HYDRO-ELECTRIC DEVELOPMENT.

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IT has become almost an article of faith with the majority of people that, given a waterfall or swiftly flowing river in any part of the country, it must necessarily be of great value for power purposes. The wonders and marvels of electricity have been so expounded in popular form to the public that there is a danger of overlooking the fact that electrical undertakings must be governed by commercial considerations. To nearly all of the hydro-electric propositions that have received serious discussion of late in the colony, Napoleon's trite saying applies: "It is magnificent, but —— it is not war." I have to admit, with regret, that for this state of affairs some electrical engineers are, in a large measure, responsible. One, an American who visited the chief water powers, framed a report of the most eulogistic nature, but carefully avoided saying anything at all as to the price at which energy could be delivered to the consumer. Another assumed that all the installations would sell all the energy they could transmit at the same price, which he fixed in an arbitary way. Theories of this kind, embodied as they are in Government reports, are largely responsible for the totally erroneous ideas current on the subject. It cannot be too highly emphasised that a water power is absolutely worthless, no matter how many horse power are in it, unless it has an adequate market to sell its energy in, and can undersell energy derived from coal or other fuel. The essential condition of success may, in fact, be summed up in the word *market*, for if energy from fuel cannot be undersold, there won't be a market. It does not in every case necessarily follow that a possible market for the energy should be ready waiting for the installation; occasionally the market is created by the power supply when a new industry can be introduced, as occurred, for instance, in one of the earlier Niagara schemes, when the manufacture of calcium carbide and carborundum was established, or in the more recent example of Swedish and American production of nitrates from the air by electrical means. But cases of this kind are few and far between.

As so many hydro-electric undertakings are now in operation, not only in the United States and Switzerland, but in Canada, Mexico, India, Burmah, and practically every European country, including Great Britain, comparison plays a great part in the arguments advanced on behalf of every scheme mooted in New Zealand. Unfortunately many advocates know insufficient of the subject to understand that comparisons are most misleading when not made thoroughly complete. It has been asserted that because a 200-mile transmission is operating in California (or was prior to the earthquake of last April) and earning a dividend, therefore a similar transmission plant in this colony would be successful also. Again, because certain railways in Canada, the United States and Italy are worked by electric power derived from hydro-electric installations, that New Zealand should harness up some of its rivers and scrap-heap its locos. without delay But what about the conditions ruling in these cases and with us? The 200-mile transmission in Mexico or California is practicable because the climate there is excessively dry, so that the enormously high voltages essential to these distances can be employed without constant breakdowns, and it earns a dividend because it has sufficient customers to take a large proportion of the maximum energy it can supply—customers who cannot get that energy equally cheap from coal or any other source. In fact, in the districts served by 100 and 200 mile transmissions coal is either inferior and tremendously expensive, or is entirely unobtainable.

The electric railways which are the sole mainstay of hydro-electric installations are rare and always will be rare. Most railways require populations at intervals along their routes; given the populations you have markets for power in a score of forms. If fuel be dear or unobtainable while waterfalls are somewhere within reach, the populations will be the mainstay of the hydro plant, and the railway, even though the largest individual power user, will become a customer of second-rate importance. The reason for this is that the railway takes its energy in heavy draughts and intermittently, thus necessitating large works and generating plant, which are only employed to their full capacity at a few times each day. As capital charges on the cost of the installation are not modified by the amount of energy supplied, but go on at a fixed rate continuously, customers who require large plant to be kept ready for them, and use it to its full capacity only now and again, make the cost of supply higher than if they kept the plant uniformly loaded. If a general supply for industrial purposes can be added to the railway supply, the total load tends to more uniformity, and the cost per horse-power hour becomes lower. The Italian, Canadian and other railways referred to are worked hydro-electrically because, notwithstanding any drawback, the energy is cheaper than what could be obtained from the dear fuel available.

In the case of New Zealand railways, or any other, the problem to be solved is just the same—what is the cheapest source?

A study of the conditions that will affect hydro-electric transmission plants in New Zealand, is too extensive for treatment in a single article, but I may point out certain features. The climate in the majority of districts is damp, this increases the difficulty of maintaining a good insulation, so that it is extremely unlikely that we shall ever be able to successfully adopt the extra high voltages essential to very long transmissions—say for 200 miles and over. In many cases the country to be traversed by the transmission lines is rough and mountainous to the last degree, densely wooded and intersected by treacherous rivers, these obstacles may not be insuperable, but they run the cost up, and increase the maintenance. In every power-using district good qualities of coal are available, and modern fuel plants of great efficiency are coming into wide use; the hydro-electric supply must beat them or go bankrupt The number, size, and importance from a power-supply standpoint, of towns or districts to be fed by a transmission plant must be critically noted; price of coal, extent of steam, gas and oil plants in use, scope of industries, financial prospects for introducing electric tramways or supplying the energy to existing ones, are all points to be studied. The conditions surrounding the supply for railway main-line operation are a whole and complex subject in themselves, as the following brief treatment will show: Consider any one of the busiest lines in the colony with two daily express trains and six or eight goods and local trains, according to the existing schedules, split up into two, three or four car trains according to electric traction schedules, with say an hourly headway; the maximum load would come on the generating station probably not more than twenty times a day, and only for a few minutes or even seconds on each occasion. If the normal load averaged 1000 h p. this occasional maximum load could easily be 3000 h.p. or more, according to the physical conditions of the line. The practical bearing of this is that the expense of an installation able to deliver 3000 h p must be incurred to supply a load that for nineteen twentieths of its time does not exceed 1000 h p Storage batteries would be serviceable in reducing the disparity in cases where a frequent train service was run, but they are quite inapplicable to such a case as the one I am considering. As already pointed out, the only salvation from a high annual cost on this installation is to be got by extending the supply, and securing a more diverse and, therefore, paradoxical as it sounds, more even load. The installation may then need to have a capacity of perhaps 5,000 h p. but the ratio of normal to maximum loads will have risen from the former 1 to 3 to possibly 2 to 3. This brings us back to the chief factor in the whole problem: Can energy produced under these conditions compete with energy derived from fuel, and find a sufficient market?

In a concluding article I shall deal with the cost of the water to the owners of the transmission plant, the cost of the plant itself, the influence of distance of transmission and other factors upon the cost of the energy to the consumer, and discuss what constitutes a market.

(*To be continued*)

Our readers will regret to learn that Mr. and Mrs. Templin were laid up in Bangkok with fever at the time the last mail left. Mr. Templin proceeded there from Christchurch to superintend the erection of two Curtis steam turbines for the General Electric Co.

The Wellington City Council have ordered thirty more arc lamps for street-lighting purposes. The whole of the tramway routes, therefore, will soon be brilliantly lighted

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The Christchurch City Council have appointed Mr. Scott as their engineer. Mr Scott was recently in charge of the Gore Electric Light Works.

The Wellington Electric Light & Power Co. intend to install a new steam turbine at an early date, and engineers will look forward with interest to the operations of this engine, which is the first of its kind to be erected in Wellington

INTERNAL COMBUSTION ENGINES.

AT the Royal Institution on August 5 Professor Bertram Hopkinson delivered the final lecture of his series on this subject. Professor Hopkinson said that in previous lectures he had described methods of regulation which were not satisfactory, but good regulation could be obtained by reducing the fuel supply if matters could be arranged so that the explosive mixture in the cylinder was stratified, consisting of practically pure air in one end of the cylinder and a strong mixture at the other. He would show by experiment what took place in the cylinder in these two cases, but he should point out that there was a practical difficulty with regard to this method of regulation because in the ordinary charging stroke of the gas engine the velocity of the entering gases was something like 60 miles per hour. It had, however, been successfully accomplished in the case of large engines, and there was reason to hope that it would be possible to work in this way with small engines. Apart from successful regulation there was this further advantage of obtaining stratification, that the piston remained cooler than under ordinary circumstances, and he need not say that the cooling problem in the case of larger engines was a very serious practical question. Reference has already been made to the improved efficiency of the gas engine over the steam engine, and the economy of the gas engine could be improved by the adoption of any method which economised the loss of heat to the cylinder walls and that carried away in the exhaust. It was not possible to effect economies in regard to the loss of heat to the cylinder walls, except by making the engine larger, and therefore it was necessary to concentrate attention upon the heat carried away by the exhaust gases. To improve the efficiency of the gas engine in this connection it was necessary to secure a greater ratio of expansion which was accomplished by employing greater compression, the two things being, of course, definitely related to each other. In theory it was possible to reduce the temperature of the gases when they left the engine to any degree, but in practice there were definite limits to the extent to which gases could be compressed by reason of the danger of pre-ignition. There were means, however, of preventing pre-ignition; for instance, water might be sprayed into the cylinder, and in that case the presence of the steam in all probability acted in preventing the gases from being prematurely ignited. By employing that and other devices it was possible to compress the gas to a volume as small as one-ninth of its original volume, and the economy of the engine could be improved to a point where over 30 per cent. of the total heat of the fuel was converted into mechanical work. The question as to whether the Otto or the two-cycle engine was the gas engine of the future had not yet been definitely settled, and he hesitated to prophesy.

Reinforced Concrete.

A correspondent writes that the Patent Indented Steel Bar Company (Limited), of Queen Anne's Chambers, Westminster, has been formed for supplying a bar of special section for reinforced concrete construction. The principal feature of the bar is stated to be great adhesion to the concrete owing to the mechanical bond formed by its indented surface.

Mr. A. E. Brown, the well-known Christchurch electrician, has disposed of his business to Messrs. Scott Bros., and is now acting as manager of their electrical department.

The new building in Wellington for Messrs. J. Nathan & Co. will require 10,000 feet of conduit for electric lighting purposes.

The General Electric Co. have just landed six G.E. 67 railway motor equipments for the Wellington Tramways. These motors are 40 h.p. each, as against the 25 h.p. motors that have been in use on all cars since the system was opened up for traffic.

In Germany goat's milk is particularly esteemed for the reason that tuberculosis is extremely rare among goats, their almost complete immunity being due, it is suggested, to the life the animals lead on the hillsides in the open air. In the kingdom of Saxony in 1894 it was reported that out of 1562 goats slaughtered only 10 were found to be tuberculous.