Tariffs and economic Considerations

In all engineering projects with the exception of the construction of works of art or memorial buildings, the question of cost is of first importance. However, the design and construction of an electric power system is undertaken for the purpose of producing electric power to be sold at a profit.

Demand:

By the demand of a system is meant its load averaged over an interval of time, there is no such thing as instantaneous demand.

Average demand:

By average demand of an installation is meant its average power requirement during some specified period of time of considerable duration such as a day or month or year giving us daily or monthly or yearly average power respectively.

$$\text{Average power} = \frac{\text{kwh consumed in the period}}{\text{Hours in the period}}$$

Maximum demand:

The maximum demand of an installation is defined as the greatest of all the demands which have occurred during a given period.

Demand factor:

Demand factors are used for estimating the proportion of the total connected load which will come on the power plant at one time. It is defined as the ratio of actual maximum demand made by the load to the rating of the connected load.

$$\text{Demand factor} = \frac{\text{maximum demand}}{\text{Connected load}}$$

The connected load can be calculated by adding together the name-plate ratings of all the electrical devices in the installation. The value of demand factor is always less tan unity.

Demand factors are generally used for determining the capacity and hence cost of the power equipment required to serve a given load, and because of their influence on the required investment, they become important factors in computing rate schedules.

As an example, suppose a residence has the following connected load; three 60-w lamps, ten 40-w lamps, four 100-w lamps and five 10-w lamps. Let us assume that the demand meter indicates a 30-min., maximum demand of 650 w. The demand factor can be found as follows:

Connected load = (3x60) + (10x40) + (4x100)+ (5x10) = 1030w.

30.min, max demand = 650w

The demand factor = $\frac{\text{max. demand}}{\text{Connected load}} = \frac{650}{1030} = 0.63$ or 63%.

Diversity factor:

The non-coincidence of the maximum demands of various consumers is taken into consideration in the so-called diversity factor which is defined as the ratio of the sum of the individual maximum demands of the different elements of a load during a specified period to the simultaneous maximum demand of all these elements of load during the same period.

$$\text{Diversity factor} = \frac{\text{sum. of individual max. demands}}{\text{max. demand of the whole load}}$$

its value is usually much greater than unity. It's clear that if all the loads in a group impose their maximum demands simultaneously, then diversity factor is equal to unity.

Load factor:

It is defined as the ratio of the average power to the maximum demand.

$$\text{Annual load factor} = \frac{\text{N° of units actually supplied/year}}{\text{max. power demand x 8760}}$$

$$\text{Monthly load factor} = \frac{\text{N° of units actually supplied}}{\text{max. power demand x 24x30}}$$

$$\text{Daily load factor} = \frac{\text{N° of units consumed/day}}{\text{max. demandx24}}$$

In general,

$$\text{Load factor} = \frac{\text{Average power}}{\text{max. demand}}\text{, per year or per month or per day.}$$

Ex.:

A generating station has a connected load of 43.000kw and a maximum demand of 20.000kw, the units generated being 61.61.000 for the year. Calculate the load factor and demand factor for this case.

Solution:

$$\text{Demand factor} = \frac{\text{maximum demand}}{\text{connected load}} = \frac{20.000}{43.000} = 0.46$$

Average power = 61.500.000/8760 = 7020w

$$-\text{: load factor} = \frac{\text{average power}}{\text{max. power demand}} = \frac{7020}{20.000} = 0.351$$

Plant factor or capacity factor:

This factor relates specifically to a generating plant unlike load factor which may relate either to generating or receiving equipment for the whole station.

It is defined as the ratio of the average load to the rated capacity of the power plant i.e. the aggregate rating of the generators. It is preferable to use continuous rating while calculating the aggregate.

-: $$\text{plant factor} = \frac{\text{average load}}{\text{rated capacity of plant}} = \frac{\text{average demand on station}}{\text{max. installed capacity of the station}}$$

It may be of interest to note that if the maximum load corresponds exactly to the plant ratings, then load factor and plant factor will be identical.

Utilization factor:

It is given by the ratio of the kwh generated to the product of the capacity of the plant and the number of hours the plant has been actually used.

$$\text{Utilization factor} = \frac{\text{station output in kwh}}{\text{Plant capacity x hours of use}}$$

If there are three units in a plant of ratings kw1, kw_2 and kw_3 and their operation hours are h1, h_2 and h_3 respectively, then

$$\text{Utilization factor} = \frac{\text{station output in kwh}}{(kw_1 x h_1) + (kw_2 x h_2) + (kw_3 x h_3)}$$

Load curve of a generating station:

The total power requirement of a generating station can be estimated provided variation of load with time is known. As shown in fig.* this curve is obtained by plotting the station load (in kw) along Y-axis and the time when it occurs along x-axis. Usually, such curves are plotted for one day i.e. for 24 hours by taking average load (kw) on hourly basis. The area under the curve represents the total energy consumed by the load in one day.

Fig.*

Example:

A power station has a load cycle as under: 260Mw for 6hr; 200 mw for 8hr; 160mw for 4hr; 100mw for 6hr.

If the power station is equipped with 4 sets of 75mw each, calculate the load factor and the plant factor from the above data.

Solution:

Daily load factor = units actually supplied in a day

Max. demandx24

Now, mwh supplied per day = (260x6) + (200x8) + (160x4) + (100x6) = 4.400

-: station daily load factor = $\frac{4.400}{260x24}$ = 0.704 or 70.4%

Plant or capacity factor = $\frac{\text{average demand on station}}{\text{Installed capacity of the station}}$

No, of mwh supplied/day = 4.400 -:
-: average power/day = 4.400/24 mw

Total installed capacity of the station = 75x4 = 300mw
-: plant factor = $\frac{4.400/24}{300}$ = 0.611 or 61.1%

Example2:

For the station whose characteristics is shown in table, find
a) the economical number and capacity of the plant.
b) Utilization factor.

From-to(H)	**P (kw)**	**From-to (H)**	**P (kw)**	**From-to (H)**	**P (kw)**
0-5	500	12-13	2500	21-23	1000
5-7	750	13-17	1500	23-0	500
7-9	1000	17-19	2500		
9-12	2000	19-21	2000		

Solution:
a) form table, mn chose
1- two plants 2x1000kw
2- One plant 1x500xkw
3- reserve 1x1000kw

b) Utilization factor kw

$$kw = \frac{\text{Energy produced}}{\text{capacity of plant x N° of hours plant has been in operation}}$$

$$= \frac{38750}{39000} \cdot 100\% = 99.4\%$$