Superpower and Its Public Relations
The Honorable Herbert W. Hoover
The Secretary of Commerce

LAST October, with the approval of the President, a conference was called in New York City for a preliminary discussion of what cooperative steps federal and state authorities can properly take in the promotion of what is called the superpower development in the New England and Middle Atlantic States. This conference was not conceived as more government in business. The public authorities were already deeply in the power business through many forms of regulation and a very large measure of control of power sources. The thought was that coordination between public authorities and industries might secure further consummation of an advance in the development of a great service to the public. The work started at the New York conference is being continued through committees of state and federal representatives.

The reason and need for this undertaking is simply that engineering science has brought us to the threshold of a new era in the development of electric power. Since 1900, the use of power in the United States has increased at a pace that doubles it every 9 years. This era promises continued and wide expansion in power use. The new stage in progress is largely due to the perfection of higher voltage, long-distance transmission and to perfection of mechanical development in generation of power. We can now undertake the development of the cheaper sources of power from water sources farther afield, such as the St. Lawrence, and cheaper generation from coal through larger and more favorably placed generation plants. We can secure great economies in distribution through the interconnection of load between systems, for thus we secure a reduction of the amount of reserve equipment, a better average load factor through pooling the effect of day and seasonal variations, together with wider diversification of use by increased industrial consumption. We can assure more security in the power supply from the effect of coal strikes and from railroad strikes or other interruptions to our transportation system.

These possibilities, these accomplishments and these economies are all blended in the recently coined word, superpower. Superpower, giant-power and interconnection are synonymous. With their slightly different meanings and applications, all of these subjects have one prime object in view, namely, the coordinated production of electric power. Superpower, shorn of its mystery, and practically applied means nothing more. When the means of production are properly coordinated all installation can be put to the best use. Interconnection, high voltage lines, and large units of production are vehicles and devices that make the most economical coordination of production a possibility. They are the physical structures that form a great power reservoir.

A superpower system comprises both coordinated production and a system of superpower lines capable of being operated as a unit, apart and distinct from the distribution systems with which it connects. In further consideration of this conception of a superpower system, it may be said that the whole object of the matter is coordinated production. It is by this means that better service is to be rendered, that resources are to be conserved and that costs are to be kept at a minimum. And this is no new departure, nor is it anything magical. It is merely the next logical step along the line in which the electrical industry has been advancing for nearly thirty years.

All this means the liquidity of power over whole groups of states. At once, power distribution spreads across state lines and into diverse legal jurisdictions. We are, therefore, confronted not only with problems of the coordination in the industries of their engineering, financial and ownership problems, but also with new legal problems in state rights and federal relations to power distribution.

The benefits of superpower systems are illus-
Ocoee No. 1 Power-house of the Tennessee Electric Power Co.

A combined steam and hydroelectric plant on Ocoee river, Tennessee, from which energy is fed into the southeastern superpower system.

Pit No. 1 Power-house of the Pacific Gas and Electric Co.

The development at one of five sites on Pit river that will ultimately supply half a million horse-power to the Pacific Coast superpower system.
trated in the systems of large operating companies which cover a considerable territory. Excellent examples of such systems are found in what might be called the "super-utilities" of California. One of these companies represents the merger of about 125 companies, once independent operating concerns. It has in its system over 30 hydro plants reinforced by scores of reservoirs distributed over six great watersheds. It has steam plants which operate on base as well as peak load, and about 3,000 miles of transmission line. This company supplies a market consisting of mining, agricultural, municipal, power and lighting load. It has an annual output fast approaching two billion kilowatt hours, two-thirds of which is produced by hydro. Such a system has a high diversity factor, a high utilization factor of water-power possibilities and, due to connections with neighboring companies, it can maintain a high capacity factor. In short, it has practically all of the advantages that are accredited to a "superpower system."

Conditions in all of the Rocky Mountain and Pacific Coast States are very similar to those in California. Each company's system covers a large territory within which there is usually ample opportunity for coordinated production. There has recently grown up in the Southeastern States a system that perhaps more nearly approaches a superpower system. The individual operating companies cover much smaller areas than those on the Pacific Coast and the lines of interconnection are of larger capacity and more direct. The combined system seems likely to become a unified, superpower system through its operating possibilities. It has about 5,000 miles of transmission line and over one million horse-power of generating equipment. Three-fourths of the kilowatt-hour production is from water-driven generators.

In the northeastern part of the United States the problem of building up a superpower system is complicated, difficult and yet most necessary. Within the area east of central Ohio, including Cleveland, and north of the Virginia-North Carolina state line, there lives 40 per cent of our population. They consume 50 per cent of our kilowatt-hour production and they operate 60 per cent of our primary power. Within this area are the great load centers, as well as great deposits of anthracite and bituminous coal. This area commands, furthermore, the great water-powers of Niagara and the St. Lawrence. It has within itself a generous sprinkling of local water-power possibilities.

It would seem, therefore, that under the growth of such conditions, with such power resources and especially on account of the proximity of load centers, every opportunity has existed for the simultaneous growth of superpower systems. Nevertheless, in their stead, there have grown up mammoth isolated production plants connected with markets hard by. The power supply located the industry in many instances. Water-power brought industries to Niagara Falls and the coal fields brought them to the Pittsburg district. Again, in New England, the early development of water-power, prior to the development of the economical transmission of power, started the flow of raw materials to that section for their manufacture. The industries thus created have expanded and become greater and greater consumers of power.

The lighting, commercial and electric railway loads that have grown along with the industrial load likewise have been supplied by independent establishments. These had, usually, a low-load factor, and it was infeasible to transmit power any distance to them. Coal could be shipped to one place about as easily as to another. Capital investments in local plant capacity were not enough in excess of that of transmission lines to warrant the hazard of the transmission experiment. In general, I believe it can well be said that the growth of isolated plants in northeastern United States is not a haphazard one but predetermined, economical development as far as the engineers and economists concerned could predict their need.

Recently, say within the last ten years, great progress has been made toward interconnection in this region. The seeds of superpower have been sown. Except in a few instances these interconnections have but little capacity. They effect economies, however, and indicate the trend of growth. Progress in the science of power transmission and economies of power
The Northeastern States are at the present time in need of the economies and stability of superpower. That this has become a feasible proposition for the northeastern zone is manifest by the general electrification of industry that is taking place and the consequent growth in the purchase of electric power from central stations. This growth should not be hampered either by lack of power supply, questionable service or high cost. Every opportunity, every avenue for the growth of superpower systems should be used. The maximum growth attainable in the application of mechanical power demands it.

In a more general consideration of superpower there appears to me to be three major considerations. These are service, conservation or national economy, and low cost.

Industry, now the greatest user of electrical power, must have service, continuous service, almost 100 per cent service. The sufficiency of power is what makes a market for power. In the steel industry, for instance, an industry which is becoming electrified, an uninterrupted flow of electric energy is a vital necessity. An interruption of power supply means far more than loss of production. It may mean serious loss in plant equipment and great hazard to workmen. One needs only a momentary consideration of this necessity to realize the dangers and inconveniences possible in subway, elevated and surface traction, in elevator service, in high pressure pumping-stations of fire-protection systems, and in numerous electrified systems in large cities, to realize the value of reliable service. The problem of making proper provision for continuity of service is of prime importance in any power system. A superpower system, through its fluidity of power, simplifies the whole matter of adequate power supply.

To conserve our national resources is the common interest of power producers and consumers. There is, no doubt, a wide difference of opinion as to the extent to which the cheapness of production should yield to conservation, but it is probable that only when direct economies result will there be a saving in consumption of coal. Recent advances in the cost of coal have brought large water-power possibilities within the field of feasible development. Development in transmission of power has brought water-power in closer competition with local steam-power, and has made it cheaper, up to distances of say 200 miles, to transport power than to transport coal and has thereby made it possible to secure economies through the higher efficiencies of large units, both steam and hydro. The recovery of by-products may prove practicable by reason of the large coal consumption of these great steam units, whether located at the mine or near the power market. The capital investment per power unit installed and operation costs are not likely to be greatly reduced.

The field for the reduction in cost of power lies in a better use of the investment. This is the opportunity of superpower. In a superpower system, a plant can be loaded to its capacity at once and the carrying charges eliminated; new installation can be delayed until actually needed; duplications can be eliminated; spare capacity can be greatly reduced; large blocks of water-power, where the unit cost is low, become feasible of development because of a ready market for its power.

We are a great power-consuming people. In our manufacturing industries alone there are installed about 3½ horse-power per wage earner. This increases the ability of each wage earner to produce by about thirtyfold. Herein lies the secret of our successful competition with foreign countries. Power—mechanical power—is the life-blood of this nation. The conversion of nearly all of our power into electric energy in the immediate future is conceded, due to its transportability and adaptability. As large as are our water-power possibilities, they can supply only a fraction of our power needs. If distances of transmission were no obstacle and we were to begin today the supplying of all of our growth in power consumption by water-power, we would absorb our 50 million horse-power in ten years. The conservation of coal through a more efficient use of it, as well as by the substitution of water-power for coal-power, is an object of superpower.

Electric energy has become a necessity and is of such general use that its field of adaptability is determining the direction of our industrial progress. This is due principally to its transmissibility. Development to supply the growing demand for power should consider the expansion of transmission systems so as to facilitate a coordination of production, a complete utilization of water-power resources, a saving of coal and, at the same time, accomplish a combined diversity factor which will result in a minimum of capital investment. By so doing, the cost of
power will be kept low and the use of electric power will be made as universal as the invention of suitable mechanical appliances can make it. Super power, with its great network of transmission, is inevitable. It is feasible on a large scale even now. The time of its growth to a correlated national system depends primarily upon the wisdom or folly of public policies expressed in national and state laws.

In the matter of public relations to power development and distribution, it appears to me that one of the first principles we must realize is that the whole of the development implies the free flow of power. We have thus created at least a physical and economic interstate question. This great development, of so much public interest, can not come about unless there is a complete liquidity in movement of power, back and forth across the boundaries throughout the whole of the United States. We can not secure centralized generation, great water-power development, or interconnection of load unless there is this free flow. Without this, we shall have permanently a large cost of power and less expansion in its service.

There are time-honored disputes over state rights with regard to water. Somewhat similar questions are being raised in many states with regard to water-power. I am advised that no embargo could be constitutionally placed upon the free flow of power across state boundaries. Yet it is being attempted by some states. Moreover, discordant methods of regulation in different states may amount to economic barriers upon free flow and thus itself stifle development. I am alive to the practical situation among our people who live near water-power sources, who believe they should have the first use of their cheaper water-power. I believe that by cooperation this right can be satisfied.

Again, my argument implies free flow within the states, uninterfered with by municipal obstruction. The economical distribution of power rests, to a large degree, upon local territorial monopoly. When we accept the principle of monopoly we must accept at once the principle of public regulation. Our states have wisely created public service commissions with state-wide regulatory power in order that rates, profits and distribution might be controlled.

I am not advocating federal super-regulation of interstate movement of power. I believe that power development and distribution will find its solution in coordinated state regulation, with perhaps, the assistance and cooperation of the federal government.
EXPLANATORY NOTE

The total potential water power in this area, available 90 per cent of the time, is 5,426,000 horsepower, which can be increased to 7,914,000 horse power available 50 per cent of the time. The present developed water power in this area is about 3,026,000 horse power, which represents 38 per cent of that available. The actual development of water power will probably never be able to meet more than 25 per cent of the total power demand in any year. And, obviously, when all potential water power has been developed, additional power demand must be supplied entirely by steam plants. Hence, our principal dependence must always be placed on generation from fuel. The present installed capacity in public utility steam plants in this area is about 10,500,000 horse power.

The rate of flow of rivers is of particular importance in this study because of the great quantities of condensing water required for large steam plants. Rates of flow of principal streams on this map indicate that large steam plants in the mine area will be limited to points along the Ohio River.
SUPER POWER STUDIES
NORTHEAST SECTION OF UNITED STATES
UNDER THE DIRECTION OF
Hon. Herbert Hoover, Secretary of Commerce
Chairman Northeastern Super Power Committee
PREPARED BY THE
FEDERAL POWER COMMISSION
FROM DATA FURNISHED BY
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OF CENSUS, STATE ENGINEERS, AND OTHER SOURCES

DEVELOPED AND POTENTIAL POWER
1922

SCALE

20 0 20 40 60 80 100 120 140 160 MILES

LEGEND

- Steam power developed. Figures represent K. V. A.
- Projected super-power steam station. Figures represent H. P.
- Hydro-electric power. Figures represent K. V. A.
- Potential hydro-electric power. Figures represent H. P.
- Soft coal fields (bituminous)
- Hard coal fields (anthracite)
- 2,000 CFS. minimum flow of river
EXPLANATORY NOTE

This map shows geographically and quantitatively the total power consumption, electric and non-electric, for the year 1922 in solid colors, and the predicted consumption for 1930 in outline.

The demand for electrical energy (shown in red) in 1922 was 21.2 billion kilowatt hours. The growth of electrical power application for the last few years shows that it has compounded at a rate of 10 per cent per annum. It is predicted that the total electrical power demand in this area in 1930 will be 30.8 billion kilowatt hours. The consumption of electrical energy includes power generated by public utilities, private concerns, and industrial plants.

In addition to the present electrical demand, there is 10,600,000 horse power of mechanical power (shown in green) used in industry, which is equal to approximately 13.9 billion kilowatt hours. The non-electrical, industrial power has been distributed for all cities of 50,000 population or over, as well as for all cities where there is a capacity to develop 25,000 horse power or more. This industrial power has been reduced to kilowatt hours on the basis of 1,600 kilowatt hours per horse power of prime-mover capacity (less electrified).
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ELECTRIC AND NONELECTRIC
POWER CONSUMPTION
1922 AND 1930

SCALE
20 0 20 40 00 80 120 140 160 MILES

LEGEND
- 50,000,000 K. W. H. for 1922
- 50,000,000 K. W. H. estimated increase for 1930
\ 10,000,000 K. W. H. for 1922
\ 10,000,000 K. W. H. estimated increase for 1930
- 1,000,000 K. W. H. for 1922
- 1,000,000 K. W. H. estimated increase for 1930

Green represents non-electrified power where the annual consumption of such power exceeds 10,000,000 K. W. H.

Note:
Total domestic, industrial commercial, railway, power, and lighting load for 1922, 23,000,000,000 K. W. H.
2. Katahdin Power Co.
5. Central Maine Power Co.
6. Cumberland County Power & Light Co.
11. Highgate Municipal Electric Plant.
17. Burlington Traction Co.
18. Vermont Marble Co.
21. Western Vermont Power & Light Co.
22. Berkshire Street Railway Co.
25. Edison Electric Illuminating Co. of Boston.
27. Edison Electric Illuminating Co. of Brockton.
29. Montaup Electric Co.
32. The Rockville-Willimantic Lighting Co.
33. Hartford Electric Light Co.
34. The Connecticut Co.
37. Long Island Lighting Co.
39. Westchester Lighting Co.
40. Rockland Light & Power Co.
41. Orange & Rockland Electric Co.
42. Southern Dutchess Gas & Electric Co.
43. Central Hudson Gas & Electric Co.
44. Honk Falls Power Co.
45. Orange & Rockland Electric Co.
46. Kingston Gas & Electric Co.
47. Chatham Electric Light, Heat & Power Co.
48. Upper Hudson Electric & Railroad Co.
49. Albany Southern Railroad Co.
50. United Traction Co.

52. Utica Gas & Electric Co.
54. St. Lawrence Transmission Co.
55. Empire Gas & Electric Co.
57. Niagara Falls Power Co.
58. Jamestown Street Railway Co.
60. Binghampton Light, Heat & Power Co.
61. Lackawanna & Wyoming Valley Power Co.
63. Commonwealth Electric Co.
64. Public Service Electric Co.
65. Richmond Light & Railroad Co.
66. Lakewood & Coast Electric Co.
67. Atlantic City Electric Co.
68. West Jersey & Seashore Railroad Co.
69. Electric Co. of New Jersey.
70. Wilmington & Philadelphia Traction Co.
72. Counties Gas & Electric Co.
73. Philadelphia Suburban Gas & Electric Co.
74. Pennsylvania-New Jersey Railway Co.
75. East Pennsylvania Gas & Electric Co.
76. Pennsylvania Power & Light Co.
78. General Gas & Electric Corporation.
79. Chester Valley Electric Co.
80. Edison Electric Co.
81. Electric Co. of New Jersey.
82. East Pennsylvania Gas & Electric Co.
83. Northern New York Utilities Co.
84. St. Lawrence Transmission Co.
85. Empire Gas & Electric Co.
87. Niagara Falls Power Co.
88. Jamestown Street Railway Co.
89. Elmira Water, Light & Railroad Co.
91. Lackawanna & Wyoming Valley Power Co.
92. Morris & Somerset Electric Co.
93. Commonwealth Electric Co.
94. Public Service Electric Co.
95. Atlantic City Electric Co.
96. West Jersey & Seashore Railroad Co.
97. Electric Co. of New Jersey.
98. Wilmington & Philadelphia Traction Co.
100. Counties Gas & Electric Co.
102. Pennsylvania-New Jersey Railway Co.
103. East Pennsylvania Gas & Electric Co.
104. Pennsylvania Power & Light Co.
84. Washington, Baltimore & Annapolis Railway Co.
85. Potomac Electric Power Co.
86. Alexandria Light & Power Co.
87. Washington & Old Dominion Railway Co.
88. Penn Central Light & Power Co.
89. Penn Public Service Corporation.
90. Citizens Light & Power Co.
91. West Penn Power Co.
92. Duquesne Light Co.
94. Wheeling Electric Co.
95. Ohio Power Co.
96. Ohio Public Service Co.
97. Northern Ohio Traction & Light Co.
98. Cleveland Electric Illuminating Co.
100. Virginia Power Co.
101. Kentucky & West Virginia Power Co.
102. Appalachian Power Co.
103. Virginia Western Power Co.
104. Virginia Railway & Power Co.
105. Norfolk Southern Railroad Co.
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TRANSMISSION SYSTEMS
1923
SCALE

- Hydro-electric generating stations
- Fuel-consuming generating stations
- Combined hydro-electric and fuel-consuming generating stations
- Substations
- Power stations without transmission systems shown in yellow
- Transmission lines 110,000-volt and above
- Transmission lines 110,000-volt and above (under construction)
- Transmission lines 60,000-110,000 volts
- Transmission lines 60,000-100,000 volts (under construction)
- Transmission lines below 60,000 volts
- Transmission lines below 60,000 volts (under construction)

Names of companies

DRAWN AND COMPILED BY FEDERAL POWER COMMISSION MAY 1924
EXPLANATORY NOTE

This map shows what may be termed the primary transmission system. The heavy, green lines show existing transmission lines of 110,000 volts and over, with certain lines of lower voltage which form interconnections. These high voltage lines are drawn on this map to indicate the present natural growth toward a super power system.

The red lines indicate certain new lines that will be necessary to bring power from possibly cheap sources of production to the larger load centers.
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PRIMARY TRANSMISSION LINES
1923
SCALE

LEGEND
= Probable water power transmission
- Existing transmission lines 1923
-- Projected transmission lines 1923
○ Steam generating station
○ Projected super-power steam plant
■ Developed hydro plant
□ Proposed hydro plant
▲ Sub-station
EXPLANATORY NOTE

The blue areas show the percentage of the total power demand in 1935, which could be met by full development of all water power resources in this area. However, it is not probable that water-power will be developed by 1935 fast enough to supply more than 25 per cent of the total power requirements at that time.

The colored figures show costs in mills, per kilowatt hour, for power from (a) local steam plants only (purple); (b) local steam and local hydro (red), (c) local steam and Niagara or St. Lawrence power (green); and (d) half from local steam plant and half from plants at the mine (blue). The basis is the predicted load for 1935, using the most economical proportion of local hydro, St. Lawrence-Niagara, or mine-plant power, in conjunction with power generated locally by steam.

For instance, in the New York territory Niagara and St. Lawrence power will be the cheapest, while, due to the distance from the coal field it will not be economical to transmit the power from plant-at-mine steam. The desirability of developing our principal hydroelectric possibilities is clearly shown.
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COMPARISON OF COSTS OF POWER
FROM VARIOUS SOURCES
MAXIMUM PERCENTAGE OF DEMAND THAT WATER POWER CAN SUPPLY IN 1935

SCALE

LEGEND
Cost figures in mills per K. W. H. include generation and transmission to load center
Figures in purple—Local steam power only
Figures in red—Local steam and local hydro
Figures in green—Local steam and Niagara or St. Lawrence power, except at Buffalo
Figures in blue—Local steam and plant-at-mine steam

☐ Below 25% hydro
☐ 25% to 50% hydro
☐ 50% to 75% hydro
☐ Over 75% hydro

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