend.

Now, I think you might be interested in another point. It is not an uninteresting point. If we assume that a kilowatt hour of electric energy is equivalent to approximately twelve men--and I think that is about the right ratio, and it has to be twelve husky men--this means that what we are projecting for 1970 is a multiplication of the power, of the labor, that one individual can do on the average, by 300. That is one of the great achievements of our society, this American society that we are living in today, and which we are carrying forward even to much greater heights.

Street lighting must go up as another element of the use of electric energy. That is obvious. The number of people is increasing. The number of highways and streets is increasing. The use of these highways and streets is being intensified. If we are going to keep them safe, they must be better lighted.

Electric traction, which at one time appeared to be headed for a really great development, strangely enough is a field where electric use offers the most, but where there has been considerable regression. In my judgment the regression is only a temporary one. It may take another generation for electric traction to come into its own; but I believe that almost certainly, within the next 20 or 25 years, we are going to see a new upward development of it, certainly on the main rail lines of the country.

CHART 6


ELECTRIC ENERGY CONSUMPTION
PER MAN-HOUR IN MANUFACTURING AND MINING
1936 - 1970
March 1956
Estimated
KILOWATT-HOURS PER MAN-HOUR
0
2
4
6
8
10
12
14
16
18
20
22
24
1936
'40
'44
'48
'52
'56
'60
'64
'68
1970
YEAR
Source: Electric Light & Power and General Electric Apparatus Sales.

Now, when you add up all of these things to see what kind of picture they lead to, you can see in power development, first looking at it retrospectively and then progressing forward--and I am referring now to chart 7, page 13--the kind of use that is indicated for the years ahead. The four columns on the left show a breakdown of electric use in the United States by classes for 1940, 1950, 1954, and 1955. There are also projections for the years 1960, 1965, 1970, and 1975.

Now, a 20-year projection, in my judgment, is not an easy projection to make; but it is not an impossible one. I think a projection like that can be made with a fair degree of reliability, certainly if you study the fundamental factors deeply enough and carefully enough so as not to miss anything. Once you get beyond 20 or 25 years, I think you are getting into some very deep water.

I want to point out to you that, if you take a look at the 1975 figure, you will find a tremendous growth in all classes of use, with the exception of traction.

I also want to underscore this: Projected here is one trillion kilowatt hours production by the utilities in 1965, and a projection of two trillion kwh for 1975. That is a doubling in the period 1965-1975.

If you think that this is a very optimistic rate of growth--and you realize that a doubling in ten years means a compound growth rate just slightly above seven percent--I want to point out to you that for our own system, which accounts for about 4-1/2 percent of the electric energy produced in the United States, we have had a compound rate of growth of over 11 percent during the last ten years. That is a doubling in slightly over six years.

Then finally I want to call to your attention again that percentage-wise the projection for self-use shows up here again as a declining figure.

Now, so much for what is ahead and what has to be the history of what I believe is ahead in this country in the way of growth if we are going to stay the kind of society we are now but with a continuation of the development of our potentialities over the next 20 to 25 years.

CHART 7

FORECAST OF ELECTRIC ENERGY CONSUMPTION BY VARIOUS CLASSES OF CUSTOMERS
1940 - 1975

CLASSIFICATION	ACTUAL				FORECAST			
	Millions of kilowatt-hours							
	1940	1950	1954	1955 [1]	1960	1965	1970	1975
RESIDENTIAL OR DOMESTIC	23,317	67,030	108,645	120,500	190,000	283,500	415,000	545,000
RURAL	1,991	7,400	10,176	10,700	12,500	14,000	18,000	22,500
SMALL LIGHT AND POWER	22,373	50,446	73,373	80,500	110,000	150,000	190,000	245,000
LARGE LIGHT AND POWER	59,557	139,065	200,155	249,000	325,000	440,000	680,000	900,000
STREET AND HIGHWAY LIGHTING	2,048	2,976	4,042	4,400	5,000	6,000	7,500	9,000
OTHER PUBLIC AUTHORITIES	2,720	7,163	9,423	10,100	12,000	16,000	19,000	23,000
ELECTRIC TRACTION	5,910	5,881	4,701	4,500	5,000	5,000	5,000	5,000
INTERDEPARTMENTAL	727	578	569	595	500	500	500	500
TOTAL UTILITY SALES	118,643	280,539	411,084	480,295	660,000	915,000	1,335,000	1,750,000
LOSSES	23,194	48,601	60,705	66,209	90,000	125,000	185,000	250,000
TOTAL UTILITY PRODUCTION	141,837	329,140	471,789	546,504	750,000	1,040,000	1,520,000	2,000,000
PRODUCTION FOR SELF USE	38,100	59,533	73,036	78,497	105,000	140,000	200,000	250,000
TOTAL UNITED STATES PRODUCTION	179,937	388,673	544,825	625,001	855,000	1,180,000	1,720,000	2,250,000

[1] Preliminary

Source: EEI

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I want to take a brief period to talk to you about the history of the United States power production vis-a-vis defense needs.

I think the record is quite clear that in the United States, power has never been a critical component in fighting a war. That is not because it has not been important, but because of the job that has been done in making it available to the national economy or to the national security pool.

If you go far back--I don't know how far one wants to go back--there is really no point in going back to the Spanish-American War--energy did not play the part in our country that it does today. And even World War I is not very helpful. World War I, I think, gave just enough indication to show that in the next war, if there was going to be one--you recall, that was the war that was fought to end wars--power would have to be seriously considered. And, of course, it was; and it was a critical component. It was a critical component in defense, certainly an important component; but it was not in short supply at any time during the war. Insofar as I know, not a single item of the war effort was retarded or failed to be carried through as it was contemplated by the military and the civilian planners due to lack of power in World War II.

I would like to show you a number of fundamental data, to give you some insight as to why that was so. If you will examine chart 8, page 15, you will find that there we have shown the power production and the growth of energy per capita in the United States in the 35-year period 1920-1955. First you will note that we had a little less than a quadrupling in the kilowatt hours used in the two decades 1920-1940. But on the other hand, noticing what has happened since 1941, you will see that we are definitely headed for a quadrupling in considerably less than 20 years. So the rate of growth between 1941 and 1961 will be more rapid than the rate of growth between 1920 and 1940.

I also want you to observe that not only have we increased the energy available to the American economy, but we have had a fast rise in the per capita availability--from a figure of less than 2,000 kwh in 1945 to a figure of close to 4,000 in 1955; and that curve is rising very rapidly, in spite of the rise in population, which is also rising at a very fast rate.

I would like to show you the same data in the form of capacity, in the next chart, (chart 9, page 16). As you know in times of crisis, in times of war, where you have an opportunity to plan, you can take a given

CHART 8

POWER PRODUCTION AND GROWTH IN POPULATION IN THE UNITED STATES 1920 - 1955

YEAR	POPULATION (000's)	KWH PRODUCED (000,000's)	KWH/CAPITA
1920	106,466	56,559	531
1925	115,832	84,666	731
1930	123,188	114,637	931
1935	127,362	118,935	934
1940	132,122	179,937	1,361
1941	133,402	208,307	1,561
1942	134,860	233,179	1,729
1943	136,739	267,540	1,957
1944	138,397	279,525	2,020
1945	139,928	271,255	1,939
1946	141,389	269,609	1,907
1947	144,126	307,400	2,133
1948	146,631	336,808	2,297
1949	149,188	345,066	2,313
1950	151,683	388,674	2,562
1951	154,360	432,319	2,801
1952	157,028	462,589	2,946
1953	159,643	513,518	3,217
1954	162,409	544,645	3,354
1955	165,248	624,901 *	3,782

* Preliminary

Source - EEI, Bureau of the Census.

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CHART 9

ELECTRIC UTILITIES' GENERATING CAPACITY, PEAK LOADS AND INDICATED RESERVES IN THE UNITED STATES 1920 - 1955

YEAR	NON-COINCIDENT PEAK LOADS MW	INSTALLED CAPACITY - TOTAL ELECTRIC UTILITY INDUSTRY MW	INDICATED RESERVES MW	INDICATED RESERVES - % OF NON-COINCIDENT PEAK DEMAND
1920	8,600	12,700	4,100	47.7
1925	14,150	21,470	7,320	51.7
1930	19,700	32,400	12,700	64.4
1935	21,000	34,450	13,450	64.0
1939	28 700	38,863	10,163	35
1940	30,800	39,927	9,127	30
1941	34,650	42,405	7,755	22
1942	35,850	45,053	9,203	26
1943	40,100	47,951	7,851	20
1944	40,650	49,189	8,539	21
1945	39,550	50,111	10,561	27
1946	45,000	50,317	5,317	11.8
1947	49,550	52,322	2,772	5.6
1948	53,750	56,560	2,810	5.2
1949	56,500	63,100	6,600	11.7
1950	64,300	68,919	4,376	6.8
1951	70,450	75,775	5,325	7.6
1952	75,450	82,226	6,776	9.0
1953	81,200	91,502	10,302	12.7
1954	88,700	102,592	13,892	15.7
1955[1]	101,650	114,371	12,721	12.5

[1]Preliminary

Source- EEI

amount of capacity and materially increase energy production merely by scheduling something close to 100 percent utilization of it. But first I would like to point out that if you examine the third column, that is, the installed capacity in the utility industry, you will find, for example, that in the decade between 1945 and 1955, in spite of the postwar hesitation--you can see the small figure you had in 1946 and the really moderate increase that you had in 1947--in spite of that, we had an increase of more than 130 percent in the capacity of the power production facilities in the United States.

You will also see, if you look at the second column, that the peak capacity, the noncoincident peak loads, actually increased by over 150 percent; these went up in the same period from a peak of 39, 550, 000 kilowatts in 1945 to over 101, 000, 000 kilowatts in 1955.

If you want to see what is ahead for the immediate future, I think you will find it worthwhile to take a look at chart 10, page 18. Here you will find the same data projected beyond 1955. I want to point out, however, that we have introduced a new figure here. This is the figure of capability. The data in the previous chart are name plate data of capacity. Actually it is the capability figures that count. Generally in a modern system the capability is greater than the name plate data of capacity. In some cases the capability could be less. It is important, however, that you take the more fundamental of the two sets of data, and that is capability.

I want to point out to you first that the projection of 165 million kilowatts of total capability in the United States for 1960 represents a value of more than four times the total capability that was available to the country in 1939, when our World War II defense program was started.

Then I want to point out to you in the second column from the right the margin expected between the capability and peak for 1960. Although it is only a 21 percent margin, as against a 35 percent margin that we had going into our defense program in 1939, it is more than 75 percent of the total capacity or capability that was available to the country in 1939. And that indicates again this rate of growth and this rate of increase in the energy producing facilities of the United States.

This 29 million kilowatts of capability shown in chart 10 is, I believe, very important. In the last war, the war load as such was about 11 million kilowatts. So this margin represents a capability of almost three times that demand.

LOAD AND CAPABILITY SITUATION
ELECTRIC POWER SYSTEMS OF THE UNITED STATES

YEAR	CAPABILITY MW	PEAK LOAD MW	GROSS MARGIN MW	GROSS MARGIN %
1939	38,850	28,700	10,150	35.4
1953	95,500	81,200	14,300	17.6
1954	107,500	88,700	18,800	21.2
1955	119,850	101,650	18,200	17.9
1956	123,800	103,700	20,100	19.4
1957	131,900	111,000	20,900	18.8
1958	141,400	118,000	23,400	19.8
1959	153,000	127,000	26,000	20.5
1960	165,000	136,000	29,000	21.3

Source - EEI

Now, that doesn't mean that in the next emergency we can stand still, and, provided we have that kind of reserve, we will be able to take care of ourselves. There are a great many reasons for that. First, some of that capacity is going to be out of commission. We simply cannot keep capacity distributed over the length and breadth of this great country and have all of it in 100 percent condition all the time. Some of it is going to be unavailable in places where you want it. At times some of it is going to be bottled up. It may be bottled up by transmission, or it may be bottled up by inability to use local capacity that is available.

In World War II there was capacity available in New York that wasn't good for very much, because the war industry wasn't located in New York. Some of you may recall that this led to an aluminum reduction operation being built, and being entirely dismantled almost immediately after V-J day, at Maspeth, Long Island. It was put there because our war industry needed an increase in the production of aluminum. But you can't produce aluminum without a great deal of power, and there was a great deal of power in New York that we couldn't find any other use for.

Now, the problems of the next war may also be on a totally different scale. They may come on rather more quickly than those we had to contend with before. Then, of course, we may lose a considerable percentage of our reserves in the first attack.

I want now to take a few minutes to discuss power in the next defense mobilization crisis, assuming that we are talking about something that may happen in the next 25 years. Again I don't want to make any projections that go beyond that.

It seems to me that the important thing is that both the peacetime and the defense portions of the economy--if we are to be prepared to meet a crisis like that--should be able to expand to their maximum potentialities. I am not going to go into a long discussion of the importance of our peacetime economic growth as a defense measure--but, if you look at the problem from both the peacetime and defense angles, I believe that power will be able to contribute its full share and make such expansion possible to the fullest extent that the country can use.

Now, the reasons for that have already been partially indicated, but I would like to develop them just a little bit more fully in the next few minutes.

The first is the satisfactory status of power development--what is going on in building new power facilities in the country, as I have just shown you. The second is the status of our technology--in engineering, in manufacturing, and specifically in such very important items as turbines, both hydro and steam, particularly steam turbines; boilers; transmission and distribution facilities; and the utilization facilities. The third is the standing of the utilities of the country and the confidence that the utilities of the country command among the people of the United States.

Still another item is the program for quadrupling of the power facilities of the country over the next two decades. This is now being visualized by a large segment of the utility industry, and is being reflected in the 1960 program of the utilities.

Finally, we are coming into an era of what I call mass production of energy in the United States. We have given clear evidence that we know what that means and what we are able to do in the field; and the amount of electric energy that can be made available to the needs of the country is simply fantastic.

This is a subject that could be discussed at great length. I will just take a minute or two to discuss the case of OVEC. The initials stand for the Ohio Valley Electric Corporation. It is a company that was nonexistent before October of 1952. It was organized in October of 1952, following a decision by the Atomic Energy Commission that in the then-pending great expansion of the diffusion facilities of the Commission, one of the large plants was going to be located in the Ohio Valley, and that a large block of power representing something on the order of 15 to 18 billion kilowatt hours a year, would be needed, and would be needed very quickly.

These ideas were communicated to a group of utilities, among whom my company was one, early in 1952; three months later a rather full plan was developed and submitted to the Commission for taking care of this huge energy requirement. The Commission accepted that proposal as the basis of negotiation. Following long negotiations, a contract was executed in October 1952. By December we broke ground for two large plants, at that time scheduled to be the two largest plants in the United States. They are not that today, but they are still the two largest plants that have ever been built by private enterprise.

Those plants today are in complete commercial operation, roughly three years after the first ground was broken, and are producing energy at a rate, and delivering it to the Atomic Energy Commission at a rate, some 25 percent greater than all the energy requirements of the City of New York, the greatest city in the civilized world.

That shows what has been done on this scale of mass energy generation that this really represents. I have some charts illustrating some features of that project which I want to show.

Chart 11, page 22, is a diagram of the scheme of power supply. I want to point out to you there that in the upper right-hand corner you see the load of the diffusion plant, marked "X-533" and "X-530." That is the newest, and, I believe, the largest, diffusion plant in the country today.

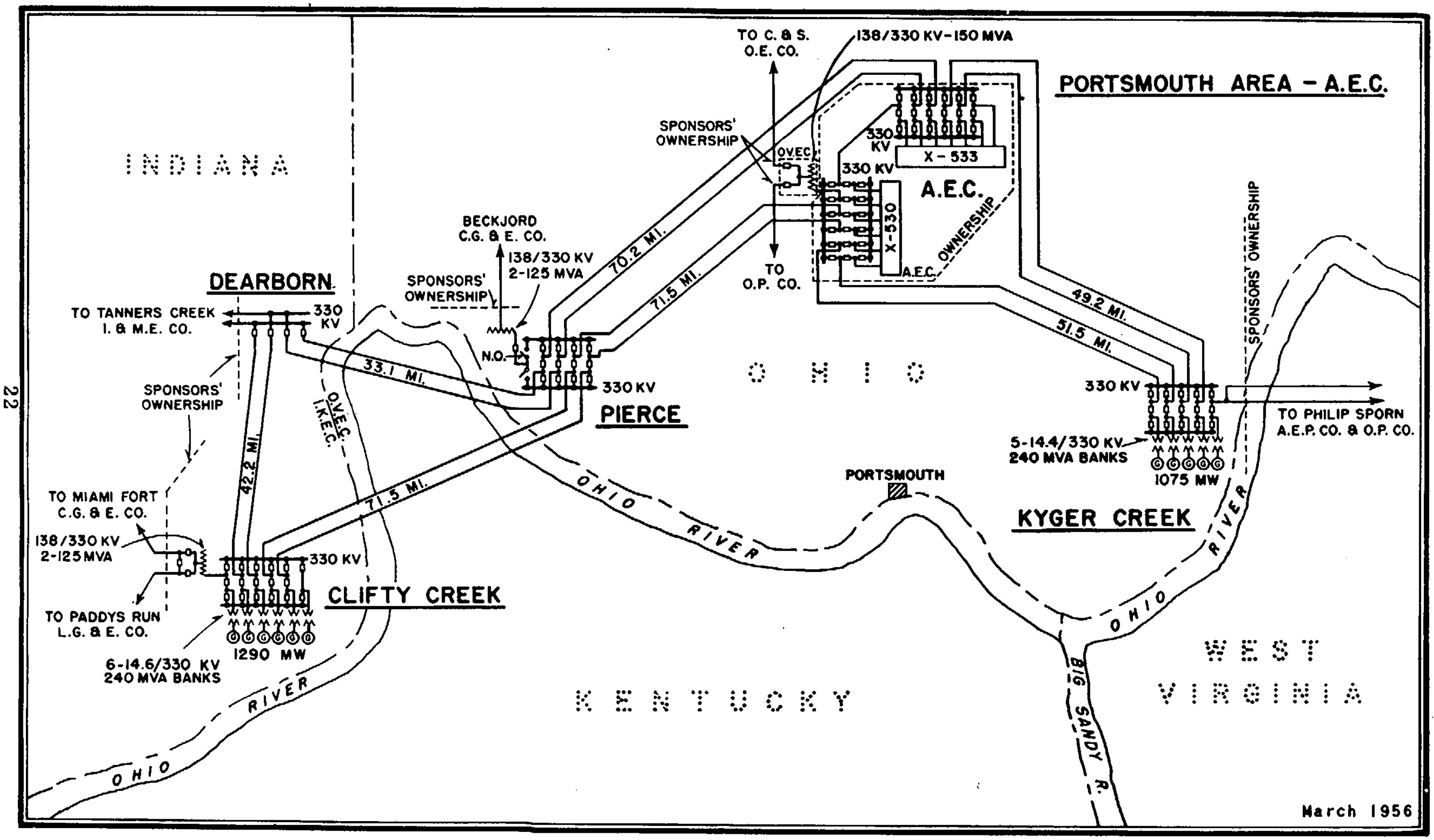
Notice on the extreme left the Clifty Creek plant, a plant of six units, each one rated at 215 megawatts, generating a total of 1, 290 megawatts and delivering its output to two single powerlines, just two lines with just four sets of conductors or circuits, and going to the diffusion plant, and ending up with four circuits there by way of the Dearborn and Pierce Stations.

Then on the extreme right of the figure is the Kyger Creek plant, of five units, with the same rating, with a total of 1, 075, 000 kilowatts, and delivering its power through four circuits, again through two power lines to the Atomic Energy plant.

Going to the next one (chart 12, page 23) you will see one of the literally hundreds of studies that were carried out prior to the commitment of the plan and the decision to proceed on the basis that I have indicated.

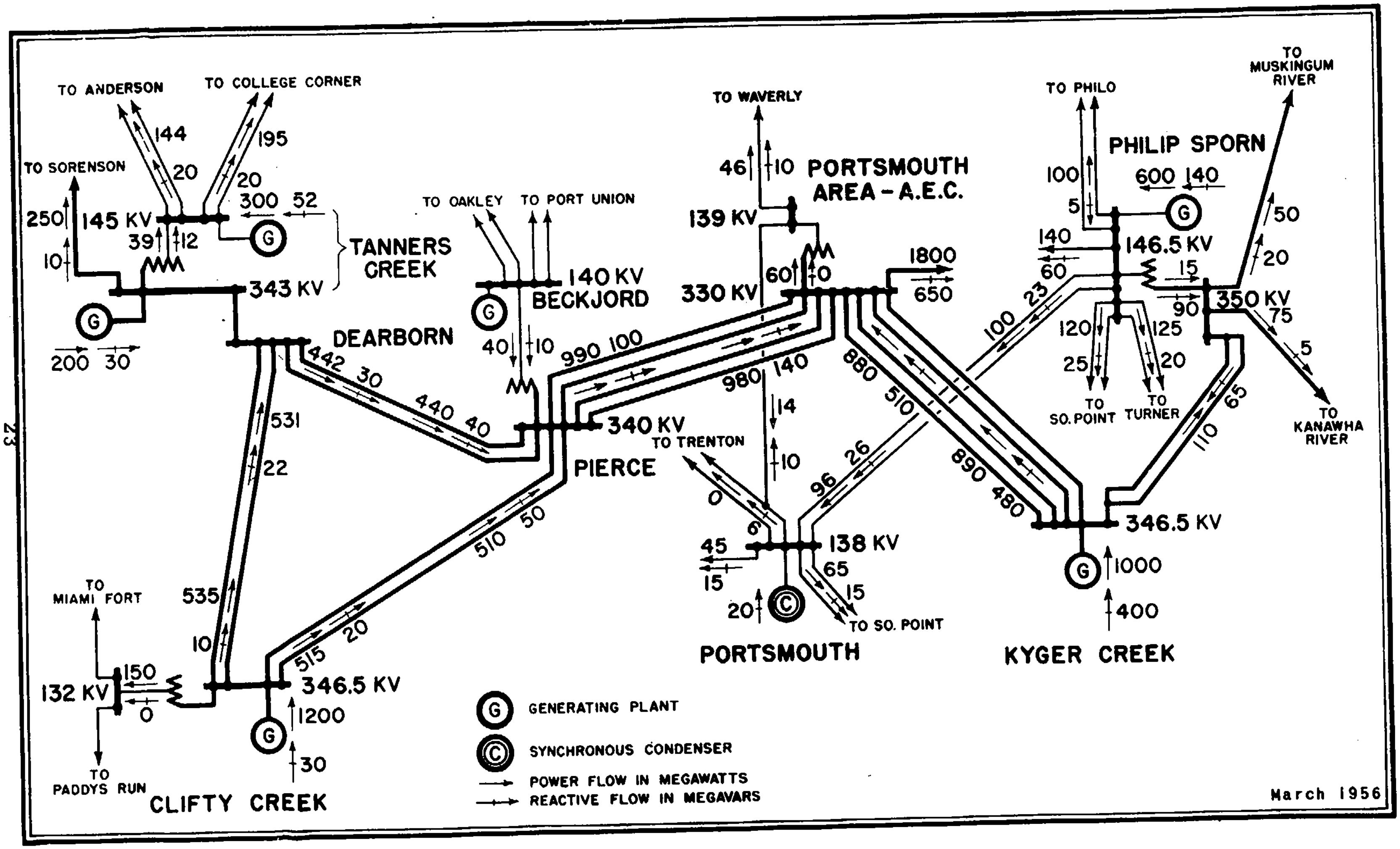
The most interesting item there to consider, for example, if you want to look at just one thing, is the power flow in the four circuits going from the Pierce station to the Portsmouth Diffusion Plant. You will notice that there are two powerlines, four circuits, with the total load of 990, 000 kilowatts. Actually we have at times delivered over a million kilowatts over these lines. But the system is so set up that either one of these two powerlines could go out of service and the load still remain uninterrupted. So that what you have to have under those conditions is a single powerline carrying and delivering a million kilowatts. That is what I call mass transmission of mass-generated energy.

CHART 11



DIAGRAMMATIC VIEW OF OVEC-IKEC GENERATION AND TRANSMISSION FACILITIES

CHART 12



ONE OF THE MANY NETWORK ANALYZER STUDIES MADE IN PLANNING THE OVEC-IKEC SYSTEM. THIS PARTICULAR STUDY SHOWS POWER FLOW AND VOLTAGE UNDER NORMAL CONDITIONS, WITH FULL GENERATION AT BOTH POWER STATIONS, AND ALL LINES IN SERVICE.

I want to show you this next chart (chart 13, page 25) for just one purpose. That is an architect's rendering of what we had projected on paper. The date in the lower right-hand corner is March 1956; but this is when the title was put in. The rendering was made sometime in March 1953.

If you will take a look at this next picture (chart 14, page 26)--this is a photograph taken just about a month ago, showing the Clifty Creek plant, located just outside of Madison, Indiana, with all six units in service--I think you will find that the conception and the execution are in very close conformity.

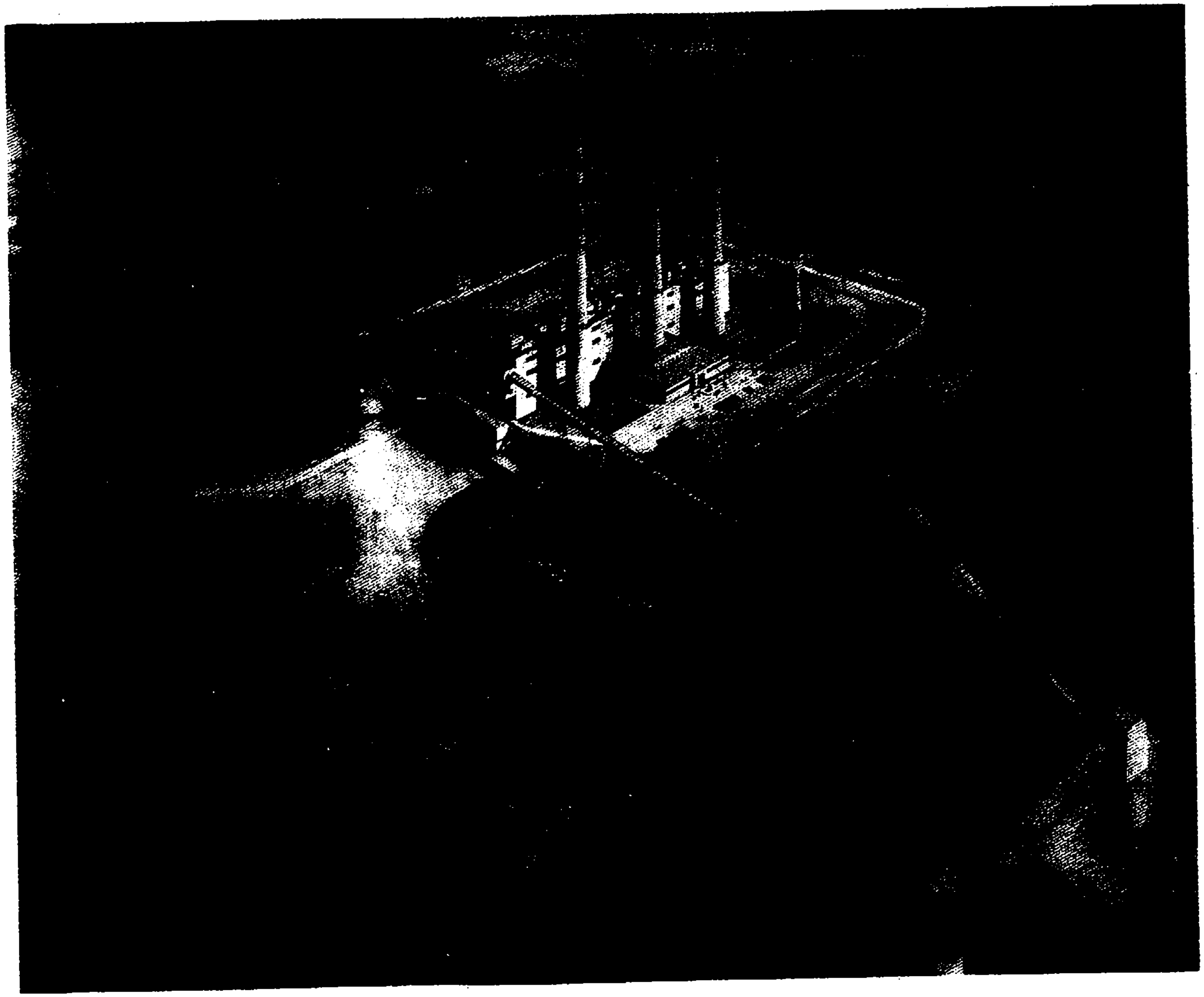
In one year, that is, in the year February 1955, to February 1956--a 12-month period--there were brought into commercial operation both plants, Kyger Creek and the Clifty Creek plant, with a combined capability of 2,365,000 kilowatts, capable of producing, and producing today, at the rate of over 18 billion kilowatt hours a year. And that is a block of capacity that has never been brought together as a single project in the history of electric power in this country or any other country.

Now, with that kind of a background, I want to point this out: If we should be bombed, if we should be attacked atomically, provided we can maintain our reserves, provided that we maintain our spare parts, and continue developing our systems--on that basis, I don't think there is going to be any serious problem from the power standpoint in any kind of attack that we may be subjected to.

Not only is that so because of the reasoning that I have developed, but we have had some considerable confirmation of that in a series of tests conducted in a staged atomic blast in Nevada last year. The report on these Nevada tests, entitled "Effect of an Atomic Blast on Electric Power Facilities," will be distributed to all of you present.

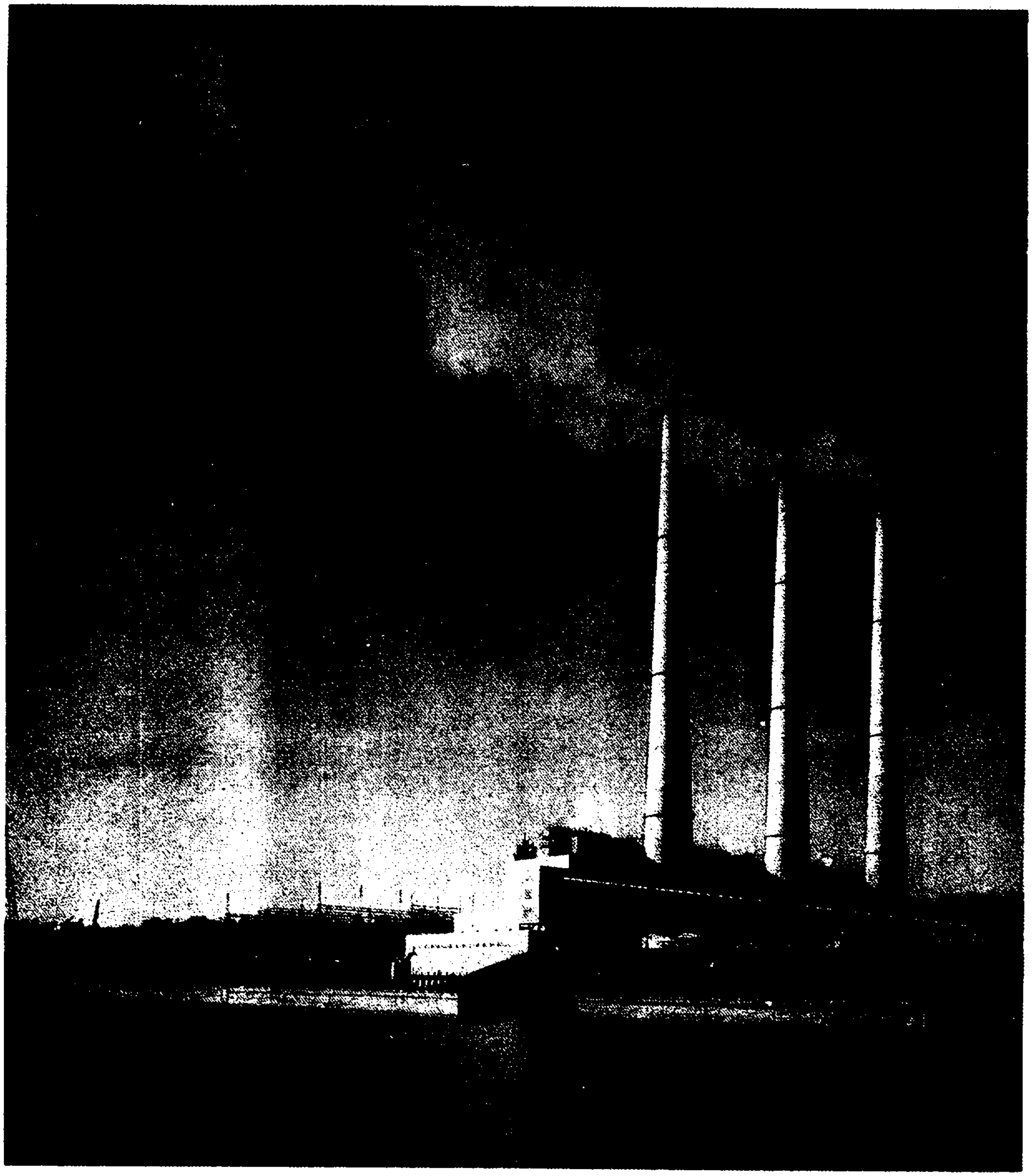
I think you find there that the effect on power facilities is fundamentally considerably less than the effect on the utilization facilities. And out of that has come the conculsion that, no matter what may happen to the power facilities, the utilization facilities in the area will be much more adversely affected. And we know that the kind of program I have been discussing will make it possible to bring in power at a much faster rate than it will be possible to develop the additional use.

CHART 13



AN ARTISTS' RENDERING OF CLIFTY CREEK STATION, SHOWING HOW THE ENTIRE PROJECT AREA IS INTEGRATED WITH THE SURROUNDING LANDSCAPE. March 1956

CHART 14



CLIFTY CREEK STATION VIEWED FROM OHIO RIVER, SHOWING ALL SIX UNITS IN SERVICE

I know you are interested in atomic power. Atomic power is here, and is particularly here in defense. In the Navy it is a full-going concern. In the Air Force, as I am sure probably all of you know, there are a number of major projects under development, and the indications give every encouragement for the belief that air projects will be feasible. The Army has a mobile nuclear powerplant under construction. And, of course, the Armed Forces stand to benefit from the work that is done in civilian power installations.

Now, when you come to competitive atomic power, there is no question that competitive atomic power is not here yet. We are going about, I believe, the business of learning how to bring about competitive atomic power. In this venture--and it is a very thrilling venture, I think--there is no question in my mind that we are ahead of the world, that we are leading the world. And whenever you read anything to the contrary as of today, in my judgment you are reading something that is fallacious or is based on poor facts.

Last August, as you know, there was a great international conference on the subject of atomic power at Geneva. I was a delegate to that conference. Following my return from Geneva, I made three brief speeches on various phases of the subject. A reprint of those, with the heading "Energy--Conventional and Atomic," will be distributed to each of you. I hope you will take the time to read them--they are all very brief.

The next 20 years may very well settle the state of civilization of the world for the next two centuries. And defense, whether it is defense of our civilian economy or national defense, will be a defense based upon the facilities that we can produce. The weapons themselves that we can produce will have to be produced by facilities, and these facilities will have to be driven by electric power. And the basic electric power of the next 20 years will not be atomic power,

Atomic power is going to make great strides forward, but it is not going to be the significant item in our civilian mobilization as an indispensable medium in our ability to produce in the next 20 years that it may come to be 20 years after that. So it is very important that we do not do anything that could possibly interfere with the carrying through of our present extensive program for expanding our conventional power facilities.

I want to take another few minutes to say something about our present and coming power technology. I have already commented on the fact that we are coming to an era of mass generation of electric power.

In that connection, I have shown you a view of the Clifty Creek plant, but I would like to show you another view of that plant. You will see it in chart 15, page 29. As I told you, at Clifty Creek we are generating at the rate of over 10 billion kilowatt hours of energy a year. But we can visualize technically--and I believe it is economically feasible, and I also believe it will come into being--single stations where we will generate as high as 15 billion kilowatt hours a year. It is not so long ago in the history of this country, in the history of even as electrically advanced a country as ours, that this represented the total energy production within its entire borders.

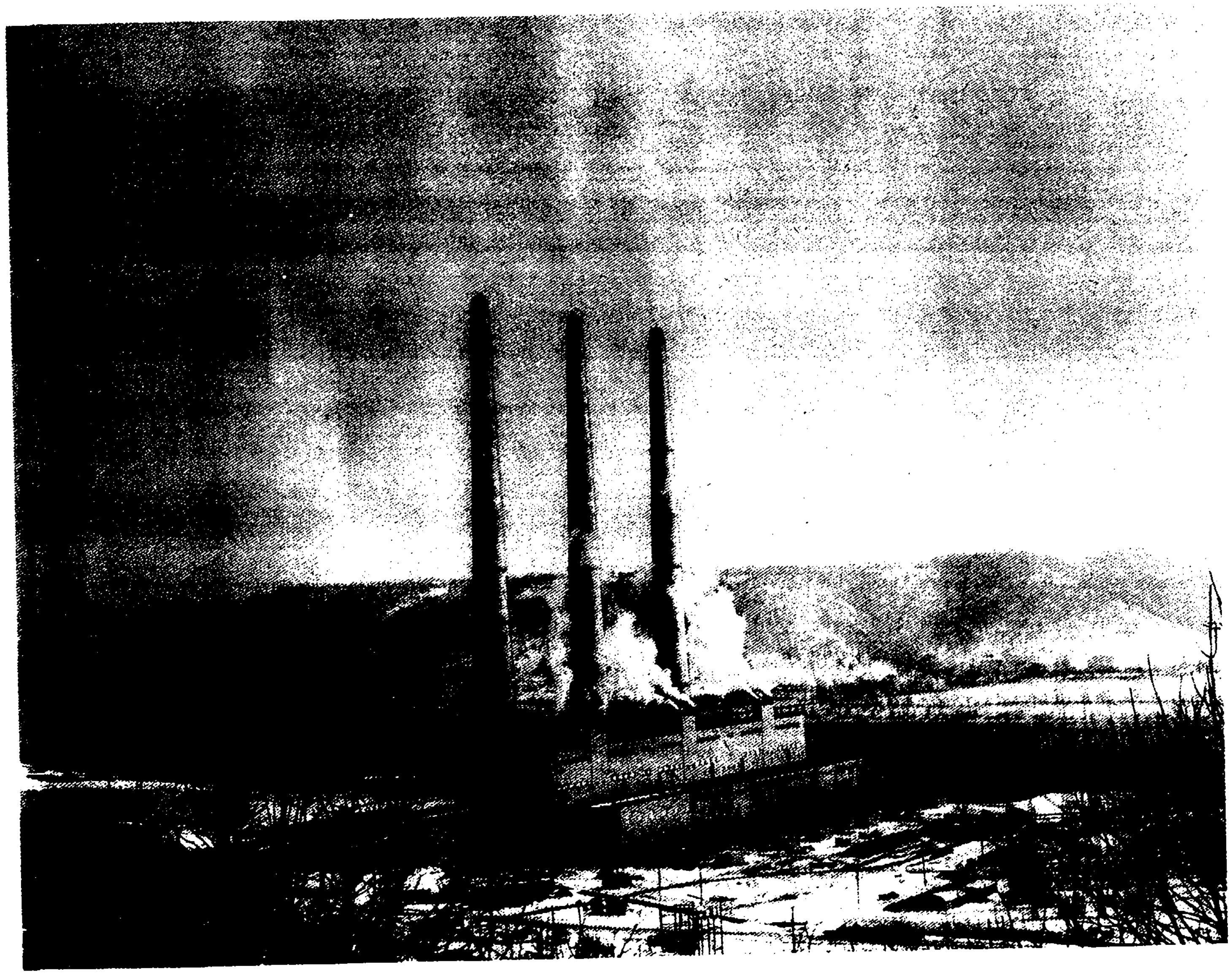
In this next chart (chart 16, page 30) I have shown a photograph of a switch yard. What you see here is a series of 330, 000-volt switches--theyare actually 345, 000-volt switches. I want to make this observation: that these particular circuit breakers or switches are designed to interrupt 25 million kilowatts of electric energy, or arc energy, and are designed to do it in three cycles of a 60 cycle system. That is one-twentieth of a second. They are designed, therefore, to break, to interrupt, to arrest, to stop, over 33 million horsepower.

If you want to visualize yourselves on the bridge of a ship with 33 million horsepower in the engine room, or perhaps behind the steering wheel of a car with that many horsepower, and you figure on stopping it going at the rate that that much horsepower will make it go, in a twentieth of a second, you can visualize the kind of operation that is being carried out here.

Here in this next chart (chart 17, page 31) is a view of a 345, 000-volt transmission line. We now have something like a thousand circuit miles of these either on the American Gas & Electric System or on the OVEC System. They are actually operating at voltages somewhat higher than their rating--the actual figure is 352, 000 volts.

As I pointed out to you, in an analysis of that study that led to the decision to proceed with the OVEC project, we found that on the six wires that you see hung up in the air you can have marching across them a million kilowatts; and that is a great deal of power.

CHART 15

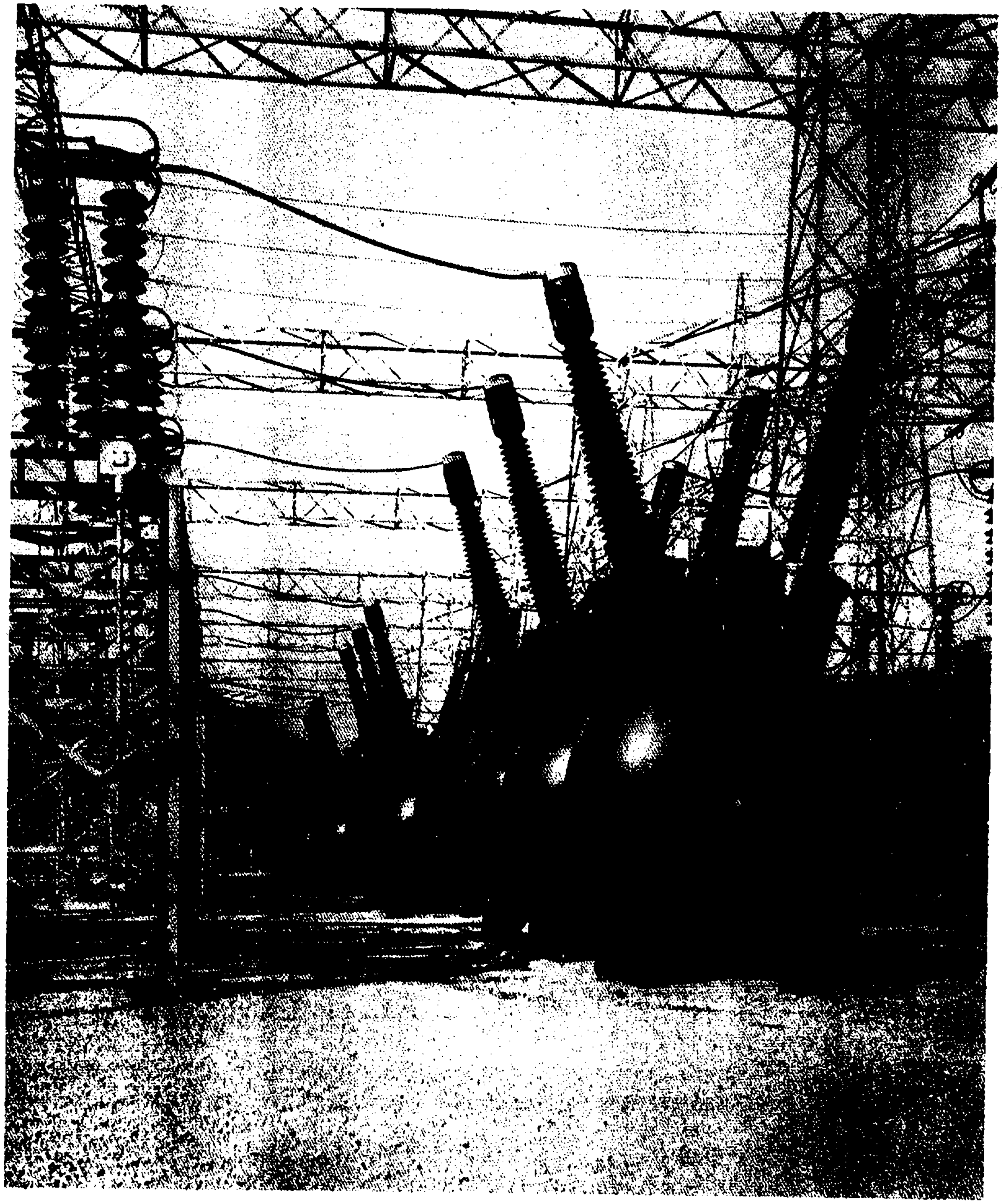


GENERAL VIEW OF CLIFTY CREEK STATION

March 1956

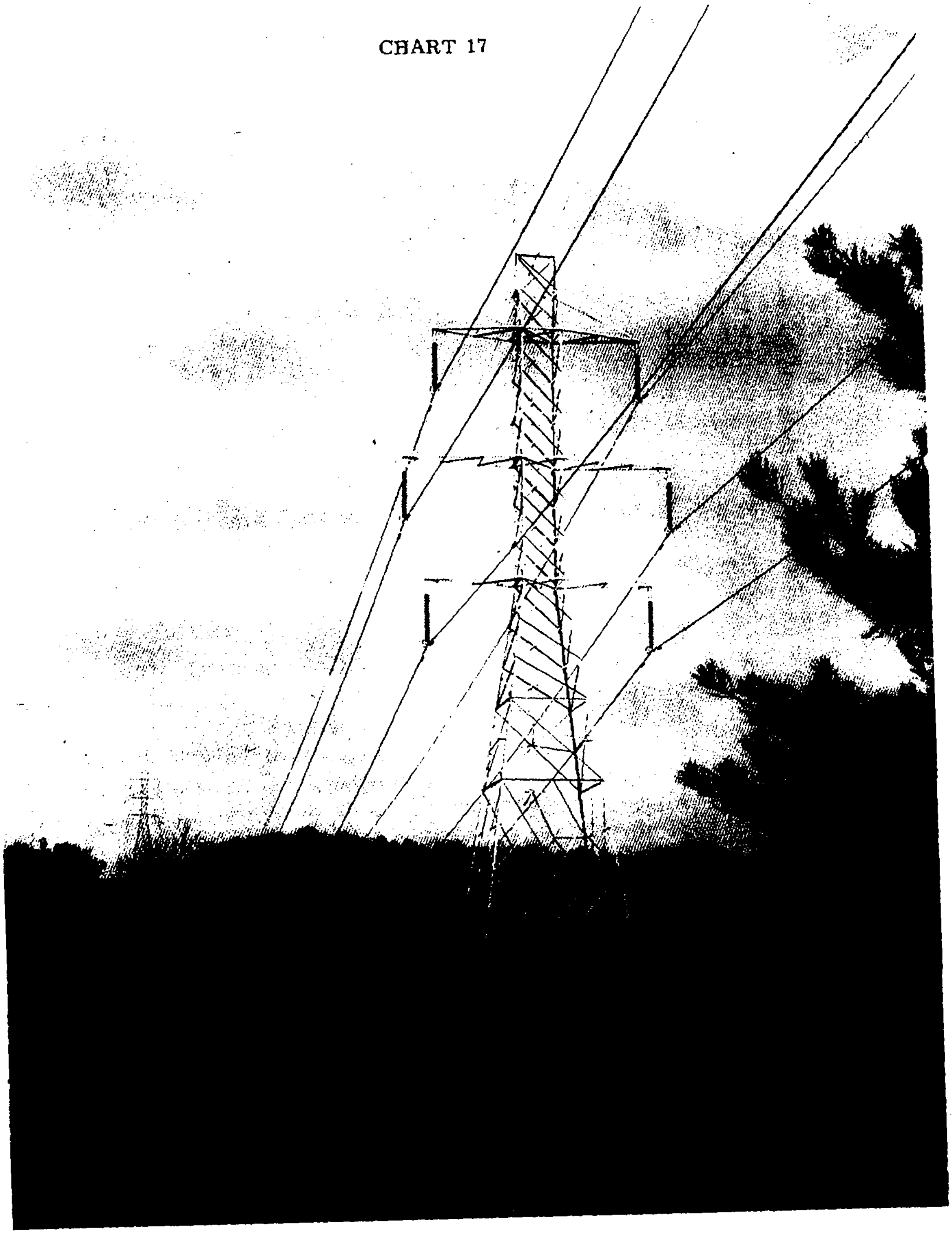
01960

CHART 16



VIEW OF CLIFTY CREEK 330KV SWITCH YARD, SHOWING BANK OF CIRCUIT BREAKERS FOR ALL SIX UNITS

CHART 17



TYPICAL DOUBLE CIRCUIT 330/345 KV TRANSMISSION LINE ON OVEC-IKEC SYSTEM

Now, one of the questions you may ask is, "Where do we find the loads calling for such facilities?" Well the answer is, "In many places."

One place is, to serve the 2,300 communities which form part of a power system like the AGE system, in which there are 2,300 small communities in the seven-state area of some 45,000 square miles in the states of Michigan, Indiana, Ohio, West Virginia, Virginia, Kentucky, and Tennessee.

Another place is in the AEC load. For example, the photograph now before you, which I am permitted to show but not to reproduce, is of the Portsmouth Diffusion Plant. It is really a very interesting plant. It came up in its requirements for load very quickly. If you will look at the next chart (not reproduced), it will show you what happened to that load.

This is what I want you to observe: You will find the schedule of power requirements in the second column from the left. Then you will find the schedule of power delivered. You will find in the last column what we called interim power.

I want you to note first that in the period of one year, from September 1954, to September 1955, the demand for power at that plant went up from 60,000 kilowatts to 1,690,000 kilowatts. It went up, therefore, 1,630,000 kilowatts. Now, that's absolutely fantastic--to build up such heavy-energy-utilization devices in that short period of time. You will also notice that in the next four months the load increased to 2,022,000 kilowatts.

Finally, if you will look at the last column for the month of October, you will find that in that month over a million kilowatts of so-called interim power--that means power that had been obtained from the excess reserves of the neighboring utilities which was not yet available from the generating facilities of the plants designed to serve this load--was brought together and delivered to the project. And that too, I think, is a great achievement.

Now, what about the plants of tomorrow? What will they be like? What are we doing to bring them into realization? I would like to give you just two brief glances.

First I would like you to take a look at this picture of boilers (chart 18, page 34). Here we have shown the cross-sections of two boilers. I would like you to take a look at the one on the left. It is marked "450-megawatt steam generator." This boiler is as yet not in existence, but it has been projected, and, I think, with more than a fair degree of coming to realization. That one boiler will generate 450,000 kilowatts.

This boiler has several interesting features. Note the rather small bunkers. Note at the bottom of the boiler the cyclone burners. And observe at the top of the boiler the absence of drums. The boiler will operate at above supercritical pressure, which you know is 3,206 pounds per square inch. Finally, you will notice that a good part of it is outdoors.

Then I want you to compare that boiler with one of the boilers of what is undoubtedly the most efficient powerplant, or was the most efficient plant in 1954, in the world--the Kanawha River Plant. That is one of our own. Compare the Kanawha River 215,000-kilowatt boiler with the 450-megawatt boiler: You will see the way some of the new concepts in expanding power use or the use of materials to generate power have been brought together in these new designs.

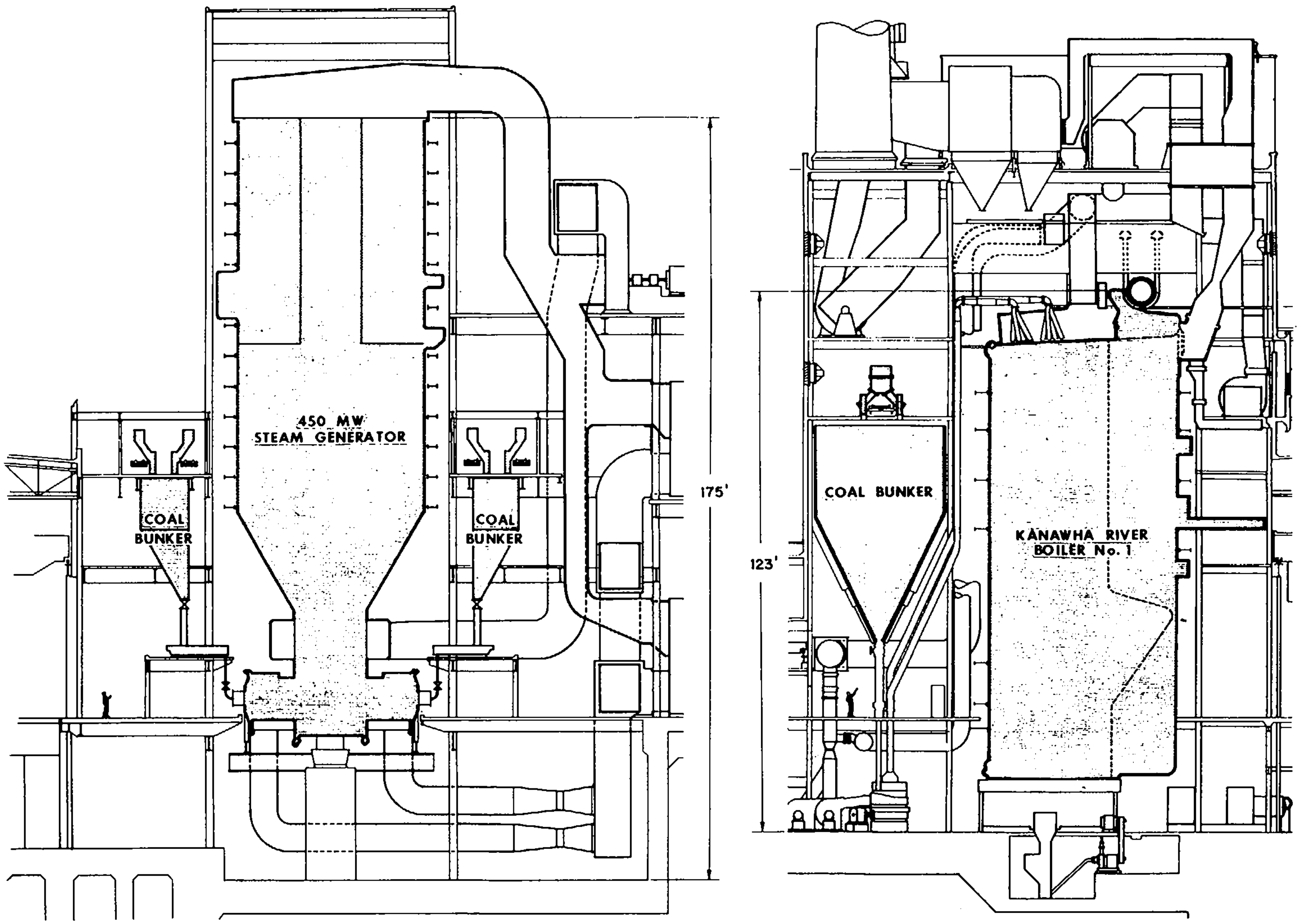
If you want to know what we are going to accomplish by this, then I would like to show you this last chart (not reproduced). Here you have the so-called heat balance of the plant. You will notice here a rather simple regenerative cycle for generating 450,000 kilowatts.

The cycle, you will note, employs double reheat. Notice that to drive one of the boiler feedpumps a 10,000-horsepower turbine will be required. And then on the forced draft fan it will be necessary to use a turbine in excess of 5,000 horsepower.

I want you to notice the thermal performance, or the expected performance, of 8,395 Btu's in the lower left-hand corner, which is a thermal efficiency of almost 41 percent. And that is one of the things, that is one of the lures, one of the things that are so appealing, about some of the developments that we are working on for the future.

I come to the end of my talk. And I would just like to summarize it by saying this:

CHART 18



COMPARISON OF STEAM GENERATING EQUIPMENT
PROPOSED 450 MW UNIT AND KANAWHA RIVER PLANT UNIT 1

March 1956

Electric power which I believe is an indispensable factor in national security, I think will be available; and national security, I think, will be safe from that standpoint as long as the power industry of the country stays dynamic.

The power industry of this country is today a dynamic one--a most dynamic one. It is dynamic because of its history. I think it is dynamic because of its tradition, now going back 75 years. It is dynamic because of the tremendous opportunities for expansion of use. And I cannot help but add, it is dynamic because of private enterprise--private enterprise, though, under our own unique American system, with state and Federal regulation, which brings it under public control.

Thank you very much.

CAPTAIN BANDY: Gentlemen, Mr. Sporn is ready for your questions.

QUESTION: From your discussion I assume that you feel that the electric power industry can produce in time of a mass attack on this country without any disruption. However, that is based on one assumption, and that is that you will be able to get a fuel supply. Suppose that our transportation centers are bombed out. How are you going to move coal from the mines to the plants?

MR. SPORN: That is a really important question, and I would think that its answer lies in a good many directions.

In the first place, quite a large number of our plants are located at the coal mines--they will have no problem. A good many of our plants are located on rivers, and receive all of their coal by water transportation. For example, there isn't a mile of railroad, except a small, company-owned railroad, that enters into the fuel supply picture for the Clifty Creek plant. The coal for the Clifty Creek plant is all transported by river, either on the Green River to the Ohio or on the Ohio River directly.

Now, where transportation centers are going to be bombed out, I would think that the only solution is going to be the coal that is in storage. Fundamentally, the industry of the country generally keeps between 90 and 120 days of coal in reserve. I would say that in case of a real bombing attack, that might very well become a much larger supply, as measured in days. Also because of the bombing, industrial capacity will be so much less that this amount of coal will go a long way toward carrying the load that will have to be served until some of the transportation facilities are restored.

But again, let me point out that if the transportation facilities are going to be destroyed, industry is not going to be producing much. Industry cannot produce unless it can have transportation facilities to bring in the raw materials and have transportation facilities to take the products out.

So you get back to the same thing--that some of the very important links in a power system are, in my judgment, a whole lot less destructible and fragile than many of the elements in our industrial complex. A transmission line can be literally bombed to death over the span of a mile, but a mile of transmission line, if we have some spare parts--and we expect to have them and we have a lot of them today--can be rebuilt in a matter of a couple of weeks.

QUESTION: What is the plant utilization factor for the Clifty Creek station?

MR. SPORN: We expect to run it as close to 100 percent as is possible and still keep the plant in operation. But actually, we expect that somewhere around 11 to 12 percent in reserves will be necessary to keep the plant operating at a full rating.

One of the reasons for this is that at Clifty and at Kyger we are carrying out an operation that hasn't really been carried out before in the history of thermal generation--that is, running a plant at a 100 percent load factor. The load curve can be plotted very simply: Find the peak and project it on any scale and any kind of chart that you want--then draw horizontal lines and you have the load for the 24 hours.

QUESTION: What is the degree of interchangeability in plant equipment? Say you lose a plant in Indiana and a plant in Tennessee is still running. Can you borrow equipment from the Tennessee plant?

MR. SPORN: Let's divide that into four very important parts--turbines, boiler, transformers, and switches. All the other things are more or less small parts.

A turbine is interchangeable if it is the same design and size turbine. There are a great many turbines that are duplicates of one another in various parts of the country. In the case of our own system, for example, we have seven 150,000 kilowatt turbines that are exact duplicates. We have another series of five 215,000 kilowatt turbines that are exact duplicates. We have five 90,000 kilowatt turbines that are exact duplicates. We also have three 110,000 kilowatt turbines that are exact duplicates. At OVEC we have seven turbines of one make that are exact duplicates and four turbines of another manufacture that are exact duplicates. All eleven boilers in the two plants are exact duplicates of one another.

In the OVEC plants we carry a considerable amount of spare parts. Because of the extent of that duplication, we can economically do so. For example, we carry a complete high-pressure turbine as a spare part; we carry an intermediate and a low-pressure turbine; we carry the generator fields for the high- and low-pressure machines; we carry a considerable percentage of the coils of these stators as spare parts. We have had occasion to gain a good deal in availability by following that practice.

One of the things that is being worked on is the building up of the spare parts reserve of the country. And certainly I would think that if the climate--and I wouldn't say the climate from the standpoint of our danger of attack is particularly favorable now--but certainly if the climate got materially worse, I would say there would be considerable action to increase and put into reserve millions of dollars worth of spare parts of various kinds.

Interchangeability, to answer your specific question, is available only to the extent that there are duplicates. In many cases, however, it is astonishing what a couple of high-grade welders can do with some basic items of material, such as steel plates or copper conductors, in the way of replacements if you are not concerned with appearances but just with getting the job back on the line.

QUESTION: Would it be any more economical in future atomic warfare to put the transmission lines underground where they wouldn't be visible like the towers that you have now?

MR. SPORN: My answer would be, No. In the first place, underground structures, by my personal observation, are more visible than overhead structures. I have been in the air, as I am sure many of you have, hundreds of times; and I know that when you get up about 12,000 to 15,000 feet, you have a hard time finding a transmission line. But there is almost no difficulty in finding a ditch or a trench that has been dug as long ago as 150 years. I am sure many of you have picked up trenches that have been dug that many years ago. So I don't think that safety necessarily lies in putting things in a trench. The transmission line is, in my opinion, not the most vulnerable part of our electric system; and it is less vulnerable as an overhead line than any other kind you can make.

For very high-voltage transmission, incidentally, we have not developed the technique of building high-voltage cable of any length. A high-voltage cable operating at 380,000 volts is quite an operation. I saw one a year ago last February, but it was a cable designed for a very limited length, and the losses on it are so high that it would be utterly impracticable in its present state of development to use it over a long distance.

We are carrying on research in this and other countries on building practical high-voltage cables, but so far have not developed a practical technique for cable above 220,000 volts. In my judgment, underground cable is not in the direction of safety.

QUESTION: You made the statement that in your opinion the atomic powerplant would not be significant in the next 20 years. Is that because the technology will not be developed until then? And in your opinion, once these powerplants become available, will the initial application be in the underdeveloped areas or do you think that it will begin in the United States and other highly civilized areas and from there extend into the underdeveloped areas?

MR. SPORN: You raise a very important question again. If you are interested, I would be glad to send you a copy of the paper that I prepared for the Geneva Conference. It discusses the place of energy and the place of nuclear energy in the United States. I didn't try to cover the world--it was just too big an area. I just tried to cover the United States. The place of energy in the world is a subject that has not had as much work put on it as I think its importance warrants. But it is a very involved subject.

Now, to answer your question: Contrary to popular notion, in my judgment, the nations that will benefit most from atomic energy are going to be the technically highly advanced nations, not the underdeveloped nations. The underdeveloped nations are all seeking to improve their economic position, certainly a laudable ambition. Many of these countries have to be helped by us and by the other countries in the Western Alliance, so to speak. But what many of them are trying to do is to find shortcuts to Utopia; and, in my judgment, these shortcuts do not exist. They are trying to help themselves by atomic power, when what they need is to help themselves by industrialization, in which power plays an important part but not necessarily a dominant part.

Because of that, and because many of them also do not have the technical foundation--they do not have the training institutions, the colleges and the technical schools and institutes, nor do they have the mass of technical personnel, the sort of foundation that technically advanced countries have--they will have an awful time getting very far very fast with atomic power.

Many of them, I think, are going to pass up opportunities--and that will be a great pity, when they might be steered on to the right course--to advance, by using nothing more romantic than a portable thousand-kilowatt diesel set. A great deal could be done with that in an area where, perhaps, the present capacity is only a few hundred kilowatts altogether.

Now, as to the industrially advanced nations: Here again you have to draw a line of demarcation between various countries. A country like Switzerland--which is wonderfully developed and has a deep technical foundation--also has, or is beginning to have a tough energy problem, because it has no fuel resources of any kind. It has developed its economy and its very high standard of living on its hydroelectric resources, and they are coming to an end. The Swiss are actually concerned by the fact that, whereas they still have some resources that they might develop, all of these have negative features to them.

For example they can put in a big storage project, but only by flooding a beautiful valley which is now agricultural. You can't have it as a lake and as an agricultural valley at the same time. And since in agriculture and the raising of food we have not as yet advanced as far technically as we have in energy, it may very well be that they are better off to stay away from hydro and go atomic.

I would think that countries like Belgium--but Belgium less than Switzerland because Belgium has coal--and other countries, like Italy, for example, will go the atomic route and will benefit more from atomic energy than the less advanced countries, and benefit earlier.

England has a unique problem. A great industrial nation and certainly our principal ally in any kind of trouble that we may run into, England is suffering a severe crisis with its coal supply situation. With coal, which was the basis of the whole industrial revolution, and which England showed the world how to use and apply to the economic improvement of a nation--England is coming to a point where they are no longer producing enough coal to meet their own requirements. And so with the carrying out of the British nuclear program, which has been enunciated in the White Paper put out a year ago and again last February, England is certainly going to benefit from atomic development, benefit by getting energy that it might not have otherwise.

It gets to the point that I made--that energy is very important when it is absent. Now, countries like ourselves, Australia, Canada, or a country like Sweden, each of which is basically beautifully set up to carry on for a long time into the future to take care of its energy needs, but not set up to take care of them in perpetuity--these countries, I think, need to move along with the development of these new energy sources, and not wait. They do not have to be driven to carry out uneconomical developments, because my own observation has been that no country can lift itself by its bootstraps. You cannot waste effort and waste manpower and waste resources and get rich in that process. You cannot improve your welfare by it. You can only improve your welfare by conserving them and putting them to effective use.

Now, to answer the last phase of your question: I believe the reason we will not have more nuclearly generated energy in the next twenty years than I have indicated is because of the dynamic character of our energy requirements. I pointed out that I expected to see the power generation facilities of the country doubled in the next ten years and quadrupled in the next 20 years. These are rough figures. The actual number of years might be eleven or nine for doubling, and 18 or 23 for quadrupling. But it is a matter of no real concern whether it is one or the other.

Since we have now about 115 million kilowatts of generating capacity in the country, it is obvious that when capacity is quadrupled, we will have roughly 400 million kilowatts of generating capacity. It is my judgment that in the next 20 years not much more than 20 million of that is likely to be atomic. Now, 20 million kilowatts is not a great deal of capacity in terms of 400 million, and the reason for this is that there is a great deal of work still to be done--some very tough problems have to be solved--before we can get economical atomic power. But when we do, then we will be in a fine position to carry on for possibly the next several hundred years with atomic fuel.

I don't think that is at all bad for the country. I think it would be much worse for us to put a great emphasis on atomic power at the expense of neglecting the conventional resources, because our economy, our defense organization, our industrial machine, our whole country's welfare, are going to be based in the next 20 years on a great increase in the use of energy. Today we are in no position to produce ten million kilowatts of atomic power a year economically. We are not even producing over half a million of economic capacity; we have not as yet learned how.

But I do want to point out that, in my judgment, we are carrying on a great program to learn how to do it. I believe this, too, based upon a great deal of study and a lot of personal contacts that not even the Russians are ahead of us in the development of economic atomic power.

QUESTION: There has been a lot of publicity given to the statement that public projects like TVA can be constructed at considerably smaller cost per unit of output than what private industry can do. Would you care to comment on the significance of that statement?

MR. SPORN: Yes. I don't believe that is so.

QUESTION: On the question of transmission lines and transmission losses, I wonder if you would give me a rough estimate, if it is not classified, as to what the losses actually are in mills per kilowatt hour, based on a couple of hundred miles of transmission.

MR. SPORN: I would say that the average transmission loss in the United States today is of the order of five percent. In the case of OVEC, for example, the loss in transmission is very, very small; actually our total loss is something of the order of 34 megawatts in the delivery of about two million kilowatts, or about a percent and a half. That is because of the extra-high voltage used.

Because of the very high load factor that we operate on, we have been able to invest additional amounts in current-carrying capacity, that is, in conductors. We realize that a transmission line, once built, is there: its cost has been fixed; its operating cost is a relatively small item in the total cost--the largest item is the carrying charge on the capital cost of the line.

The higher the load factor at which the line can be used, the more economical it becomes to use it, or, conversely, the better position you are in to justify additional aluminum or copper in conductors to bring your line losses down.

QUESTION: I gained the impression from Mr. Putnam's book on energy that solar energy is going to become important. I wonder if you would care to comment on the use of solar energy.

MR. SPORN: I think solar energy is one of the energy sources that we are going to exploit, but I think solar energy is a very difficult source to exploit economically. It is quite likely that eventually, when we have utilized all of the uranium and thorium that we have in the crust of the earth and have to look for other sources, direct solar radiation will be the source that we will go to.

I don't think that this source of energy generation is going to come into any prominence in energy production over the next one hundred to two hundred years. I think other, more conventional sources--and in this case I would call uranium and thorium more conventional--will do the job until solar comes in.

On the other hand, I think there is a good possibility that in utilization, solar energy may come to play an auxiliary part. We have found, for example, a number of people who, in talking about the heat pump, say that it should not be passed by. If I had more time to devote to that subject, I would discuss the heat pump, but I will pass it here. The heat pump is the ideal instrument to exploit low-temperature energy sources and therefore relatively low-value thermal energy, and put it to work at a much higher temperature to give you the heat needed to heat houses or to heat water.

Again, if any of you are interested, you will find that we presented a paper at the recent World Symposium on Applied Solar energy in Phoenix, Arizona, last November on the use of the heat pump as a means of putting to work solar energy that you couldn't put to work otherwise.

I think that solar energy is one of our long-term resources that we have only started to do some work on. But it will take a long time to bring it into service, certainly for the people of the United States.

QUESTION: In view of the tendency of industry to migrate, in efforts to achieve some potential dispersal, will we be able to effect proper distribution of electric energy to these sites? If so would there be any problem in transmitting it long distances?

MR. SPORN: Whether we are properly dispersed or not is a very technical subject. I don't think I can answer it. I think you will find that some of the plants that have been given help recently have received that help more or less in proportion to whether they met criteria for dispersal. Some plants that have sought help, for example, through a certificate of necessity, were unable to get it because they were not willing to go out far enough with the plant to meet requirements of dispersal.

If we should adopt a program of more universal dispersal of industry--and that is not an easy thing to adopt--I am sure that power facilities can be created as fast as industry can be dispersed.

QUESTION: Apparently your company negotiated the contract to furnish energy to the AEC's Portsmouth installation without any particular difficulty. We are all well aware, from reading the papers, of the Dixon-Yates controversy. I would like to ask if you would comment on why your company had no difficulty when these other companies had so much.

MR. SPORN: Let's take the second part of your question first. I will answer that by saying that I had no connection with the Dixon-Yates situation whatever. I know Mr. Dixon and Mr. Yates, and I think they are very fine, hard-working utility executives.

Now for the first part of your question: I negotiated the OVEC contract, and I assure you it was anything but routine. I also assure you it was anything but easy.

We had our first discussion with AEC late in January 1952. Following very intensive work a proposal letter was submitted in May 1952, and after a series of negotiating meetings we executed the contract in October 1952. I am sure all of you know that was under the Truman Administration.

No contract such as that is a particularly easy affair, but I would say that we didn't have too much difficulty in implementing it. Perhaps it was because we have been more fortunate than some of the others. We have been able, for example, in spite of heavy rises in costs of labor and materials, involving a good deal of escalation running to many millions of dollars, to project a cost of power for the Commission of under four mills per kwh. Actually we have succeeded in beating that figure by a good fraction of a percent.

We have recently negotiated with the Commission a contract for an additional 150 megawatts for a shorter period. That contract is now on file with the Joint Committee on Atomic Energy of the Congress in connection with the provisions of the Gore Amendment to the Atomic Energy Act of 1954. Whether we will run into any problems with that, you know as much as I do. I wouldn't expect to. But if we run into any, the only thing that will bother me is that it will take up some of my time. I don't know of anything that would bother me otherwise. If the Joint Committee finds that it is in order, the contract will go into effect some time in the next 20 days. It has now been on file for about ten days.

CAPTAIN BANDY: Mr. Spron, I want to thank you for a very interesting and informative discussion this morning. I am sure the College has enjoyed it very much.

(10 Aug 1956--450)B/mmg