THE GROWTH OF ELECTRIC SYSTEMS

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(Continued from last week's issue)

ALL that I have stated hitherto shows the growth of electric systems. The reason for the growth is, of course, because electric systems have supplied the demand. They have not only supplied this demand, but to a certain extent they have created the demand also. The figures showing use of electrical energy per capita per year in the United States show this growth as follows:

K.W.H. per capita:—1902, 31.5; 1907, 67.0; 1913, 121.5; 1917, 265.0.

This means that each year the amount of power used directly or indirectly by all users has increased rapidly, not only in such evident uses as light, trolley rides, etc., but as the wealth of the country is increased, in more clothes, food, automobiles, phonographs and a host of other things which are constantly being purchased by the general public.

You can generally analyze any manufactured product into raw materials, labor, skilled and unskilled, and energy. Not that the energy always remains in whole or in part, but it has been used, changed in form, and the result in the shape of work remains.

The Energy Component

This energy component, so to speak, of the cost of the finished article, varies in amount from 3% of the cost of fine cotton goods, to over 50% of the cost of some electrically refined metals.

The distribution of energy is by no means uniform. In cities where a great number of industries are in operation, the average K.W.H. per year varies from about 400 in Baltimore to 700 in Montreal. The figure for the entire United States is 265.

In those centres where electric energy is cheap, such as Niagara or Shawinigan Falls, we find a very different condition. The kilowatt hours per capita per year at Niagara is 33,000, Shawinigan Falls 41,000, and in some of the towns in Norway, where huge amounts of power are used in making nitric acid, the kilowatt hours per capita per year are even higher than these figures.

Transmission lines have grown around water-powers for an obvious reason. To use the water-power it must reach the market. As in most cases the user could not build his works near the power, transmission lines were necessary. So transmission lines and water-power developments have grown up together. So, too, the steam engineer who sees no good in the water-powers has until recently condemned the transmission line as well. But the march of events has compelled the steam-power plant engineer to alter his views, and we are just at the opening of a new chapter in the development of electric systems, and this development involves the construction of huge steam plants at favorable locations, where coal and water are cheaply obtainable, and starting from these stations there will radiate a network of transmission lines. The energy will be sent over the wires as electricity instead of shipped as chemical energy, as coal in railway cars.

Where Power is Cheapest

Such systems are already in existence. The first extension naturally took place by supplying territory adjacent to the large city plants such as the Chicago Edison and the Detroit Edison, but new plants have recently been built in Pennsylvania and elsewhere, based on the same theory as water-power developments; that is, the establishment of a plant where the power is cheapest and the transmission of the power from that point to the consumer.

There has been a great deal of talk and much written of the water-powers of the United States. Very exaggerated estimates appear constantly in the public press as to the amount and value of these water-powers. Up to the present time not 25% of the electrical energy used in the United States has come from water-powers.

The cost of a transmission system in cases of small developments may equal the cost of the water-power development itself. So the development of water-powers, with a few important exceptions, has followed and fluctuated with the development of steam engineering. The steam engineers have held the trench; only here and there have the water-power engineers succeeded in capturing a section.

The war has made a great change which undoubtedly will have lasting effects. Service is difficult to express in terms of money. The value of electric service was only appreciated when the customer saw a chance of being deprived of this power. Now a steam station depends on many complicated performances for its success. On coal; on labor to get coal; on transportation, which involves weather, labor, and the effect of Government control of rates.

Water Powers Have Scored

Water-powers after they are built depend on the sun and rain, and curiously enough, the results of the last year have impressed men's minds deeply with the fact that, proverbially uncertain as the weather is, the elements involved in a steam plant are still more uncertain. So, generally speaking, the water-power has scored.

Then, too, the price of labor has gone up enormously. The effect on the cost of power from existing steam plants, as compared with existing water-powers, has been to practically double the cost of power from steam plants, and to only slightly change the cost of power from the water-power plant previously built.

But as new plants are built under the present conditions, the advantage may not rest with the water-powers. Its capital cost is twice that of a steam plant, and is permanently fixed. If this cost is high because of high labor costs, then the plant is handicapped forever. I have gone into this phase of the subject because I think it is important, at a time when most public men are talking a great deal about water-powers, to emphasize the fact that the day of the huge steam plants is just beginning instead of having passed, as some folks would like to have us believe. For very many years to come I believe the steam plants will be of primary importance, and water-powers of secondary importance.

This does not mean that water-powers are of little importance,—far from it. In exceptional cases water-power developments, even including long transmission lines, can compete successfully with steam, particularly where coal is expensive, and if Government consent could be obtained for large developments on such rivers as the Niagara or St. Lawrence, enormous benefits would result and the truest kind of conservation would be accomplished.

Will Build Large Steam Plants

Then, too, for special uses such as electro-chemical works, water-powers are superior—for in these cases the continuous use of power really adds little or nothing to the expense; so as the revenue is proportional to the energy derived it is evident that for high-load factor loads, good water-powers are much more economical than steam. There is more demand than the water-powers can supply, so the natural result would seem to be to supplement the steam-driven generating station with the water-power, so far as it will go, keeping in mind that unless new and radical improvements in heat engines are made, the slow increase in cost of steam power will result in the construction of water-power plants now deemed of no immediate value.

So we may look forward to the building of large steam plants to which will be connected the water-power plants in the vicinity. These steam plants will be spaced perhaps 100 miles apart, depending on the density of the population and the natural conditions. One system, a uniform voltage, a standard frequency, will enable these future systems to deliver service at minimum rates.

In England a special commission has reported to Parliament, recommending the division of England into sixteen