NOTES ON WATER SUPPLIES AS SOURCES OF POWER*

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IN few branches of engineering has progress been so rapid as it has been, for the last few years before the war, in water power engineering. Not only have the design and efficiency of water turbines and generators of electricity been greatly improved, but the transmission of power to considerable distances by high-pressure three-phase alternating current has become a comparatively simple matter. Owing to the great advances made, and to the demand for power which is to-day almost insatiable, many water power schemes, considered impracticable 20 or even 15 years ago, must be now possible and ready for development.

In Italy, no doubt owing to the limited supply of coal available in that country, there are at present some 400 large water power schemes which are apparently giving every satisfaction, and the total water power already harnessed is stated by Dr. Liuggi to be some 1,300,000 horse-power. Water power has also been considerably developed in Sweden, Norway, Spain, France and Switzerland, and other European countries. In Switzerland, electric power from plants of moderate size is distributed in the rural districts and used for agricultural purposes. Under favorable conditions, water power can be obtained at 40s. and less per horse-power per annum. Many large water power schemes have also been carried out in the United States and in Canada.

The subject of water power can hardly, perhaps, be so important in this country, where coal of good quality is so easily obtainable, as in countries where coal, oil, and other forms of fuel are more costly and difficult to obtain. Nevertheless, there are several important water power installations in the British Isles, among which may be mentioned: (1) The Kinlochleven Works in the West of Scotland, the present capacity of which is 30,000 horse-power, with provision for extension; (2) works of about one-fourth this capacity at Foyers; (3) the works of the North Wales Power Company, in the Snowden district, which supplies a number of large quarries; (4) works at Conway, in connection with which an Act of Parliament was obtained last year (1916), authorizing the linking of the works with the water supply works of the Conway Water Board; and (5) an installation at Chester, where power is obtained from the River Dee, the head utilized varying from about 1 ft. to 9 ft. This latter plant is understood to be capable of supplying power at a maximum rate of about 500 horse-power, depending on the discharge of the river. The works are linked up with the steam plant of the Chester Electricity Works, the cost of the current obtained from the water power plant being much less than that of the current generated by the steam power plant. There are also some small works in Ireland.

Although there is not very much water power available for development at a remunerative cost in this country, owing to the smallness of the rivers, the scarcity of large lakes at high elevations, and the necessity generally of building costly storage reservoirs, the total being estimated at about 1,000,000 horse-power, there is likely to be a great development of water power in other countries, such as Canada, Australia, New Zealand, Africa, India, Mesopotamia, South America, as well as in Europe after the war, and the subject should not be neglected by water engineers who desire to share in the pioneering work to be done in other countries than Britain. The subject should also be interesting to such manufacturing firms as may be in a position to provide the hydraulic and electrical plant which will be required.

Mechanical power of all kinds is destined to take a more important place in the future activities of the world than it does at present, and water power will become especially valuable owing to the increased cost of coals, oils, and other fuels.

Quite apart from the hydraulic power supplies at high pressure, it is, of course, common for water undertakings to supply water power within their areas of distribution for operating hydraulic lifts, and small water motors used in various trades, but in recent years this demand has been seriously diminished by the competition of electricity, which, at a charge of 1½d. per Board of Trade unit—the charge for large powers is often much less than this—or about 1⅛d. per horse-power, is equivalent to a charge of less than 1d. per 1,000 gals. of water under a head of 150 ft. It is not, however, feasible for waterworks to make such very low charges for the supply of power from their distribution systems.

Low electric power charges are, no doubt, due very largely to the desirability of cultivating power loads to neutralize as much as possible the effect of high peaks on the station load diagram, due mainly to the lighting loads. The generating station plant has to be large enough to deal with the peaks and the power loads designed to fill the gaps or valleys can be accepted at charges approximating to the running costs of the plant, which are often little more than one-third of the total costs of current.

The load or supply factor (*i.e.*, the percentage of average to maximum load) has a much less important influence on the costs of supply in a waterworks where the power can be accumulated in elevated reservoirs, and there is little advantage to be gained in encouraging power loads in preference to supply loads by selling water power from the distribution mains at a lower charge.

On the other hand, the question of load factor in a public supply electricity generating station in connection with the ability to accumulate power possessed by a waterworks appears to suggest certain advantages in the combination of electricity and waterworks, as for example, in pumping into a service reservoir. A regular all-day pumping load dovetails very satisfactorily into an electricity generating station load, especially if the pumping can be discontinued during the period of peak load, as is possible in some cases. Another factor which suggests advantage in combining electricity and waterworks is that the consumption of water for ordinary purposes is generally lower in the winter, when not only is the available supply of water greater, but the consumption of electricity is at its maximum, and coal supplies are in more general demand.

Many waterworks are in a position to generate power from the water before it reaches the service reservoirs, and in some cases, especially in districts far from coal supplies, water power could be generated and supplied at a reasonable cost. Some watersheds are capable of supplying as much as 100 million gallons of water per day from a considerable elevation, and the difference in level between the impounding reservoirs and the service reservoirs varies in different waterworks up to and over 500 ft. Of course, there must be many cases where the cost of the works necessary to utilize power externally would be out of proportion to the available revenue which it would command, but, on the other hand, there would be other

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