# AN ANALYSIS OF THE DEMAND ON THE ELECTRIC POWER SUPPLY OF TAURANGA, ESPECIALLY FOR COOKING.

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*(Note: It appears that the paper was revised in 1924 after the presentation - David de la Hyde)*



The method of cooking by electrically produced heat has several advantages over other available methods.

For household use the advantage that appeals most to the cook is the effectiveness of the electric oven, any good make of which can be relied on to turn out its work perfectly done, and with uniform regularity.

The improved conditions in the kitchen, owing to the absence of fumes and dirt, and to the ease with which the electric cooker can be kept clean and tidy, are other features, while another one is the fact that the adoption of the electric service simplifies the design of a comfortable and roomy house.

These facts are of course well known to electrical men and it is the writer's opinion that, as they become generally realised, there will be an insistent demand for the electric service. The meeting of this demand introduces numerous problems which are at present interesting many engineers in this country where investment in electricity supply is proceeding at a rate which brings home to engineers the importance of seeing that the expenditure is wisely made, and, at the same time, with due provision for probable future developments.

The following notes relating to experience met with by the writer in the development of the Tauranga Borough Council system arc therefore offered to members of the Society in the hope that the resulting discussion of the question may help to elucidate the lines on which sound progress may be expected in the future under conditions as we have them in New Zealand.

*Description of System*—The Tauranga system commenced operation in 1915; the supply being derived from the Omanawa Falls, some 13 miles distant from the town, where two units, each of 150 h.p. maximum output, were installed.

Initially the transmission line between the Falls and the town was the only high voltage (11,000) line of the system. This line traverses rough and undeveloped country, except for five miles adjacent to the town, and it was not then tapped until the Borough is reached—here the pressure was dropped to 400 volts and fed into the 4 wire network at two points 11 miles apart.

The year following the line was tapped at a third point and supply given therefrom to a group of dairy farms. Since then various extensions have been effected by the Borough Council and territory extending from five miles west to 18 miles east of the town is now supplied.

Bulk consumers outside the Tauranga Borough area include the Te Puke Town Board using 50kW., and a gold mining battery using 350kW.

The extensive use of the current for heating and cooking purposes is at present mainly confined to the Borough area itself, and therefore the following remarks will be confined to operations within that area.

The town itself has an area of 875 acres and the population in 1922 was 2,401.

For motive power the chief users of current are a Dairy Factory in which the installed motor capacity is 61 h.p. and a Bacon Factory and Cool Store using 25 h.p. There are also several Joinery shops with installed motor capacities up to 25 h.p.

The Borough water and sewage services are gravitational throughout and it will therefore be seen that the demand for current for motive power in the town area is small.

It is therefore suggested that the problem of supply to this area is very similar to that to be met with in the residcntial areas surrounding the chief cities, there being but little demand to be catered for except the residential consumption.

*Statistics.*—There are 718 consumers within the Borough and the properties taking current may be classified as follows:—

| | |
|---|---|
| Residential | 562 |
| Shops, Offices and Manufactories... | 141 |
| Public Buildings | 15 |
| | 718 |

Tariff.—It was recognised when initiating the supply that all prospective sources of revenue would require to be exploited in order to meet all costs including capital charges on a comparatively high expenditure (for that time) of £20,000. A tariff was therefore arranged with a view to making the use of current for heating purposes feasible, the following net charges being adopted—current for lighting 8d; power 2d, and 1.5d; heating 1.5d, continuous water heaters 20s per kW. per month.

These charges have remained in vogue ever since except that the lighting and motive power rates were amended in November, 1922, lighting then being reduced to 7d per unit. An alternative heating charge has also been made available to consumers of heating current. This is at consumers' option and is charged at the rate of 1s 6d. per month per kW. of installed heating capacity plus 0.75d. per unit metered.

Town gas is available through most of the area and was sold for heating up to 1917 at 7s 6d. per 1,000 c. ft, but this charge has latterly risen to 10s nett.

*Metering.*—Simplicity in metering arrangements has been adhered to in order to minimise capital charges and maintenance under this heading. No demand indicators or device, other than the watt-hour meter, have been installed.

For a period after the advent of war prices many residential consumers of current for light and heat were provided with one meter only and the usual arrangement of assessing the lighting consumption and charging the balance at heating rates was adopted.

Principally with a view to securing definite data regarding current consumption for heating and cooking this arrangement was soon discarded and separate meters are now installed in all cases.

The water heating circuits have not at any time been metered except for test purposes. The advisability of this arrangement may be questioned owing to the facility with which current may be dishonestly diverted from the unmetered circuit. In a small town, however, where the authority maintains its own staff for wiring work, close supervision of installations is possible and the above consideration is therefore here of little weight. In any case a current limiter would be preferable to the use of a watt-hour meter as the wear and tear on the latter is likely to be high on 100 per cent, load factor circuits.

*Development of Cooking Load.*—Some interest in electric cooking was early displayed by consumers, and the original canvass for consumers, which was carried out in 1915, met with a fair response in this direction.

The owners of two houses, who were commencing erection, changed their plans by cutting out all chimneys and substituting a complete electrical service, including water heaters, worked on the lines which are now general. It may be of interest to state that the present owners of these installations remain hearty advocates of the use of electricity in the kitchen after eight years' service. Here it may also be stated that the development of electric cooking has been entirely on its own merits, and it has not been artificially forced by any means. On the other hand the Borough Council does not hire out appliances, or sell on terms, nor has it a show window, while during two periods applications for connection of cookers have been refused owing to shortage of power.

The contribution to the revenue by heating and cooking in successive years is shown by the following table of annual receipts:—

RECEIPTS FROM SALE OF CURRENT.

| Year ending 31 March | Power £ | Private Lighting £ | Heating £ | Ratio of Heating to Lighting per cent. |
|---|---|---|---|---|
| 1917 | 209 | 946 | 241 | 25.5 |
| 1918 | 337 | 1,198 | 472 | 39.4 |
| 1919 | 293 | 1,458 | 612 | 42.2 |
| 1920 | 465 | 2,274 | 946 | 41.5 |
| 1921 | 643 | 2,519 | 1,268 | 50.2 |
| 1922 | 1,817 | 3,483 | 1,719 | 49.5 |
| 1923 | 4,223* | 3,676 | 2,114 | 57.5 |

*Includes revenue from bulk supply.

It will be seen that the proportion of revenue derived from heating has shown a fairly steady increase and there is at present every indication that the heating revenue will ultimately exceed that derived from lighting.

This, it appears, is the condition already obtaining in some Canadian towns, and, although high fuel costs may in some measure account for the striking developments over there, the writer believes that similar developments will shortly occur in New Zealand.

Before, however, this can obtain some provision will require to be made to meet the extra demand on the capacity of the reticulation and generating systems. To a certain extent this is indicated by the fact that, to secure the above stated revenue for 1923, there were 224,898 units metered in the Borough for heating, and 420,000 were estimated to have been consumed in water heaters, whereas only 90,937 units were metered for private lighting.

*Effect on Load Curve.*—improved load factor resulting from the combined heating and lighting load of course obviates the necessity of increasing the plant and reticulation capacities by anything like the ratio indicated by these figures. An endeavour is made in the following discussion to arrive at the extent to which the heating load has necessitated increased capacity. A correct analysis here is of first importance in determining the cost of the heating services.

It is of course to be expected that, owing to improved diversity, the influence of the heating load on the load curve will become proportionately less on the part of the system considered where we trace from consumers service to the power station.

This, however, there is hardly time to do. Consideration of the influence of the cooking load on the load curve will be therefore limited to that of the main town sub-station. The enquiry is of course complicated by the fact that the various demands, including general power, street lighting, private lighting, heating, cooking, and water heating overlap each other more or less in such a way as to make it usually impossible to state definitely in what proportion these various items constitute the load at any moment.

*Analysis of Local Load Curve.*—However, some consideration of the local factors involved render it possible to obtain a very fair idea. For instance the street lighting is switched off at 1 a.m. and after this hour only a few hundred watts of public lighting remain in circuit and a similar amount of private lighting. The load during these hours, therefore, comprises only water heating together with no load losses of meters and transformers.

The recorder usually represents this load as an absolutely straight line from 1 a.m. to 5 a.m. and of about 70 kW in value. Assuming constant voltage regulation this load may of course be considered as operating uniformly through the 24 hours.

The relative amounts by which the lighting, cooking, and radiator demands influence the peak load can be obtained by an examination of the variation of the load curves as they vary through the year. The late shopping night in Tauranga is on Saturday and the yearly maximum demand for the town supply usually occurs on a Saturday evening in winter. Hence the Saturday load curves will be chosen for examination.

In fig. 1 representative recorder curves for various seasons of the year are reproduced. The general shape of the curves, it will be seen, arc fairly similar. Throughout the year preparations for breakfast commence near 6.30 a.m., and the load reaches a definite peak about 8 a.m. There is then a slight falling off, but from 9.30 a.m. there is a fairly regular increase up till noon, after which there is a pronounced falling off, but the valley is not reached until 2 p.m. Saturday afternoon loads are usually lighter than those on other week days owing partly to less consumption for motive power, and also to a reduced cooking demand. The chief feature of dissimilarity of the curves produced by the change of season will be seen on reference to the shape of the evening peaks. Whereas in summer time the evening cooking is completed before the lighting load comes on, thus resulting in a satisfactorily flat curve, in winter the two demands of course overlap and produce a pronounced peak between 5 and 6 p.m.

With a view to further study of the evening demand fig. 2 is given. These curves also relate to Saturday evenings only. The peak load for the evening is plotted together with the time at which it occurred. The time of sunset is also plotted, and it will be seen that the peak occurs consistently between half an hour and one hour after sunset. The effect of the increasing overlap of the cooking and heating load with that of lighting is quite pronounced during the month of April, where it will be seen that the evening peak rises in that time from about 180 kW to 260 kW The point at which this overlapping ceases during the months of spring is not so clearly defined. It is believed that this difference is partly due to the fact that the use of radiators commences somewhat abruptly, while in spring they are discarded more gradually. It may also be noted, however, that this want of symmetry in the yearly load curve results from the vagaries of the equation of time as the time of sunset is a much steeper curve in autumn than in spring.

The load existing at 7.30 p.m. is also plotted. This time is chosen because at that hour it may be reasonably assumed that the cooking load will be almost negligible, while the lighting demand will be near its peak, at any rate for the period of the year during which sunset takes place before 6.45 p.m.

With a view to gauging the influence of the radiator demand a curve of temperatures has been plotted which shows the minimum temperature for the 24 hours up to 9 a.m. on Sunday. This can be only a rough guide as to the radiator requirements of the consumers for the date in question as other conditions, such as humidity, play an important part in determining this. However, it will be seen that there is a reasonably close correspondence between temperature and peak load. What is of further interest is that this correspondence can be seen to the same degree in each of the yearly curves for evening and midday peaks, as well as for the 7.30 p.m. demand, thus indicating that the radiator load on any given date is sensibly equal at each of these hours.

The motive power consumption being less in winter than in summer it is fairly obvious that the rise in the demand which occurs after the above mentioned increase due to overlapping of the lighting and cooking loads is due to radiator demand. This upper portion of the winter load curve is therefore designated “radiator demand'' in the figure and it will be seen that it reached about 70 kW on the 23rd June.

Reverting to fig. 1, an attempt has been made to subdivide the curves into the separate constituent demands of water heating, motive power, heating and lighting. It is believed that the subdivision reasonably represents the actual state of things, though it is hardly possible to enumerate the considerations which have guided the sub division.

It will be seen that, at 5.30 p.m. on the 23rd June, which was the time of maximum demand of the Town supply for the year, the load of 330 kW was made up as follows:—

| | | |
|---|---|---|
| Lighting | 130 | kW |
| Radiators | 70 | (see above) |
| Cooking | 60 | |
| Motive Power | 0 | |
| Water Heating and core losses | 70 | |

Copper losses in the distribution system are of course included among these figures.

The actual peak demands of each kind of load for the year, together with the time of maximum, are believed to be approximately as under:-

| | | |
|---|---|---|
| Lighting | 130 kW | Saturday, 7 p.m. in winter |
| Radiator | 70 kW | |
| Water Heating | 58 kW | continuous |
| Cooking and Irons | 110 kW | Tuesday and Saturday noon; Monday, 5.30 p.m. |
| Motive Power | 70 kW | 11 a.m. September to March |

*Load Factors:-* Records being available of the total units sold to consumers under the headings of Light, Heat and Power, the only further information required in order to calculate the load factors of the various demands is the separation of the units sold for heating into the sub divisions (a) Cooking and Ironing,—(b) Radiator consumption.

This subdivision can be readily made since the consumption under subdivision (a) is, disregarding new consumers, a uniform one throughout the year. Although contrary to expectations this fact can be established by examining the consumption for cooking in houses which use the electric service entirely for cooking but not for radiators. Eleven such houses were taken at random and their total monthly meter registrations were as follows:—

| | | | | |
|---|---|---|---|---|
| October | 1922 | 1,880 | April | 1,976 |
| November | ,, | 1,760 | May | 2,370 |
| December | ,, | 2,110 | June | 1,880 |
| January | 1923 | 1,970 | July | 1,914 |
| February | ,, | 2,125 | August | 2,180 |
| March | ,, | 1,516 | September | 1,750 |

The variation from month to month in these figures can be accounted for entirely by variations in the date of meter reading. It is therefore necessary only to deduct from the total annual heating consumption, the cooking consumption as given by the figures for the summer months. This is done in figure 3 from which it appears that the sale of current for cooking and ironing was, for the year ending November, 1923 - 220,300 units, and for radiators 28,000 units.

Incidentally it may be noticed that the use of radiators in the northern climate is spread over the months of April to September inclusive.

If is now possible to set out maximum demands, load factors, etc., relating to the different kinds of load as above considered as under.

| Kind of Load. | Total Connections k.w. | Total Annual Consumption Units | Annual Maximum Demand | Load Factor | Demand Factor |
|---|---|---|---|---|---|
| Private Lighting .. . | 435 | 93,200 | 122 | .104 | .28 |
| Public ,, .. .. | 8 | 20,000 | 8 | .285 | 1.00 |
| Radiators .. .. .. | 191 | 28,000 | 70 | .045 | .37 |
| Cooking & Ironing (including Irons only 285 k.w.) .. | 788 | 223,300 | 110 | .231 | .14 |
| Motive Power .. .. | 225 | 113,500 | 70 | .184 | .31 |
| Water Heating .. .. | 58 | 503,600 | 68 | .991 | 1.00 |
| TOTALS .. | 1,705 | 981.600 | | | |

No precision can be claimed for these figures but the analysis is believed to be sufficiently accurate to be of use. In conjunction with the daily load curves previously given they should be of assistance in estimating the effect of adding a considerable heating and cooking load on to the existing load of any given system.

It will be apparent that in the case of a power board operating in a dairying district and having the usual two sharp peaks at 6.30 a.m. and 4.30 p.m. during the summer months only, that the addition of a cooking load will be most beneficial, and even radiators will be quite beneficial also. As to their significance in the matter of cost it may be seen from the above figures that at existing rates (1.5d per unit) the radiator consumption only returned £2 10s per annum per kW of substation peak load which is unprofitable.

The cooking load however returned £23 for each kW by which it increased the annual maximum demand. Seeing that the total local costs of generation and distribution to retail consumers amount to approximately £11 per kW of substation demand there is no doubt that cooking is a remunerative load.

*Consumers' Installations.*—Some reference to consumers' installations may be of interest.

*Tea Rooms.*—Each of the tea rooms depends on the electric service for cooking, etc. and it is nowhere more popular. The equipment in a tea room where light luncheon is also provided, and having seating accommodation for about 50 persons, includes the following:—

| | | | |
|---|---|---|---|
| 2. | Ovens each | of 2,400 | watts. |
| 1 | Grill | of 2,000 | „ |
| 1 | Water heater | 800 | ,, |
| I | Water boiler | 1,500 | ,, |
| 5 | Boiling rings | 6,500 | „ |
| I | radiator | 2,000 | ,, |

Excluding the continuous water heater the monthly consumption for such an installation in summer amounts to approximately 1,000 units. The water boiler is of a specially developed type which, within its capacity, provides boiling water at the tap continuously, as required for tea making.

*Private Houses.*—There are 68 houses using electric cookers, 52 of them being entirely dependent on it. Of these seven are entirely dependent on electric radiators for' heating, 21 use radiators to a fair extent, but have also other means of heating. In addition there are about 25 kW of cooking appliances and 30 kW of radiators in commission in the hotels, shops and offices.

An installation suitable for five persons comprises:-— One oven (2,000-2,500 Watts), three boiling rings (3,000watts), one water heater continuous heat (300-500 watts), and auxiliary (750 watts).

Electric fireless cookers have not found favour in the Tauranga district as those who have tried them do not seem prepared to permanently alter their methods in the kitchen, which is necessary for this type of cooker.

*Monthly Consumption*.—-This is a very variable quantity depending more on the amount of care exercised in using the equipment economically rather than on the number of persons to be catered for.

Statistics show that the household consumption, excluding lighting and water heating, approximates:—

| | | | | | |
|---|---|---|---|---|---|
| 1,400 | units | with | 2 | persons | resident |
| 2,000 | " | " | 4 | " | " |
| 2,800 | " | " | 7 | " | " |

but in the latter two cases individual households may easily vary 50 per cent.

The above figures will also cover the use of radiators to a limited extent.

An average monthly account for such a consumer who is not using radiators is then as follows:—

Lighting 15 units @ 7d   8s 9d.
Cooking and Ironing  190  units @ 0.75d plus fixed
charge on 6.5 kW of heating equipment @ 1s 6d    22s 6d.
Water heating say, 400 watts ® £12 per kW year  8s.

It is unnecessary to draw attention to the increase in revenue to the supply authority which must follow the general adoption of electric cooking.

*Maintenance of Equipment.*—The time is no doubt coming when electric cooking equipment will be as reliable as gas cookers. Some considerable advances have been made in this direction of late, but in the meantime it is a first essential for the success of the electrical equipment that facilities be provided for its economical and expeditious repair when this is necessary. As all this work in Tauranga is done by the Municipality at the expense of the consumer the cost of maintenance is easily available. Figures have been taken out covering 29 complete private house installations taken at random. The ranges in these cases vary from one to six years' service.

The total cost for 9 months of the current year 1923 is £19 equal to 13s 1d per range which is equivalent to 1s 6d per month.

## CONSTRUCTIONAL FEATURES.

*Voltage.*—For a time it appeared as though our 230 volt distribution pressure might prove an obstacle to the successful development of reliable cooking equipment, and there are still some who hold the view that absolute reliability will not be obtained until some form of transformer is introduced into each unit as in an induction furnace.

The impression that 230 volts is too high a pressure to be applied direct to the element is no doubt partly due to the fact that most of the equipment used in this country has been of American manufacture and therefore designed originally for 110 Volts. This resulted in various troubles in some cases due to the reduced rigidity of the 230 Volt resistor wire which caused it to sag out of position, while other troubles showed that the insulating support of the conductor, although perhaps adequate for 110 Volts, was insufficient for our higher pressure.

However, with changes in design these particular difficulties have about disappeared. There are manifest advantages in retaining the higher pressure for distribution of current, particularly for cooking. The reduced demand on the current carrying capacity of switches and other of the consumers' fittings is very important while the benefit in reticulation costs is most marked.

The higher pressure enables a wider spacing of distribution transformers and this latter results in securing the benefit of the big diversity between individual consumer's demands on these transformers.

*Shock*.—Closely allied to the question of voltage is the consideration of the danger shock.

Although in the writer's experience he has met with no case of serious shock, nor any prejudice against the electric cooking service on this score, still the possibility must be guarded against.

For this reason it is his practice to introduce only one phase into a house as a 400 volt shock would otherwise not be an impossibility from the exposed type of elements at present largely in use. It is to be noted that earthing the frame, in the case of a single phase installation with this type of element, rather accentuates possibility to shock, and it is suggested that the preferable practice in the case of electric cookers is to place them on an insulating mat or linoleum In a position well removed from any earthed conductor and to leave the frame unearthed.

*Water Heating.*—The figures above quoted relating to total consumption apparently show that the quantity of energy sold for water heating is out of all proportion to that for cooking. This is due to the fact that there are over twice as many residences fitted with electric water heating services as with cookers, the total of the former being 161.

Seeing that the water heater was originally introduced as an auxiliary to the cooker, in order to fill the place of the ordinary coal heated high pressure hot water system, the above result appears paradoxical. It is at any rate evident proof that at the rate charged for this service (equivalent to $d per unit) the electric water heating service is popular, and it is in fact now a standard feature in local house design.

The continuous availability of a hot water supply without any other thought for its provision than the payment of a moderate monthly account makes a strong appeal.

As above stated the water is heated (A.C.) on an unmetered circuit which in Tauranga is continuously energised. In districts where it is specially desirable to keep these circuits off at times of pronounced peak load various methods may be adopted- The change over switch between the cooking and water heating circuits may he used. Time switches arc available which in some cases would require to be set to operate twice or three times daily. Another method which has been proposed is the actuating of relays controlling the individual water heaters by means of a superimposed higher frequency alternating current.

Another method which the writer has considered is the provision of a special low tension water heating main, fed from the usual distribution transformers but controlled by automatic switches operating in cascade, the first one being controlled from the main substation manually, or by time switch. The slight additional expenditure which would be incurred in the erection of this main on a new system in a suburban area would be easily justified.

In the development of the water heater various troubles have been met with; one difficulty dealt with has been the vulnerability of the ordinary immersion element to damage by lightning and another met with in some districts is the scaling up of the element.

These have eventually been dealt with by winding an element with a much higher arc over and with a greatly reduced intensity of heat on the heating surface.

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Diagrams and the Discussion follow on the next page.

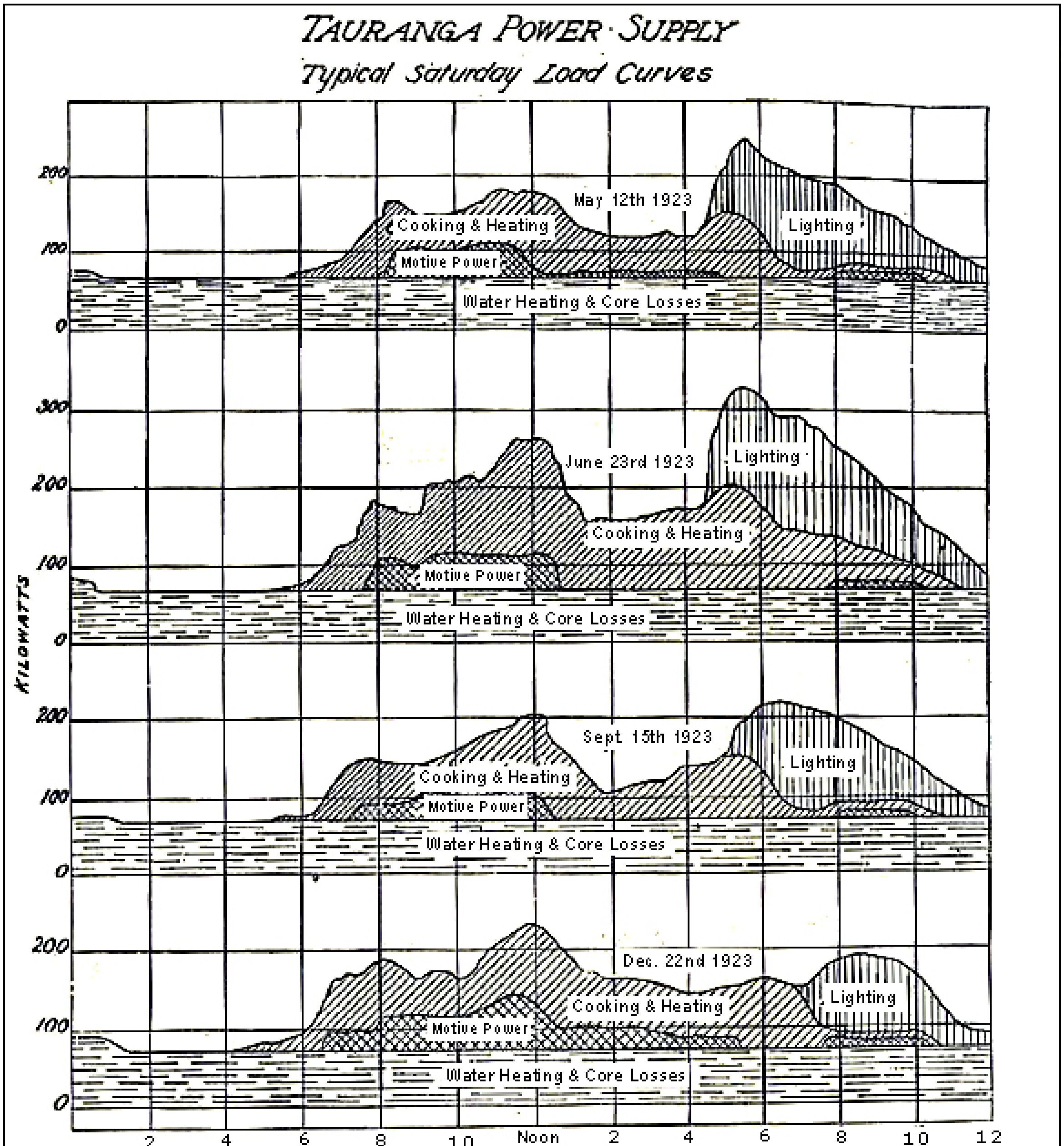
TAURANGA POWER · SUPPLY
Typical Saturday Load Curves
KILOWATTS
May 12th 1923
Cooking & Heating
Lighting
Motive Power
Water Heating & Core Losses
June 23rd 1923
Cooking & Heating
Lighting
Motive Power
Water Heating & Core Losses
Sept 15th 1923
Cooking & Heating
Lighting
Motive Power
Water Heating & Core Losses
Dec. 22nd 1923
Cooking & Heating
Lighting
Motive Power
Water Heating & Core Losses
0
100
200
300
2
4
6
8
10
Noon
12

Fig. I

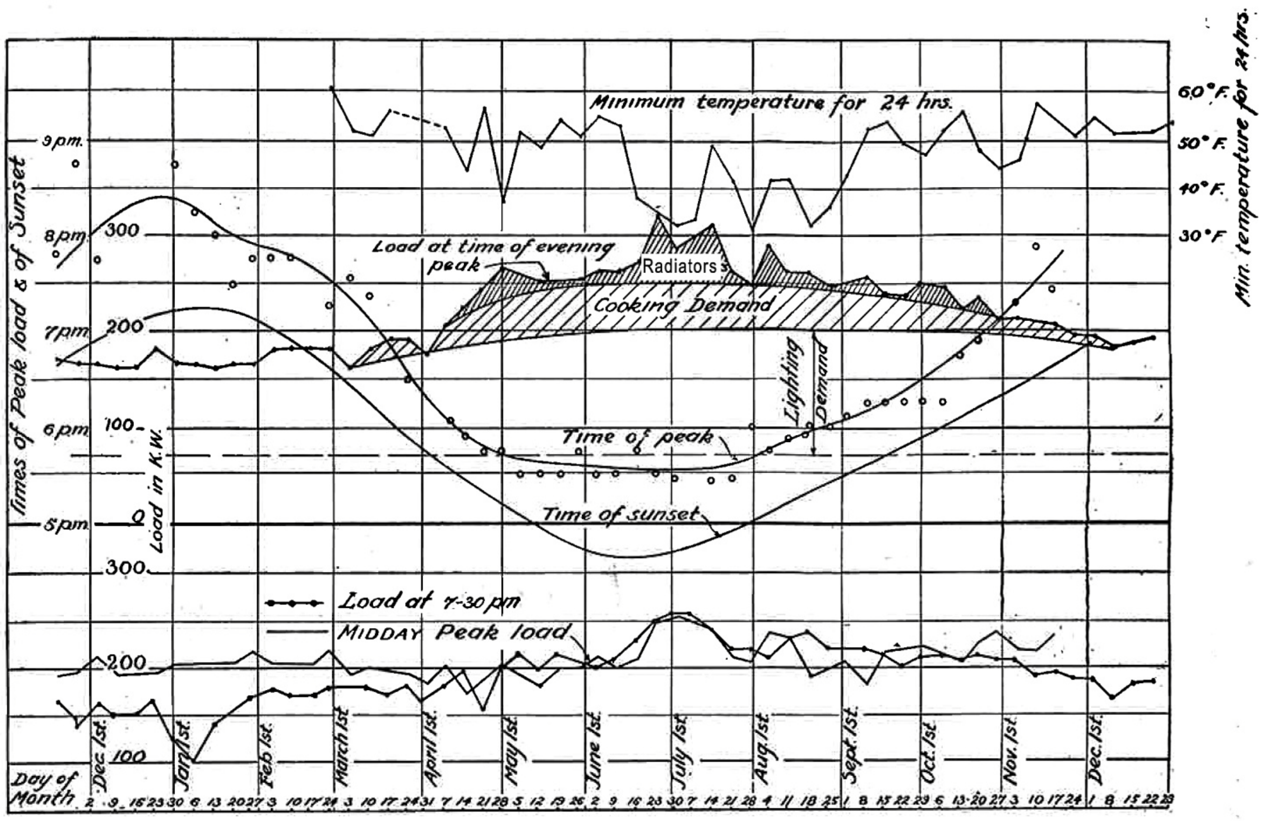


*Fig. 2. Curves shewing Seasonal variation of Demand. 1922-23.*

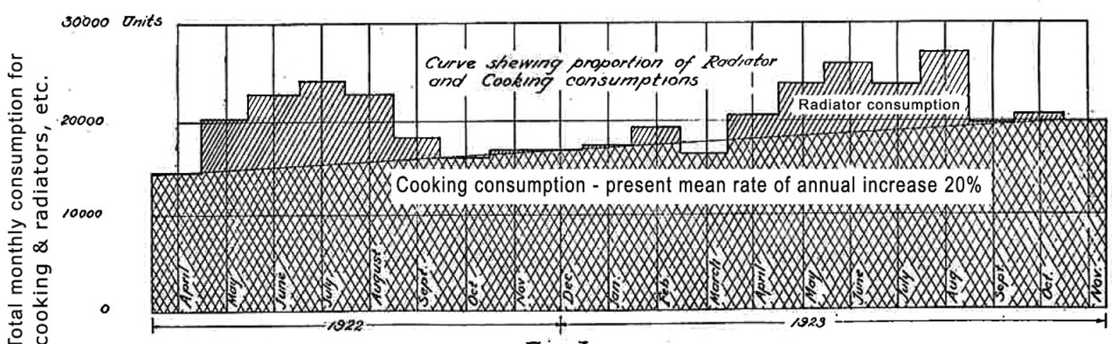


*Fig. 3.*

**Mr F. W. MacLean** asked that Mr Mandeno should give some idea of the cost of installing this system. He would like to have an estimate, say for a five-family house, of the cost of installation.

**Mr Mandeno**, in reply to the discussion, said he was very much indebted to members for the very hearty reception given to the paper. As the writer of a paper for the first time, he had had an opportunity of looking at the matter from the point of view of .a paper writer, and he could assure those who had not written a paper so far, that it was not all “beer and skittles.” It was very pleasant, however, to have one’s efforts appreciated as they had been. There was not very much of a reply required of him.

**Mr Birks** alluded to the question of shock, and to the importance of doing everything possible to safeguard against that. While he made every allowance for the possibility of that in the paper, and referred to the importance of guarding against it, he would point out that although there was this danger connected with electric power it was also present with other methods of cooking, and that it had not been very uncommon during the last 12 months to hear of very unpleasant accidents occurring in connection with other .agents available for cooking. He referred to explosions and such accidents as were frequently reported.

**Mr MacLennan** asked about how many, with a full equipment, could be supplied with 100 kilowatts. His reply was that the figures given in the table in the paper indicated that the maximum load was, he thought, 110 kilowatts in respect to cooking and ironing only. It would be seen from that table that the total connections were about 500 kilowatts for cooking and between 200 and 300 kilowatts for ironing under that heading.

It could be stated that the demand from each house, when the diversity between the various houses was taken into account, was not more than ij kilowatts, although the total loading in each house, averaging about six or seven, was indicated in the paper. Where he gave the figures for a typical installation he should say that not more than 1.5 kilowatts was a very safe figure.

**Mr Aldridge** referred to the flat rate system, but he thought he did not clearly understand that that referred only to the water heating circuit. Their by-laws required that a circuit should not be tampered with, and they had never found any attempt made to tamper with it so far, and in a small town he did not expect anything of the kind. With regard to Mr MacLean’s inquiry as to the cost of installation he might say that the cost had been coming down very considerably during the last year or two, and he thought that in his district an electric range now cost about half of what it did some time ago.

The ranges in Tauranga were about from 4.5 to 7 kilowatt capacity, and the prices charged to consumers varied from about £22 10s within recent months, up to £35. The cost of installation would be-about £5 per range, and that would cover all the requirements in regard to cooking.

For an electric hot water service, which was absolutely essential, a heater cost about £15 in an average case, and the cost of installation, including plumbing, taps, sink, hand basin, etc., brought the cost up to a total of from £22 10s to £26, including the wiring. Radiators varied in price from about 35s to £10 or £12. The hotels were fitted with radiators varying from 1.5 to 3 kilowatts.

**Mr Hitchcock** said Mr MacLean had asked about the cost of installation in a house. The cost in Christchurch was about £2 per point, and with ironing and radiator points a little more. From about £14 to £25 covered most houses. A small family range could be bought for about £18, a larger one for £25 or £27, and a quite pretentious range for about £45.

The case for these sort of ranges was very much stronger in a new house because of the chimneys and their foundations and other things, the omission of which would, in most cases, pay for the range, than in a house where some of the apparatus had to be scrapped. In a good many cases the range was put into a room where there was no range and the rooms were changed round to a certain extent. In the winter an open fire could be used in a room if desired. In the summer electric heaters could be attached to a copper cylinder with a minimum of trouble. With regard to the. danger of using electric cookers he might state that, in Christchurch, there were over 300 installed, and, so far, there had not been an accident with any of them. There were many houses in Christchurch in which cooking was done by electricity all the year round.

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Searchable PDF version compiled by David Hyde (Nom de plume David de la Hyde) with the assistance of Peter Browne - a former Tauranga city Electrical Engineer.