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HYDRO-ELECTRIC SCHEMES COMPARED WITH THE GAS INDUSTRY:

BEING A REPORT BY MR. JAMES LOWE, A.M.I.C.E., ENGINEER AND MANAGER, AUCKLAND GAS COMPANY, TOGETHER WITH REPLY BY MR. EVAN PARRY, B.Sc., M.I.E.E., A.M.I.C.E., CHIEF ELECTRICAL ENGINEER, PUBLIC WORKS DEPARTMENT.

Laid on the Table of the House of Representatives by Leave.

HYDRO-ELECTRIC SCHEMES COMPARED WITH THE GAS INDUSTRY.

INTRODUCTION BY MR. J. H. UPTON, CHAIRMAN OF DIRECTORS.

(1)

THE question is sometimes asked, What effect will the competition of the hydro-electric schemes of the Government have upon the gas industry? The answer to that question involves an examination into the economic soundness of the schemes themselves, and also opens up various large questions of a political character. But, of course, the fundamental question is, Are these schemes financially and economically sound?

(2)

The directors of the Gas Company have asked Mr. J. Lowe, engineer and manager of the company, to prepare a report on this important question, and have thought it well to put it into print for the benefit of the shareholders.

(3)

The Public Works Statement for 1917 has supplied definite information regarding the Lake Coleridge scheme, upon which Mr. Lowe has been able to base reliable calculations showing the results that may be anticipated from similar enterprises in other parts of New Zealand if the Government should be unwisely induced to borrow large sums of money for such works, when the country stands in urgent need of railways and roads for the opening-up of virgin lands and the promotion of settlement.

(4)

In considering this report it must be borne in mind that Lake Coleridge was selected from among all the hydro-electric schemes submitted for consideration by the Government as being the one which promised the best results from the smallest outlay of capital, and the comparison which Mr. Lowe institutes between the practical working-out of this scheme and the proposed supply of electricity from Arapuni, as recommended by the Chief Electrical Engineer, is very instructive, and, so far as gas investments are concerned, very reassuring.

(5)

The first outstanding fact to which Mr. Lowe's report directs attention is the proof which the official returns afford that electricity for lighting and power cannot be supplied to consumers in Auckland at lower rates than are already current in the city, if State enterprises of this description are to be placed on a self-supporting basis. The reason for this is made very plain. While the initial installation of the Arapuni scheme, providing for 30,000 horse-power, would—according to the estimate of the Government Engineer—involve an expenditure of £1,200,000, the chief gain resulting from the substitution of water for steam power would consist in the saving of the expenditure upon coal used at the city electrical works, which, as Mr. Lowe points out, consists almost entirely of slack that would otherwise become a waste product, but the carriage of which now provides a very substantial revenue to the Railway Department.

(6)

Experience in other countries has shown that the profitable development of hydro-electric schemes in competition with services employing steam-generation depends entirely upon the distance of the source of water-power and the cost of utilizing it, as compared with the cost of coal at the chief centre to be supplied. It is clearly shown that the competition which gas enterprises in Auckland may anticipate in the future can be no greater than that which the Auckland Gas Company is now sustaining with a steadily growing business.

(7)

Sixty per cent. of the gas sold in Auckland is for cooking, and the cost of heating by electricity is about nine and a half times that of gas. In other words, consumers can purchase for less than a halfpenny as much heat in the form of gas as would cost them at least 4d. if produced by electricity.

(8)

The facts quoted by Mr. Lowe regarding the successful competition of gas against electricity in Toronto (Canada) and Bergen (Norway) are of especial importance, because the hydro-electric services which supply these cities are among the most up to date in the world.

(9)

The official figures in Mr. Lowe's report, showing that the capital outlay on the Lake Coleridge scheme greatly exceeded the estimate—that the estimated cost was £23·2 per horse-power, whereas the actual cost has been £45·8 per horse-power—are significant of what New Zealand may expect in future if similar schemes are authorized. The unfair competition to which private enterprises are exposed, through the exemption of Government and municipal trading concerns from taxation, also demands public attention. In Great Britain similar enterprises are not subsidized in this way. The entire population of the Dominion is being taxed for the benefit of one section of the community, and public funds are employed under a system that tends to destroy the healthy competition which is necessary in order to secure efficiency. This is a matter that should be strongly urged upon the attention of the Legislature.

J. H. Upton,
Chairman of Directors.

Report by Mr. J. Lowe, A.M.I.C.E., Engineer and Manager, Auckland Gas Company.

Lake Coleridge Results.

(1)

The following data regarding Lake Coleridge results is taken from the Public Works Statement, 1917:—

	Year ending 31st March 1917.
Capital outlay	£366,984
Plant capacity	6,000 kw.=8,000 h.p.
Revenue from sale of current	£20,754
Working-expenses	£12,889
Interest at 4 per cent.	£13,743
Depreciation at 2 per cent.	£6,078
Total annual cost	£32,710
Maximum load in power-station	4,366 kw.
Average weekly load factor (per cent.)	52·9
Energy issued from power-house (kilowatt-hours)	14,774,960
Energy sold (kilowatt-hours)	11,664,961

The price or prices at which current is sold are not given, but the average price received can be calculated, and is found to be 0·427d. per unit sold.

(2)

(*a.*) It is important to notice that the capital outlay is largely in excess of the estimates by the Hon. R. McKenzie in the report of the second reading of the Water-power Bill, Wellington, 13th October, 1910.

The estimate for the complete works, including transmission-lines, was £232,000 for a plant capacity of 10,000 horse-power (*vide* Appendix A attached hereto). The estimated cost was therefore £23·2 per horse-power of plant, but the actual expenditure from the Public Works Statement works out to £45·8 per horse-power of plant installed.

This figure would have been considerably greater had import duties been paid on the plant in accordance with the Customs tariff.

(3)

(*b.*) That the total annual cost is given as £32,710, made up of working-expenses, interest, and depreciation, while the revenue from sale of current is £20,754, so that there is a total loss on the year's working of £11,956. The annual report does not indicate how this deficit is met.

(4)

Is it to be charged against the revenue of the Dominion, or to be carried forward at the debit of profit and loss in the hydro-electric accounts?

(5)

Government electric supply is Government trading, and the accounts of such an undertaking should be treated exactly as would be the case were the enterprise a private one.

(6)

All deficits should be carried forward at debit of profit and loss, to be wiped out by future trading surpluses, if any. After the undertaking is properly started, such a price should be charged for current as will make the undertaking self-supporting.

(7)

The undertaking should also pay all the usual charges that have to be met by private enterprises, including rates and taxes.

(8)

(c.) The average price per unit sold, found by dividing the revenue by the energy sold, is 0·427d. per unit for the year 1917.

(9)

The cost of the unit to the undertaking, calculated by dividing the total annual cost by the energy sold, is 0·673d. It may be said that the output could have been increased without any increase in capital expenditure and operating-costs. This seems to be the case, as the plant is capable of generating 6,000 kilowatts, and the maximum load on the power-station during the year was only 4,366 kilowatts.

(10)

The output, assuming the load factor to have remained constant at 52·9, might have been increased in the ratio of 6,000 to 4,366, and the energy sold would then have become 16,030,638 kilowatt-hours.

(11)

This amount of current, sold at the average price (0·427d. per unit), would have yielded a revenue of only £29,189, so that there would still have remained a deficit of £3,521, and this without any charges for rates and taxes, and possibly management. It therefore appears that the prices charged for current are too low to make ends meet. If the average price charged was ½d. per unit, and if the maximum load on the power-station was equal to the capacity of the plant, the revenue from the sale of current would be £33,397, and this sum would be sufficient to meet the working-expenses, interest, and depreciation charges, totalling £32,710, as shown in the accounts for 1917.

(12)

Had the hydro-electric station been a private enterprise, paying 4 per cent. dividend on its capital, it would have been required to pay income-tax on £13,743; and it does not seem fair that it should be exempt because its capital is loan capital and not share capital, especially as it is in competition with other interests which are subject to taxation. It thus appears that, even under the most favourable circumstances, an average price of ½d. per unit would not be sufficient to make the undertaking self-supporting if all legitimate charges were met.

The Hydro-electric Scheme for Auckland District.

(13)

Mr. Parry, the Chief Electrical Engineer, proposes for Auckland district a hydro-electric station at Arapuni Gorge, on the Waikato River, and he proposes an initial installation of 30,000 h.p. for an expenditure of £1,200,000.

(14)

He states (Public Works Statement, 1917, page 50): "One objection to this scheme is that, whilst the development is an exceptionally economical one for the full development, the initial cost of the large hydraulic works required makes it unduly expensive for partial development of under 40,000 horse-power; but if it can be found that within reasonable time there is a prospective market for this amount, the development of the scheme would be justified on an economical basis."

(15)

Without expressing any opinion as to whether there will be a market for 40,000 h.p. within a reasonable time, it may be pointed out that, as compared with Lake Coleridge plant, the Arapuni scheme suffers from two disadvantages:—

(1.) That the hydraulic works will be unduly expensive for partial development:
(2.) That the chief centre of population to be supplied (Auckland) is about twice as far away from Arapuni as Lake Coleridge is from Christchurch.

(16)

The cost per horse-power of plant installed at Lake Coleridge has largely exceeded the estimate of £23, and is now actually over £45.

(17)

The estimate of the Arapuni scheme is £40 per horse-power of plant with a development of 30,000 h.p., and this is probably also an underestimate, while for partial development it is certain that this figure will be greatly exceeded.

(18)

If the same disparity be assumed between the estimate and the actual cost as was found to be the case with the Lake Coleridge scheme, the cost per horse-power of plant installed will be in the neighbourhood of £80 for complete development, and very much more for partial development.

(19)

It has been shown that the average price received per unit sold by the Lake Coleridge power-station is 0·427d., and that this does not pay expenses; and, further, that the average price should not be less than 0·5d. in order to meet working-expenses, interest at 4 per cent., and depreciation at 2 per cent., without any allowance for rates, taxes, and management.

(20)

If, then, the Lake Coleridge installation requires an average price of at least 0·5d. per unit sold, how much more will the Arapuni scheme require in view of the admittedly greater expenditure required for hydraulic works and the much greater length of the transmission-lines from the principal market?

(21)

If the actual cost exceeds the estimate in the same ratio as has been found to be the case with the Lake Coleridge plant, the average price per unit in order to make ends meet, without rates, taxes, and management charges, will require to be in the neighbourhood of 0·8d., and this for a development of 30,000 h.p.

(22)

For partial development the price would require to be very much greater, or else there would be a very large annual deficit.

(23)

There is a great difference between the area proposed to be supplied from Arapuni and that already supplied from Lake Coleridge, because in the former area there are abundant supplies of lignite or brown coal, and in the latter area there are no coalfields at all. The slack and cheaper varieties of the Waikato coal are at present chiefly used for steam-raising and power-production within the district.

(24)

One might expect to find, therefore, that the cost of generating power by steam would be less in the former district than in the latter, and this is in fact the case, and it forms an additional circumstance which will militate against the success of the Arapuni scheme.

(25)

The cost of electric current generated at the steam-driven station of the Auckland City Council, deducted from the accounts for the year ending 31st March, 1917, is as follows:—

	£	Per Unit generated. d.
Coal	11,491	0·3389
Oil-waste, stores, and water	448	0·0132
Wages	3,559	0·1050
Repairs and maintenance—		
Buildings	1,288	0·0380
Engines and boilers	1,456	0·0429
Instruments and tools	519	0·0153
Dynamos, exciters, and transformers	143	0·0042
Accumulators	60	0·0177 (? *0·00177*)
		0·5752 (? *0·55927*)

Units generated, 8,119,000; units sold, 6,842,000.

(26)

In the event of the City Council deciding to take a bulk supply from the hydro-electric installation, the cost of the first item, and possibly two-thirds of the second item, which includes water, and also half the wages-cost, could be saved. It is doubtful if there would be any saving in repairs and maintenance charges, because, although these charges could be eliminated on the engines and boilers, this saving would be counterbalanced by additional charges on the transformer plant.

(27)

The savings would therefore amount to 0·4002d. per unit. But this saving is less than the average price charged for power by Lake Coleridge Station (0·427d.), and greatly less than the price which a station at Arapuni would require to charge, operating, as it would do, under less favourable conditions with regard to cost of transmission and cost of hydraulic works.

(28)

No advantage would therefore be obtained by the electricity-consumers in Auckland City, unless the Government should sell the current at a price much below the cost of production and place the deficit on the shoulders of the general body of taxpayers.

(29)

The report of the Government Chief Electrical Engineer makes a great feature of the saving to be obtained by displacing coal by water-power.

(30)

It is worthy of note, however, that the coal which would be displaced by the hydro-electric scheme for the Auckland district is chiefly slack, which is produced in the hewing of household coal, and will be produced and brought to the surface in any case.

(31)

It may be deplorable that water should flow through the Arapuni Gorge unharnessed, but it is equally deplorable that slack coal, after being brought to the surface, should go to waste. The price of slack coal at the Waikato mines is from 3s. to 5s. per ton, and the freight to Auckland is 7s. 11d. per ton. If hydro-electric power from Arapuni displaces coal the Railway Department will lose this revenue.

(32)

The country generally will lose thrice: first, by the adoption of an unprofitable scheme; second, by the loss of revenue to the Railway Department; and third, by turning slack coal into a waste product.

(33)

It is not clear from the reports of the Chief Electrical Engineer that steam-power for the generation of current can be entirely dispensed with. To quote the report of 20th August, 1917 (Public Works Statement, 1917, page 47): "Arrangements have been made with the Christchurch Tramway Board for the use of the whole of their steam plant, amounting to 2,000 kilowatts, for stand-by purposes. This provision will enable the Department to dispense with a spare unit at the power-house and to utilize the whole of the plant for revenue-earning purposes. It also enables the Department to maintain a local supply up to 1,000 kilowatts in the event of the breakdown of the transmission-lines." And, further on: "A similar arrangement is under consideration for the use of some spare plant belonging to the Christchurch City Council, and which they are putting in order for stand-by purposes."

(34)

And in the interim report of the 19th February, 1917 (Public Works Statement, page 51), with regard to the scheme for the Wellington district, it stated, "In the present instance I propose that the stand-by unit should be a complete steam set. The advantage of a steam stand-by set in this scheme is that not only does it serve the purpose of a spare unit, but it also provides means of tiding over short periods of exceptional or abnormal low water, thus enabling the available water to be used to a larger extent. The additional cost of the steam unit over water-power is not great, and the cost of running on infrequent occasions would be a negligible proportion of the total operating-cost, whilst the additional security and value conferred on the water-power plant is out of all proportion to the added expense."

(35)

In view of these quotations it seems to be a reasonable conclusion that in order to make reasonably sure of continuity of supply we must either have two transmission-lines, each capable of carrying the whole load, laid by different routes to the city, so that in case of accident to either the other can be used, or, alternatively, a complete steam-generating plant in the city.

(36)

Duplication of the transmission-lines would add enormously to the cost of the scheme, and perhaps also cost more than a steam plant; therefore it is likely that a steam plant capable of supplying all demands would have to be maintained as a stand-by. If this is so there would be no saving of capital expenditure at the city power-station, but quite the reverse, as there would be required both a steam-generating plant and a transformer plant for breaking down the high-tension current from the hydro-electric station to the ordinary pressure of supply.

(37)

The report of the 19th February, 1917 (Public Works Statement, page 49), lays down some interesting conditions, to which no exception can be taken:—

(1.) "All things considered, the capital cost of headworks, power-station, and plant, including everything up to the point of transmission, should not exceed £20 per horse-power of plant, otherwise, when account is taken of the cost of transmission, the extent of the capital expenditure will tend to swamp the advantages to be derived from substituting water-power for fuel."

(2.) "As regards the area to be supplied, there is an economic limit to the area over which a given amount of power can be distributed."

(38)

In the *New Zealand Journal of Science and Technology*, January, 1918, page 50, Mr. Parry states, "The capital cost of an electric-power-supply system, including generating plant, transmission, distribution, and transformation, is about £40 per horse-power of generating plant when fully developed."

It appears, therefore, that the cost of the hydro-electric plant at Arapuni should not cost more than £20 per horse-power of plant if the scheme is to be economically successful; also that the expenditure on transmission-lines should for the same reason not exceed £20 per horse-power of plant. The aggregate expenditure should therefore not exceed £40 per horse-power of plant.

(39)

The Lake Coleridge plant has already cost £45 per horse-power of plant installed, or approximately double the estimated cost of £23, and it appears to be necessary to provide a stand-by steam plant in Christchurch.

(40)

The proposed Arapuni hydraulic works are admittedly more expensive than those at Lake Coleridge, and the transmission-lines required will be at least twice as long. It will also be necessary either to duplicate the transmission-lines or to provide a stand-by steam plant in Auckland.

(41)

In view of these considerations, can it be expected that the estimated cost of the Arapuni scheme—£40 per horse-power of plant installed—will be realized?

(42)

Is it not more probable that the estimates will be largely exceeded, perhaps doubled, as has been the case with the Lake Coleridge scheme?

(43)

Even if the estimate of £40 should be realized, it has been shown that current cannot be supplied in Auckland as cheap as the cost of generating by steam in the City Council electric station.

Some Interesting Comparisons.

The question now to be considered is, What effect will the Arapuni hydro-electric scheme, if carried out, have upon the business of the Auckland Gas Company (Limited).

This question has been already answered, as it has been shown that the City Council Electric Station is at present generating current cheaper than it can be supplied from Arapuni, except the hydro-electric current be supplied at a loss.

The capital expenditure of the Auckland City Council Electricity Department was £335,411 18s. at 31st March, 1917, and of this amount about one-third, or £109,927 5s., had been expended in machinery, transformers, &c. It is not clear that there could be any saving in future expenditure under this head. Even if steam-engines and boilers were not required, transformers would have to be provided, and it does not appear that engines and boilers can be dispensed with except the transmission-line be duplicated. Any such duplication would certainly add largely to the cost per horse-power of plant installed, and would have to be charged for in the price of current delivered to the Auckland power-station.

The following is an analysis of the costs per unit generated and sold by the City Council Electricity Department for the year ending March, 1917:—

	Price per Unit generated.		Price per Unit sold.	
	d.	d.	d.	d.
Generation of electricity—				
Coal	0·3389		0·4031	
Oil-waste, stores, and water	0·0132		0·0157	
Wages, generating-station	0·1050		0·1249	
		0·4571		0·5437
Repairs and maintenance—				
Buildings	0·0380		0·0452	
Engines and boilers	0·0429		0·0511	
Instruments and tools	0·0153		0·0182	
Dynamos, exciters, transformers	0·0042		0·0050	
Accumulators	0·00177		0·0021	
		0·10217		0·1216
Distribution of electricity—				
Wages, repairs, and maintenance of mains and meters		0·0749		0·0891
Public lamps		0·0185		0·0220
Management—				
Salaries and office charges		0·0721		0·0857
Special charges		0·0576		0·0684
Bad debts		0·0058		0·00688
Interest on loans		0·42384		0·5040
Depreciation		0·2618		0·31137
Sinking funds		0·06196		0·07368
Average cost		1·2958	(? *1·5357*)	1·82643

These figures are exceptionally good, and are the result of the fact that the power load during the day is about equal to the lighting load in the evening.

Current is sold by the City Council for power purposes at various rates below the average cost of production, the lowest published rate being for large consumers, 1⅜d. per unit for the first 25,000 units per quarter, and 1d. per unit for all units in excess of this quantity per quarter.

The price-reductions to power-users are based on the consideration that they take the current principally in the daytime, when the generating plant and mains would otherwise be lying idle, and that, consequently, anything obtained per unit from the power-user more than the costs of generation and distribution is profit.

The lighting-consumer is saddled with the whole charges, including interest on capital expenditure for both classes of consumers.

At the present time 60 per cent. of the gas sold is for cooking, and the chief cooking load occurs between 5 p.m. and 7 p.m. The cooking demand for gas at lunch-time and breakfast-time is considerable, but is greatly exceeded by the demand at dinner-time. At the latter time gas is required for cooking at the rate of 230,000 cubic feet per hour. This quantity of gas represents a delivery of 124,000,000 British heat units per hour from the gasworks, and to obtain the same amount of heat from electricity 48,342 h.p. would be required.

This heat is required through the greater part of the year during the chief lighting-hours—on the peak of the load, as an electrician would express it. Consequently, if electricity were employed for this purpose, the plant would have to be capable of generating, and the distributing mains would require to be capable of carrying, this amount of current in addition to the current required for lighting. The load factor would thus be reduced, and all charges per unit sold increased, and electricity for cooking would require to be sold at a price which would include its due proportion of all charges.

A consideration of these points makes it clear that it would be ruinous for an electric station to sell a preponderance of its output for cooking purposes at prices approaching power rates. In fact, it looks as though the price per unit for such business should approximate to the price charged for lighting. It would certainly have to be considerably more than the average price already given.

Now, as one unit of electricity has a heating-value equal to 3,420 therms., it is about equal in heating-power to seven cubic feet of gas; but seven cubic feet of gas at 5s. costs 0·42d., in comparison with 5½d. per unit, the flat rate, and a possible average of, say, 4d.(?) for lighting under the maximum demand system of Auckland City Council Electricity Department.

The City of Toronto, Canada, is supplied by current from the hydro-electric installation at Niagara, and the Toronto Consumers' Gas Company is therefore in competition with electricity from water-power. Nevertheless the Gas Company has made progress by leaps and bounds, and doubled its output between 1908 and 1914.

The president of the company, in moving the adoption of the report in 1914, said, *inter alia*, "When it was borne in mind that the amount of gas put out during the past year was nearly double the quantity sold six years ago, the necessity for the large increase in the company's trunk mains would be apparent. It would be noticed that the number of meters installed had just about touched the 100,000 mark, and, taking an average of five people to a family, it would seem that nearly all Toronto was using gas."

Mr. B. Schieldrop, of Bergen, Norway, stated in 1914, "In Norway there is keen competition with exceedingly cheap electricity generated from water-power. Eight years ago the Bergen Gasworks sold 30 per cent. of its make for lighting purposes; at present the sale is probably less than 5 per cent. The proportion cannot be given with any certainty, because there are no separate meters for lighting purposes, but, strange to say, the gas industry has not suffered by the reduction in the supply of gas for lighting. Gas for cooking and heating has more than compensated for the loss. The increase in sales has never been so great as since the competition with electricity set in. The increase in gas made last year over the preceding year for the whole of Norway was 15 per cent. For Bergen alone for the last three years the annual increase in gas sold was between 25 per cent. and 33 per cent., and this in spite of the fact that the population within the district of supply during this period was practically stationary. When the new gasworks at Bergen were put in operation late in 1908 everybody said they were built on too large a scale; but three years later new settings of vertical retorts were installed, and this year (1914) four more settings of verticals will have to be ordered. Electrical energy is very cheap with us, and the producers of it are very eager to sell it. We have to meet this competition; but it is very uphill work for the electric people to compete with gas, for the simple reason that the amount of heat in a unit of electricity falls so very short of the quantity of heat in a unit of gas, having regard to the price to be paid in either instance. Most people, when talking about this matter in a general way, will say, 'There we have a waterfall. It is simply a question of putting a turbine to it, laying a wire to the nearest populated place, and then setting up some apparatus so as to get the energy out again.' And they will add, 'Thus you have heat and light practically for nothing.' But this is not the way it will turn out, as you gentlemen know. To get the energy transmitted is an exceedingly expensive thing itself. Therefore, when every consideration is taken into account, it is found that electricity cannot be sold for nothing. On the contrary, when electricity has to compete with gas as a fuel it is driven to the wall. This does not, however, prevent one project after another coming forward. We have seen them promulgated in such a way that they claim to be able to get several hundred per cent. of activity out of it—that it can be done very economically, and that it can be produced on a very paying basis. Of course, as soon as these promises are tested they fall to pieces, and then we are enabled to laugh at them."

APPENDIX A.

(Extract from *Lyttelton Times*, 14th October, 1910.)

From a Report of the Second Reading of the Water-power Bill, Wellington, 13th October, 1910.

Re Lake Coleridge: The Hon. R. McKenzie said he had worked the cost out as follows:—

	£		£
Headworks	80,000	Store	200
Generators (four), 2,000-kilowatt	11,450	Tools	1,000
Exciters	618	Freight	6,655
Transformers	8,452	Cartage	2,258
Switchboards and lighting arrestors	1,900	Erection	1,810
Turbines (four), each 2,500 h.p.	15,000	Poles	25,200
Cranes	1,500	Line-duplication, 70 miles	28,500
Cooling system	440	Insulators	13,440
Lubricating system	260	Substations	19,000
Power-house building	3,600	Emergencies	850
Foundations	7,584		
Staff houses	2,100	Total	£231,997
Workshop	200		

HYDRO-ELECTRIC SCHEMES COMPARED WITH THE GAS INDUSTRY.

REPLY by Mr. EVAN PARRY, B.Sc., M.I.E.E., A.M.I.C.E., to the foregoing Report by Mr. James Lowe, A.M.I.C.E., Engineer and Manager, Auckland Gas Company, and Introduction by the Chairman, Mr. J. H. Upton.

Introductory and General.

This is a report the purpose of which, according to the introduction by the chairman of the Auckland Gas Company, is to ascertain "What effect will the competition of the hydro-electric schemes of the Government have upon the gas industry?" This is capable of a direct and simple answer. Instead, however, of taking the direct course the directors have preferred the indirect course involving "an examination into the economic soundness" of the Government schemes, apparently with the object of discrediting State enterprises. That this investigation is not at all necessary in order to satisfy inquiry is evident on reading the report, as ample evidence is adduced by Mr. Lowe to prove that so far from suffering from competition with electricity the gas industry has prospered even in Toronto, where it is in competition (so-called) with a State hydro-electric-power undertaking operating on a colossal scale. However, it is customary to adopt these tactics in similar circumstances, a notable recent instance being the attempts made to discredit the Hydro-electric Commission of Ontario by the financial interests of the United States.

The effect of these tactics in the present instance is to place the gas interests in a few towns in direct antagonism to the national interests generally and to the country districts in particular.

The object of the State is to place a flexible and adaptable form of power at the command of the individual, the farming community, and industry generally, wherever situated, with a view to economizing labour and increasing production, and generally raising the standard of efficiency throughout the State. The effect of such a policy is not to discourage but to encourage and stimulate private enterprise.

I have elsewhere expressed the opinion that in towns where a gas-supply is already available the gas and electricity undertakings should be co-ordinated and managed by the same authority, and if the gas companies were purchased by the local authorities, with or without State aid, it would remove the apprehension which now exists amongst gas companies and their shareholders at the approach of hydro-electric power.

In his report Mr. Lowe has committed the error of comparing an estimate of the capital outlay required to provide a supply of electricity to Christchurch only with an actual outlay which includes a distribution throughout an area of about 300 square miles, and other things not included in the Hon. Mr. McKenzie's estimate. This error vitiates the whole report.

The expenditure upon the Lake Coleridge works, transmission, distribution, substations, and a certain amount of local reticulation, amounts to about £45 per horse-power. This is a very moderate figure, and will and should be exceeded as the area of supply is extended, much to the benefit of the community and the financial advantage of the undertaking itself. I have elsewhere mentioned £40 per horse-power as attainable, but this is for a completed scheme and not for a partially developed scheme, and covers the expenditure on purely bulk supply business only.

Mr. Lowe argues that if the expenditure on the Lake Coleridge undertaking has reached £45 as compared with an estimate of £23, then the estimate of £40 per horse-power for a scheme for the Auckland Province must cost in the neighbourhood of double this, or £80 per horse-power.

In the first place, the comparison with Lake Coleridge is an erroneous one, and, even if it were not, the argument based on it is fallacious; and, further, even if the expenditure should reach £80 per horse-power the figure is quite a normal one.

I submit a detailed reply to both Mr. Lowe's report and Mr. Upton's introduction, taken seriatim. I have made every effort as far as time permits to deal fully with every point raised, and I have made every effort to treat each argument fairly.

In Reply to the Chairman's Introductory Remarks to Mr. Lowe's Report.

Paragraphs 1 and 2.

The question is asked, "What effect will the competition of the hydro-electric schemes of the Government have upon the gas industry?" the answer to which "involves an examination into the economic soundness of the schemes themselves."

The answer to this question is direct and simple—viz., that gas and electricity each has its special function, and that in its own special field of usefulness there is no competition between the two. Where, however, the gas industry has had the field to itself the introduction of electricity has necessitated a readjustment of its business, but in every case much to its advantage.

Instead of answering the question in a direct and simple manner, Mr. Lowe was instructed to prepare a report which involved "an examination of the economic soundness of the Government schemes," and the answer to the question of "What effect will the competition of the hydro-electric schemes of the Government have upon the gas industry?" is sought by propounding another question, "Are these schemes financially and economically sound?"

The motive is obvious—viz., to discredit Government enterprise; and I notice that under similar circumstances the tactics are always the same. Recently the financial papers of the world affected to be scandalized at the business methods of the Hydro-electric Commission of the State of Ontario. The agitation originated in the New York financial papers. But why should financial houses in New York take such an interest in the conduct of a State department in Canada? The reason is simple. It has found that power could be obtained in the Province of Ontario much cheaper than in the State of New York, and, moreover, the provincial scheme was so comprehensive as to render a supply of electricity generally available in country districts as well as the towns. The result of this was that the citizens of New York State and other States began to agitate for a similar system conducted by the State on similar lines; hence the alarm of the New York financiers. And instead of reforming their own methods in order to enable the citizen of the United States to obtain electricity at the same price as the citizen of Ontario, they adopted the method of trying to discredit the Hydro-electric Commissioners of Ontario.

Paragraph 3.

Mr. Upton has arrived at the conclusion that the Government would be unwise to embark upon any more hydro-electric schemes, and that the money would be better spent on railways and roads. He bases his conclusion upon "reliable" calculations by Mr. Lowe, based upon an analysis of the Lake Coleridge figures as disclosed in the Public Works Statement for 1917.

It will be seen in my reply to Mr. Lowe's report that his premises are unsound, and even if sound the deductions therefrom are quite illogical.

As regards expenditure upon railways and roads: The existing railways cannot be worked to their full advantage unless certain critical sections are electrified; whilst the question of roads is largely a question of the nature of the settlement. It is very little use opening up backblock sections whilst at the same time the population is drifting into the towns. It is claimed that a supply of electricity to the settler will provide him with such amenities as will induce him to stay on the land, and will ease the burden of the housewife and contribute to an increased production. It is claimed that production in a certain district in Canterbury has increased considerably since the farmer has been supplied with electricity, in spite of the fact that the sons are at the war It can be confidently predicted that electricity on the farm will conduce to closer settlement, and closer settlement demands and justifies good roads.

Another aspect of the question is that not only does a general supply of electricity stimulate production and attract new industries, but it also economizes coal to such an extent that the whole expenditure is recoverable in a few years.

Paragraph 4.

In this paragraph Mr. Upton points out that the Lake Coleridge scheme was selected for development because it promised the best results for the smallest outlay; and that, as any other scheme will necessarily cost more, especially if Mr. Lowe's calculations are correct, in consequence the prospects as far as gas investments are concerned are very reassuring.

The cost of developing Lake Coleridge as a power source is low in first cost considering the amount of power developed, but at the same time the cost is nearly twice as much per horse-power developed as some of the North Island schemes when fully developed. So that the prospect is not at all reassuring as far as gas investments are concerned, if the view that cheap electricity is detrimental to the gas industry is the correct one. My view is that gas and electricity react one on the other, and that the prospects as regards the gas industry are just as reassuring in spite of and probably as the result of cheap electricity.

Paragraph 5.

In this paragraph it is pointed out that "the first outstanding fact disclosed by Mr. Lowe's report is the proof that electricity for lighting and power cannot be supplied to consumers in Auckland at lower rates than are already current in the city if the bulk supply business as undertaken by the Government is placed on a self-supporting basis." He also points out that the Auckland City Council generates steam from slack coal, which is a waste product at the mine.

In answer to this: Mr. Lowe is very far indeed from proving the above contention, but in any case the supply of electricity in Auckland is comparatively restricted. There are townships and boroughs outside the present limits which have no supply of electricity, and the Auckland Province as a whole does not seem to merit any consideration at all either in Mr. Lowe's report or Mr. Upton's introduction. Whilst it may be granted that the City of Auckland can very well provide for its needs

in a satisfactory manner, it does not help to solve the problem of national efficiency. The first object is and should be to place an unrestricted supply of power at the command of the individual wherever situated, but more particularly in country districts where a supply of electricity is otherwise unobtainable, and on the principle that the more isolated a person is the more is he in need of mechanical aid. The expenditure of £1,200,000, quoted by Mr. Upton, is an estimate which covers headworks and power plant, with transmission to Auckland and other centres in the province, together with a moderate amount of distribution-lines in the province generally. The chief gain from this expenditure is not, as Mr. Upton states, the saving of expenditure upon coal-slack in the City Electricity Works, but the national one resulting from placing power at the command of the individual, thereby increasing the national efficiency and stimulating production. Compared with this, the question as to whether Auckland City Council finds it advantageous or not to take a bulk supply from the Government is a negligible issue.

As to the burning of the slack, there are more ways than one of dealing with slack, particularly if a supply of electric power is available.

It is also certain that as a direct result of increased national efficiency the demand for coal will increase for purposes other than the production of power. And as regards the revenue lost to the Railway Department, I question whether the railing of slack coal is profitable to the Department or worth the wear-and-tear on the trucks and road-bed. I think the tracks and railway service generally could be put to a better use in railing an increased quantity of agricultural produce and industrial products which would result from a generally diffused supply of electricity throughout the province.

Paragraph 6.

In this paragraph it is claimed that the profitable development of hydro-electric schemes in competition with services employing steam generation depends entirely upon the distance of the source of water-power and the cost of utilizing it, as compared with the cost of coal at the chief centre to be supplied.

So far from this being true as regards hydro-electric power, it is not even true as regards electric power derived from fuel plants. Were this true a colliery could not afford to take a supply from an electric bulk-supply undertaking with long transmission-lines, yet that is a common experience. Large numbers of very large collieries in South Wales take a supply in bulk from a power-supply authority. The same is the case in Lancashire and Yorkshire, which I know from personal experience; and it is stated in the Report of the Coal Conservation Sub-committee of the Reconstruction Committee of Great Britain that coal-mines having together an output of 20,000,000 tons per annum obtain a supply of electricity from the North-east Coast Power System. In every case the power is generated by means of a fuel plant; and were it true that profitable development depends on the single factor of distance, then it is a foregone conclusion that a colliery could not afford to take a supply of electricity from a far-distant coal-burning power-station.

In the same paragraph Mr. Upton expresses himself as satisfied that the competition which gas enterprises in Auckland may anticipate in the future can be no greater than that which Auckland Gas Company is now sustaining with a steadily growing business.

I quite agree with this view; but it does not require an investigation into "the economic soundness of the Government schemes" to prove this. The proof lies in the nature of the two agencies, gas and electricity, together with a recognition of the special functions of each. And, as I have said elsewhere, so far from the two services being run by separate authorities, they should be conducted and run by the same authority in towns where both gas and electricity are available.

Paragraph 7.

In this paragraph we learn that 60 per cent. of the gas sold in Auckland is for cooking; it is also stated that the cost of heating by electricity is about nine and a half times that of gas.

Gas is pre-eminently a heating-agent, and its advantages in this respect must be conceded; and although this advantage may not be so great as it is claimed above, due to a difference in efficiency, it is still so great as to be able to claim the field of heating as its own.

Paragraph 8.

Attention is called in this paragraph to some facts quoted by Mr. Lowe in his report regarding the successful competition of gas against electricity in Toronto (Canada) and Bergen (Norway), where it is claimed the electric services which supply these cities are amongst the most up to date in the world.

This confirms the view already expressed by me that gas succeeds on its merits as a heating-agent, and that in order to reassure the shareholders of the Gas Company regarding the effect of the Government schemes upon the gas industry in the few towns in which it is available it is not at all necessary to try and discredit electric-power supply as a State enterprise. It is worth nothing that in the case of Toronto, quoted above, the gas interest is in so-called competition with a State enterprise—viz., the Hydro-electric Commissioners of the Province of Ontario.

Paragraph 9.

Here Mr. Upton quotes Mr. Lowe to prove that the capital outlay upon the Lake Coleridge undertaking greatly exceeded the estimate—viz., £45·8 per horse-power, against £23·2 per horse-power. This is held to be significant of what New Zealand may expect in the future if similar schemes are authorized.

The above comparison is entirely fallacious, as the estimate covers only the outlay necessary to deliver a certain amount of power in Christchurch, and as such it is a fair estimate. The actual outlay

covers a wide system of distribution, and New Zealand is to be congratulated if a general distribution throughout New Zealand can be effected at the same cost per horse-power.

It is claimed in the same paragraph that a general supply of electricity made available to all, wherever situated, exposes private enterprise to unfair competition. But, if we except a few gas undertakings in the principal towns, what private enterprise needs and is loudly clamouring for is a general and abundant supply of cheap electricity; and even in the case of the gas companies Mr. Lowe has adduced evidence to prove that the gas interests survive and flourish even in Toronto, where the supply of electricity is obtained from the State in bulk.

In Reply to a Report by James Lowe, A.M.I.C.E., Engineer and Manager, Auckland Gas Company (Limited).

Paragraph 1.

This paragraph contains a summary of the Lake Coleridge accounts for the year ending 31st March, 1917, taken from the Public Works Statement; and, as the result for a second year of working, would be regarded as most satisfactory by any power-supply authority in the world.

Paragraphs 2 and 3.

In these paragraphs comparison is made between the actual expenditure incurred on the Lake Coleridge works up to the end of the financial year in March, 1917, which is at the rate of £45·8 per horse-power of plant installed, with an estimate of £23·2 per horse-power made by the Hon. R. McKenzie during the second reading of the Water-power Bill in October, 1910.

The Hon. R. McKenzie's estimate, as is evident on the face of it, provides only for headworks, power-house, transmission to Christchurch, and a substation in Christchurch, but does not provide for a general distribution system to enable a supply to be given to the surrounding districts.

The expenditure for the year ending 31st March, 1917, covers not only a plant of 6,000 kilowatts, but headworks and buildings for double this capacity, as mentioned in the annual report; it includes interest during construction; it includes also the cost of a distribution system in an area of about 300 square miles, which supplies, in addition to the Christchurch City Council, the following local authorities, directly or indirectly: the boroughs of Riccarton, Spreydon, Woolston, New Brighton, Sumner, Lyttelton, and Kaiapoi; the counties of Halswell, Waimairi, Springs, Paparua, Heathcote, and Eyre; the Christchurch Tramway Board, Cashmere Hills Sanatorium, Sunnyside Asylum, Prison at Templeton, the Christchurch Meat Company at Islington, the Canterbury Meat Company at Belfast, Borthwick's Freezing-works at Belfast, the North Canterbury Farmers' Freezing-works at Kaiapoi, and a number of flour-mills and dairy companies. The total also includes expenditure upon local reticulations in districts where the local authorities are unable to undertake the work themselves.

Briefly, Mr. Lowe compares the expenditure on a partial development of headworks, an extended system of distribution, and a measure of local reticulation with an estimate for a full development of headworks, no distribution, and no reticulation.

In spite of this, the figure of £45·8 per horse-power of plant installed is well within our estimates for a general supply system, having regard to the limited scale upon which we are working. The figure, however, will inevitably be exceeded—with very great advantage to the community—when the system is more generally extended so as to serve every householder and settler in the area of supply, which is the ultimate object of the scheme. It is evident from the discussion in the House that at the time the Hon. R. McKenzie submitted the estimate referred to the immediate object seems to have been to supply the principal towns in the same way as Dunedin is now supplied, and the expenditure by the Dunedin Corporation on headworks, power plant, transmission-lines, and substation appeared to have been adopted as a basis of estimate. It is clear that a universal system of distribution throughout the country districts was not then in contemplation. The estimate submitted by the Hon. R. McKenzie is a very fair one, having regard to the extent of the work covered by the estimate.

Paragraphs 3, 4, 5, and 6.

In these paragraphs, after quoting the deficit on the Lake Coleridge working of £11,956 for the year ending 31st March, 1917, it is remarked that the annual report does not indicate how the deficit is met, and indicates for our benefit how the accounts should be kept, and how to charge for the power supplied.

A reply to these questions is to be found by reference to Table 5, printed in the Public Works Statement for 1917, which appears to have escaped Mr. Lowe's notice.

In answer to paragraphs 3 and 4: The annual deficit is carried forward to the debit of profit and loss in the hydro-electric accounts (see pages 13 and 14 of the Public Works Statement, 1917).

In answer to paragraph 5: The accounts are treated on a strictly business basis, on sound business principles, and on lines approved by Parliament.

In answer to parargaph 6: The intention is that the deficits inevitable in the early years of the undertaking shall be paid out of future surpluses, after providing for depreciation, sinking fund, and a limited reserve; and an Act was passed last session authorizing the procedure.

As regards the suggestion that after the undertaking is properly started such a price should be charged for current as will make the undertaking self-supporting, this is putting the cart before the horse. The procedure adopted by the Department is the more businesslike one of determining what prices will enable power-users to compete with the lowest prices obtainable elsewhere or in any other part of the world, and to design the works on such a scale and at such a cost as will enable the prices so determined to be charged and to make the business ultimately self-supporting. Briefly put, the

expenditure is not incurred unless the Department is satisfied that the business is ultimately self-supporting, apart from the indirect benefits accruing to the State resulting from placing a cheap and flexible form of power at the command of the individual, and also quite irrespective of the large national economy resulting from saving in coal-consumption.

Paragraph 7.

In this paragraph it is claimed that the State hydro-electric-power undertakings should also pay all the usual charges that have to be met by private enterprises, including rates and taxes.

This is a question of Government policy. Another point of view which presents itself is that the power-supply business should be conducted at the lowest possible cost, so as to enable economies to be effected and production generally increased, to the benefit of the State indirectly, for if the whole benefit does not go to the consumer the State gains a new source of revenue as the business develops and a surplus is obtained. As a question of policy, however, the real point at issue is not whether State enterprises should or should not contribute to taxation, but whether any sort of enterprise, private or public, should be taxed on its improvements.

Paragraphs 8, 9, 10, and 11.

These paragraphs deal with the average revenue per unit obtained for the Lake Coleridge supply—viz., 0·427d. and point out that had the average price charged been 0·5d. per unit instead of 0·427d. per unit a sufficient sum would have been earned to pay all capital charges as well as working-expenses.

I find no fault with the arithmetic. A power-supply business is not, however, amenable to the kind of reasoning displayed in this paragraph. I have never known a power-supply undertaking to reach a self-supporting stage in the second year of operation, or even the fifth; whereas the Lake Coleridge undertaking has earned enough in its third year to pay working-expenses and interest, with a surplus to the credit of depreciation—a stage which we did not expect to reach until the fourth or fifth year—and this in spite of the fact that the undertaking has been hampered, and indeed brought to a standstill, because of the impossibility of obtaining the necessary plant to cope with the demand. Restrictions upon the growth of business have been in operation for nearly two years, and power for new industries, partly from outside the Dominion and partly from other districts within the Dominion, aggregating 3,500 h.p., has been refused. Moreover, the works are only half-completed, and they were never designed with a view to paying their way at such a stage. All we expect the business to do is to pay its way when fully developed, and to yield a small surplus with which to pay off the deficits on the first few years' working, and to write off items of expenditure not represented by tangible assets, such as preliminary expenses and compensations.

Paragraph 12.

In this paragraph the argument is advanced that the State in carrying out this undertaking is engaged in an unfair competition with other interests which are subject to income-tax and other taxes, whilst the State is exempt from such taxation.

The object of the State, I take it, is to place a supply of power at the command of the individual, especially in the country, and in the interest of economy and increased production. It is not in competition with any other interest in doing it, because there is no other power offered in the field capable of meeting the requirements. It may be alleged that it enters into competition with the gas interests in certain towns; but proof is adduced in the pamphlet that electricity cannot compete in price with gas for heating and cooking, and that the usual increase in the gas business in a certain district continues in spite of a supply of cheap electricity. This, I believe, is a fact, and is quite general; and I am convinced that the demand for gas will continue to increase, and that both have a special field of use, and that a town community needs both.

In any case, the argument of competition only applies to a few favoured towns, and leaves out the farmers and the smaller towns.

Even as regards the towns, it is a remarkable fact that the demand for a supply of electricity has been just as insistent from those boroughs which own a municipal gasworks, such as Lyttelton, Sumner, Rangiora, as from other districts. It is noteworthy also that the Dunedin Corporation, whilst owning a gas business, found it incumbent, in the interest of the municipality, to embark upon a hydro-electric enterprise.

The following resolution recently passed by the Borough Council of Blenheim is also pertinent to this issue: that "A supply of electricity to this borough, already supplied with gas municipally owned, is necessary and desirable." (*Marlborough Express*, 14th September, 1918.)

Paragraphs 13, 14, and 15.

The object of these paragraphs is to show that a supply to Auckland from Arapuni suffers in comparison with Lake Coleridge in two ways, viz.:—

(1.) That the hydraulic works will be unduly expensive for partial development; and

(2.) That the chief centre of the population to be supplied (Auckland) is twice as far from Arapuni as Lake Coleridge is from Christchurch.

With reference to the first comparison, it is probably true that for a development of 12,000 h.p. Lake Coleridge would be less costly than Arapuni, but on the other hand the advantage would be in favour of the latter for a development of, say, 30,000 h.p. The argument advanced by Mr. Lowe fails if it be conceded that the requirements of the Auckland Province are so much in excess of Canterbury as to require an initial outlay on 30,000 h.p. instead of 12,000 h.p. We now know that,

to suit the requirements of Canterbury, when regarded from a national standpoint, the initial development should have been at least 20,000 h.p. instead of 12,000 h.p.; so that on a population and industrial basis an initial development of 30,000 h.p. for the Auckland district is not too optimistic Further than this, it seems probable that Arapuni or some other source on the Waikato is destined to become a main source of supply for the North Island, in which case the argument that the cost of developing Arapuni for anything less than 30,000 h.p. is unduly expensive has no weight at all.

In answer to the second alleged disadvantage—viz., that the chief centre of the population to be supplied (Auckland) is about twice as far away from Arapuni as Lake Coleridge is from Christchurch—this is so; but on the other hand the power to be transmitted is greater, whilst there is a good general market on the way, and some concentrated industrial loads to be supplied, whilst there is at least one locality destined to become a large industrial centre. As a result, power can be supplied in Auckland at the same prices as in Christchurch, despite the alleged disadvantages; and I doubt if this will come as bad news to the people of Auckland.

Again, although Arapuni is some distance from Auckland, which is about the centre of the population of the Auckland Province, it is not far from the centre of the population of the North Island considered as a whole; and, as the power to be obtained from this source is large and capable of supplying a larger area than the Auckland Province, it is well placed when regarded from a national standpoint.

Paragraphs 16, 17, and 18.

The argument advanced here is an extraordinary one viz., if the Coleridge system was estimated to cost £23 per horse-power, and has now actually cost £45 per horse-power, or about double, therefore the Arapuni scheme, if estimated to cost £40 per horse-power, will cost £80 per horse-power.

The estimate of £23 per horse-power covers a full development of headworks, whilst the supply is confined to Christchurch, in a manner similar to the supply to Dunedin from Waipori; whereas the expenditure of £45 per horse-power includes expenditure on headworks which are as yet only partly utilized, also expenditure on a system of distribution to the suburban and country population, also expenditure on account of retail business in certain areas. The Arapuni scheme also provides for a system of distribution in the Auckland Province, and the estimate is based upon the actual expenditure on a similar system supplied from the Lake Coleridge works.

Paragraphs 19, 20, and 21.

The purpose of this is to prove that power cannot be delivered remuneratively to Auckland at less than 0·8d. per unit.

The argument employed is as follows: The charge for a supply from Lake Coleridge in 1917, instead of being 0·427d. per unit, should have been 0·5d. per unit in order to make the undertaking pay its way, and as the capital cost of supplying Auckland must be, according to the arguments advanced in the preceding paragraph, £80 per horse-power against £45 per horse-power expended on the Coleridge undertaking, it follows that the average price of the supply from Arapuni must be at least 0·8d. per unit in order to make the undertaking remunerative.

The conclusion is founded upon the assumption that the Arapuni scheme will cost £80 per horse-power; but even then the conclusion is not sound. The capital charges on the basis of 7 per cent. per annum on £80 will amount to £5·12 per horse-power per annum. The working-expenses would certainly not exceed £30,000 per annum for a sale of 30,000 h.p., which is at the rate of £1 per horse-power per annum, making a total of £6·12 per horse-power per annum to cover all charges. This, on the basis of a 50-per-cent. load factor, usual in hydro-electric plants, is equivalent to 0·36d. per horse power hour, or 0·483d. per kilowatt-hour in the average, compared with which the figure 0·8d. per unit seems to be a wild guess.

Paragraph 22.

This reads as follows: "For a partial development the price would require to be very much greater [than 0·8d. per unit], or else there would be a very large annual deficit."

Even on the assumption of a capital cost of £80 per horse-power, I have shown that the price per unit does not need to be 0·8d. per unit to make the scheme self-supporting. The statement that for partial development whilst the business is being built up there would be annual deficits is a self-evident one, and inevitable in some classes of business, amongst them being power-supply undertakings, whether the power is derived from fuel or from head of water. Nevertheless, this disadvantage does not militate against the rapid growth and expansion of power-supply undertakings. Evidently deficits of the early years of the undertaking are of little account in comparison with the economic gain to the community.

Paragraphs 23 and 24.

It is pointed out in these paragraphs that coal is cheaper in Auckland than in Christchurch, and that in consequence the cost of generating power by steam is less in the Auckland district than in the Christchurch district, and that this circumstance will militate against the success of the Arapuni scheme.

The argument that because coal is cheap there is no room for a general power-supply undertaking, or that it militates against its success, is disproved by the facts. It is within my own knowledge and experience, for instance, that coal-mines are the most remunerative consumers on a power-supply system, and also the most willing and ready users. Yet one would be well justified in arguing beforehand that an electric-supply undertaking generating electricity by means of a steam plant would have no prospects at all in a mining district. The contrary is, however, the fact, and in this connection a reference to the Coal Conservation Sub-committee of the Reconstruction Committee of Great Britain is interesting. It is stated on page 27 thereof that collieries having an output of 20,000,000

tons of coal per annum in the north-east coast of England are dependent upon a supply from the north-east coast power system, and that a saving of 1,000,000 tons of coal per annum has been effected in consequence. Large collieries in the Midlands, in Lancashire, Yorkshire, and South Wales obtain a supply of electric power for power-supply authorities in whose area of supply they are situated.

Paragraphs 25, 26, 27, and 28.

The purpose of these paragraphs is to show that the Government could not supply Auckland City Council to its advantage except at a price which would not be remunerative, and therefore at the cost of the taxpayer in general. In proof of this a table of the works-cost of the Auckland City Council electric generating-station for the year ending 31st March, 1917, is submitted, showing a total works-cost of 0·5752d. per unit, or 0·55927d. per unit according to another table. This is indubitably a fine performance. The plant is modern and of a most economical type for its size. Coal is cheap, and it is burnt and handled in the most economical way possible. In fact, it is one of the best municipal plants I know of. But when interest and depreciation are added I do not suppose that the total would be less than 0·9d. per unit. This is, then, the cost of generating electricity in Auckland under the best possible conditions and with an expert staff. This does not compare favourably with the average selling-price per unit from Lake Coleridge, nor even with what Mr. Lowe says it ought to be.

It is next stated that after taking account of the saving in coal, oil, waste, stores, repairs, and maintenance it would not pay the Auckland City Council to take a supply at the average revenue per unit from the Lake Coleridge undertaking, and the statement is reiterated that the cost of supplying energy to Auckland from the Waikato is greater than the cost per unit of supplying Canterbury from Lake Coleridge. I have disproved this in answer to a previous paragraph.

But, admitting Mr. Lowe's contention as to the increased capital and annual cost, I see no difficulty in the way of supplying Auckland to advantage and without loss to the Department. It is evident that Mr. Lowe has overlooked the effect of diversity and load factor as well as bulk upon the unit-prices, and he also seems oblivious to the fact that the Auckland City Council will be only one bulk consumer amongst many from the very outset, and possibly not the largest by any means when the scheme is fully developed. In discussing prices all the factors mentioned must be taken into account, without which any statement of price has little or no meaning. As an instance we may refer to the pamphlet under the heading of "Some Interesting Comparisons," where a statement is printed of the total costs of generating and distributing electricity by the Auckland City Council, including interest and depreciation—viz., 1·826d. per unit sold; and yet I have no doubt that the Auckland City Council have many customers paying at a lesser rate per unit than this, whilst at the same time they may be regarded, and rightly so, as being quite as or more remunerative than other customers paying more than the average cost per unit. This should show that Mr. Lowe does not prove his case by quoting either unit-costs or average prices.

Paragraphs 29, 30, 31, and 32.

The intention here is to show that the saving in coal resulting from a supply of hydro-electric power would only apply to slack coal, which is produced in the hewing of household coal, and which must be brought to the surface in any case, and that if it is not used it will be wasted and the Railway Department will lose revenue.

I do not know how far it is true that all the slack so produced is used for steam-raising in Auckland, but it is quite certain that a measure of economy which results in economizing coal creates a demand for coal for use in other ways than steam-raising for power purposes; and I am of opinion that the coal-mines will profit as much as any one else by the increase of general prosperity and of production. From my previous experience I feel confident that the coal-mines will be amongst the first to take advantage of a bulk supply of electricity and to use it in more ways than one. As regards the railways, a supply of electricity in bulk is essential if they are to keep pace with the development of the country. In any case I suppose they do not regard the transport of slack coal as a very profitable business, and that they would be glad to replace it with more remunerative business, such as the transport of produce and manufactures.

Paragraphs 33, 34, 35, and 36.

The arrangements made with the Christchurch Tramway Board and with the Christchurch City Council for maintaining steam for purposes of a standby are quoted in these paragraphs as proof positive that in order to make reasonably sure of a continuity of supply a complete steam-generating plant would be necessary in the City of Auckland for standby purposes, or else a duplicate line each capable of carrying the whole load.

I do not know why it is necessary to make deductions of this kind when the facts regarding the necessity, expediency, and use of standby plant are ascertainable by reference to the Waihi plant, or the Lake Coleridge plant, or the Dunedin City Corporation plant. Referring to Lake Coleridge, there are in use two transmission-lines each capable of supplying the whole of the present load, which load is two and a half times the maximum supplied to the Christchurch City Council. The Tramway Board maintain at their own expense the plant necessary to run the whole of their service in the event of failure of supply. The Christchurch City Council maintain at their own cost a plant of about one-third of their maximum load. The Dunedin City Corporation have duplicate lines, and maintain a standby plant consisting of oil-engines for their tramways only, but have no standby for their power and lighting load. The Waihi Gold-mining Company rely on a single transmission-line, and maintain a standby for pumping consisting of gas-engines and a steam-engine. These are examples of what

is found expedient in practice; and in face of these examples in New Zealand let alone examples outside New Zealand, which may be quoted by the hundred there is no need to make any assumptions as to what is necessary for Auckland, with a view to drawing conclusions that standby provisions are too costly.

As regards results, I would refer to the statement made in public by the chairman of the Waihi Gold-mining Company at the meeting of the shareholders held in London on the 8th May, 1916, and reported in the *Mining Journal*, that the saving in working-expenses as a result of the adoption of hydro-electric power, directly and indirectly, is between £20,000 and £25,000 per annum, after allowing for interest and depreciation on the cost of the new plant.

The chairman of the Christchurch Tramway Board has publicly stated in regard to the Board's operations for the year ending March, 1918, that instead of showing a surplus of £5,800, after providing for interest, sinking fund, and depreciation, which they are able to do as a result of taking a supply from Lake Coleridge, they would have shown a deficit due to increase in cost of coal and other working-expenses.

It is quite evident that none of the authorities quoted regard the maintenance of a standby plant as burdensome, even when it amounts to the whole of the power requirements, as in the case of the Christchurch Tramway Board.

As a rule the standby provision is not more than a third of the maximum, and only just sufficient to maintain the more essential services; and in the case of the Christchurch City Council is employed to reduce the peak-load demand from the Government.

Another point in connection with the employment of a standby plant is this: that as time goes on and the system of supply is enlarged so as to link up with more than one source of supply, and when the number of transmission-lines is increased with the increased demand, the necessity of standby plant becomes less and less, and that they may be regarded largely in the nature of temporary expedients.

As regards Auckland, there would be inevitably two lines at the outset, supplemented later by a third and then a fourth line.

Paragraphs 37, 38, 39, 40, 41, 42, and 43.

Some opinions of my own are here quoted regarding desirable limits to the expenditure upon headworks and generating plant, and also quoting an estimate of my own of £40 per horse-power as the cost of large power-supply systems when fully developed. The question of the expenditure per horse-power is a most involved one, and it is quite possible for a scheme costing £80 or £100 per horse-power to be more successful financially than one costing only one-half this rate. The capital expenditure per horse-power depends largely upon the extent to which the power is made available. If the supply is confined to the towns and industrial districts the expenditure is so-much; if extended to supply every farmer and settler, however remote, the expenditure per horse-power is greater, but in so doing the range and diversity of uses is increased and a proportionately greater return is obtainable, whilst at the same time the gain to industry and to the State generally is much enhanced by the greater area covered, and by the fact that the power of production is greatly increased, not only by reason of electric power being placed at the disposal of the individual, but by the possibility of closer settlement and by attracting the population from the towns to the country.

Mr. Lowe seems to be under the impression that the £45 per horse-power spent on the Lake Coleridge system is not only in excess of the estimate—which is not the case—but considers it to be an abnormal figure altogether, whereas any one acquainted with power-distribution would regard it as abnormally low. I have no doubt that the expenditure on the Lake Coleridge undertaking per horse-power of plant will exceed the figure of £45 by a considerable amount, much to the benefit of the community generally. I also anticipate that ultimately, as the lines become more and more utilized, the capital expenditure in terms of the horse-power of plant will be restored to about the present figure.

In paragraph 42 the argument is again repeated that the Lake Coleridge undertaking cost twice the estimate—which is not true—and that therefore the supply to the Auckland district will cost twice the estimate. This does not follow even if the first assumption is true; and even if it did it would not be regarded as an abnormal figure from the point of view of a comprehensive power system designed to supply all the needs of the community, nor would it be unprofitable as an investment.

"*Some Interesting Comparisons.*"

The matter under the heading "Some Interesting Comparisons" may be dealt with conveniently *en bloc*, as the purport of it is to answer the question, "What effect will the Arapuni hydro-electric scheme, if carried out, have upon the business of the Auckland Gas Company?"

The inference from the arguments and evidence adduced is that, so far from having to fear competition, the Gas Company is going to benefit by it. Then why worry about it? The answer that one infers Mr. Lowe would give to this question is, "Oh, we are not afraid of fair competition. What we object to is electricity supplied by the State at less than cost price." But the evidence of the chairman of the Toronto Consumers' Gas Company, quoted in this connection, is to the effect that the business of the company has increased by leaps and bounds in spite of the fact that they are in competition with a State supply of electricity—viz., the Ontario Hydro-electric Commission, operating on a colossal scale, and, from Mr. Lowe's point of view, selling electricity at less than cost price, as it does not pay rates and taxes. So that the Auckland Gas Company has nothing to fear in any case. Why then should the Gas Company trouble themselves about the matter? It is difficult to believe that the Gas Company as such should go to the trouble of proving that the State hydro-electric

schemes are not financially and economically sound, or that the moneys expended thereon would be better spent on roads and railways, or that the power-user in and around Auckland would not benefit by a national system of electricity-supply, or that electricity cannot possibly compete with gas for working, unless it was felt that the advent of a national system was in some way inimical to its interest. It is quite evident from the chairman's introduction to Mr. Lowe's report that, in spite of the repeated assertion that the company has nothing to fear, it is somewhat anxious about its position—which, of course, is quite natural.

My own view, based on long experience, is that, whilst the functions of the two services overlap in some respects, each has its peculiar field in regard to which there is no competition. The special field of electricity is lighting, power, and electro-chemical industry; the special field of gas is domestic heating and cooking generally, factory heating, forges and furnace work. The two systems overlap, as a large number of people prefer gas-lighting, and benefit the gas interest by demanding an illumination equal to that given by the more adaptable electric-light system. On the other hand, a number of people will not have gas heaters at any price, and will cheerfully pay the extra price for electric heating. In addition, there are some situations, such as pay-boxes at theatre-entrances, and occasional use in sickrooms and bedrooms, where electric heating is better adapted for the purpose than gas heating. As regards cooking, the disparity in cost is not so great as it is represented by Mr. Lowe, for the reason that a substantial proportion of the heat supplied by the gas passes into the flue, whilst in the case of the electric oven a lesser proportion of heat is dissipated.

The point, however, is that each agent has its peculiar and special function, and the real explanation of the anxiety displayed by a gas company at the advent of electricity lies in the fact that before the advent it has all the field to itself, but after the advent of electricity it is faced with the necessity of readjusting its functions and of confining itself to its proper field. This necessitates a reorganization and an extension and possibly reconstruction of its work to provide for an increase in demand for gas, which always follows the advent of electricity to a town.

The real solution of the difficulty with the gas companies is for the municipalities to acquire them by State aid, and to work the gas department in conjunction with the electricity department as a joint service for the benefit of the public. I see no incongruity at al in this. This Department has frequently referred customers to the Christchurch Gas Company for their heating, and a municipality should be in a position to supply both services, not as rival services but as co-ordinate services, each with its special field of use; and it is my intention to advocate this policy as part of a national system of power and heating services.

E. PARRY,
Chief Electrical Engineer.

The Hon. Sir Wm. Fraser, Minister of Public Works.
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