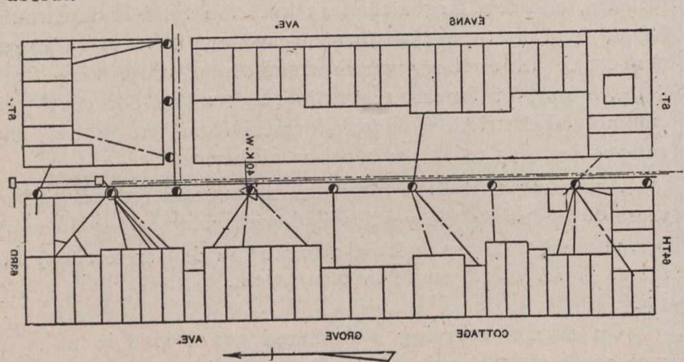
In the substation, there is a diversity factor due to the difference in the character of the load carried by the different feeders. The maxima on the power feeders occur during the daylight hours, while the maxima on lighting feeders vary from 5.30 p.m. in commercial lighting to 7.00 p.m. in residence lighting.

With three-phase distribution, there is a diversity factor between phases where the lighting is carried single-phase. The net result is that in a substation with ten or more feeders the diversity factor averages about 1.15. In the substation supplying power feeders and general lighting it is likely to be as high as 1.2 while in a residence district with little power load, it is about 1.1.

Having thus analyzed the diversity between the various elements of the distributing system it is of interest to derive the total diversity factor from substation to consumer for various classes of business. For convenient reference the following table of diversity factors will be useful.



	Residence.	Commercial light.	Scattered power	Large users.
Substation to feeders	...1.15	1.15	1.15	1.15
Feeders to transformers	..1.8	1.25	2.0	1.25
Transformer to meters	..3.0	1.6	1.1	....
Total diversity factor	....6.20	2.30	2.53	1.44

From this table it is apparent that the total diversity factor for residence lighting is 6.2, for commercial lighting 2.30, for scattered power 2.53, and for large users of light or power 1.44. The latter figure would apply to consumers requiring from 100 to 500 kw. The combined diversity factor of systems giving all of these kinds of service should range from 2.5 to 3.5, depending upon the relative proportion of each kind served.

These factors may be illustrated by a concrete example:—

Assume a residence district, well settled, in which the sum of consumer's demands during the heaviest month of the year is 100 kw. The transformer capacity required to carry the co-incident demands of these consumers will be $\frac{100}{3} = 33.3$ kw. The feeder capacity required, will be $\frac{33.8}{1.8} = 18.5$ kw. The sub-station capacity required will be $\frac{18.5}{1.15} = 16.0$ kw.

Similarly, the capacity required for a commercial lighting district in which the sum of the consumer's demands is 100 kw. will be 43.5 kw., for scattered power it is 39.5 kw., and for large light or power consumers, it is 69.5 kw.

This reduction in the amount of capacity required in generating and distributing equipment makes a corresponding reduction in fixed charges which form a large part of the cost of producing electricity. The investment cost is further reduced by the ability to use large generating units which cost less than half as much per kilowatt as the cost of generating machinery in the sizes commonly used for independent plants.

The merging of all these demands has also a pronounced effect on operating costs, in that the load factor of the generating station and distributing systems is very much higher than that of the consumers who take their supply from it. This permits the station to be run at an economical load a large part of the time, thus reducing both labor and fuel cost per unit generated.

The combination of these economies constitutes the central station's justification for existence, and it is unnecessary to add that the justification is well nigh complete in these days of steam turbines and 20,000-kw. generating units.

Thus far the point of view has been from the consumer toward the central station. It is important, however, that the situation be seen from the point of view of the central station toward the consumer, as the diversity factor has a very marked effect upon the investment accounts which must be carefully considered in determining the cost of rendering the different classes of service.

Stated in the reverse manner for each 100 kw. of substation capacity used to supply residence lighting, the central station company must provide 620 kw. of meter capacity, 207 kw. of transformer capacity, and 115 kw. of feeder capacity. In serving large light or power customers it must provide 144 kw. capacity in meters and transformers and 115 kw. in feeder capacity for each 100 kw. of substation capacity.

The diversity factor for small and scattered consumers is higher than these figures and they require more equipment and a larger investment than is required for the consumers in thickly settled districts.

The investment required per kilowatt varies considerably with the type of construction, and the geographical situation of points of supply and delivery. It is considerably more for underground lines than for overhead, and no figures can, therefore, be given which will have great value for other systems than the one to which they apply.

It may, however, be instructive to give some figures to show in a general way how the investment is distributed between various parts of the system under a set of assumed conditions, which are fairly representative.

Assuming the average cost of a meter at $10, line transformers at $7 to $10 per kw., transformer substations and transmission lines at $35 per kw., and generating station capacity at $150 per kw., the investment is divided approximately as shown in the following table.

It is apparent from these figures that as far as that part of the cost of electricity supply which depends upon investment is concerned, small and scattered consumers are the most expensive to serve. This is due chiefly to the high investment in meters and distributing mains. For instance, the cost of meters in residence lighting is about 25 per cent. of $820 or $205 per kw. of station demand. This means that

(Continued on Page 296.)