CHAPTER 2

Variable Load on Power Stations
(Load management)

Definitions related to load management

Energy

• In electrical industry it is generally expressed as kilowatt hour (kWh). It is the amount of energy it spends in one hour. If one kilowatt electrical heater (which consumes one kilo-Joules per second) is turned for one hour it will consume one kWh.

• In electrical industry it is commonly called unit.

• Mechanical work done over a period of time is also a form of energy like heat.

Work done

• It is applied force times distance covered (N x m). Its unit is N.m. The thermal energy is also a form of work done. It's unit is Joules after the famous scientist Joule, who discovered that energy and work are equivalent. It is also at times expressed in the heat unit of calorie.

• 1 calorie = 4.186 Joules

• Electrical work is the product of voltage difference and the current that flows . Volt x Amp = watt = Joule/sec

Installed capacity

• It is the designed power generation capacity of a plant. It is expressed in terms of energy generated per unit time. Megawatt electric (MW or MWe) is the most commonly used term for electricity generating plants. In case of process steam plant it is either expressed in amount of steam generated per unit time (t/h or kg/s) or in Megawatt thermal (MWth).

Power

• It is the rate of work or work done per unit time. In the power industry it is generally expressed as Megajoules per second or MW. The basic unit is watt (Joules per second).

Base load Plant

• It is a type of plant which caters to a constant load demand. Such plants run 100% of the time. Nuclear and Coal fired plants are suitable for this

Peak Load Plant

• These plants help tide over short term (15%) demand peak. Gas turbine,hydro plant can be used.

Heat rate:

• It is the amount of energy (kJ) that the fuel must supply to produce unit amount of electrical energy (kWh). It is expressed as kJ/kWh or kCal./ KWh or BTU/kWh. This represents the overall efficiency of a power plant.

HR = (KJ fuel burnt/kWh electricity produced)

Turbine Heat rate:

• It is the amount of heat steam (kJ or BTU) must deliver to produce unit of heat (kWh). It gives the thermodynamic efficiency of the steam cycle, but it does not include the boiler efficiency.

Thermal efficiency

• It is the amount of heat carried by the steam per unit amount of heat delivered through the fuel.

Combustion efficiency

• It is the ratio of the amount of energy or heat released by the fuel and the energy contained in the fuel burnt

• **Availability**
It is the fraction of the time a plant is available for generation. Sometimes a plant may be partially available due to lack of operation of some components of the plant. It is called partial availability. This term, however, is not very commonly used.

Outage
• It is another term for shut down of the plant either for planned maintenance (Planned outage) or due to unforeseen break down (forced outage).

• **Utilization factor**
It is the ratio of present maximum generation of the plant and the installed or the original design capacity of the plant.

Utilization factor = (Maximum load)/ (rated capacity of plant)

• **Capacity factor**
It is the ratio of total generation of the plant for a given period and that the plant is capable of delivering over the same period.
Capacity Factor = (Average load)/ (rated capacity of plant)

• **Average Load**
• Average load = (Area under load curve)/ (duration of the load curve)

• Demand factor = (Actual peak demand of the system) / (Total connected load)

• Diversity factor = Sum (Peak demands of individual subdivisions) /Maximum demand of system

• Load factor (Lavg/Lmax) = (Average load over a period) / (Peak load in that period)

• Capacity factor (Lavg/Cap) = (Average load) / (rated capacity of plant)
= (Total energy output in a period) / (Rated capacity of the plant x period)

• Utilization factor (Lmax/Cap) = (Peak output in a period) / (Output if the plant operated in full rated capacity over the period)

Also known as Plant load factor (PLF) or Use factor

• Reserve factor = Load factor/ Capacity factor

Load curves

Introduction:

In general each generation plant in any power may have more than one generating units.
Each of the unit may have identical or different capacities. A number of power plants can be tied together to supply the system load by means of interconnection of the generating stations.
Interconnected electric power system is more reliable and convenient to operate and also offers economical operating cost .
Generation unit , Transformer Unit, Converter Unit, Transmission Unit, Inverter Unit and Consumer Point. This combination of all the unit is called the overall power system units.

SYSTEM LOAD VARIATION

Effects of variable load. The variable load on a power station introduces many troubles in its operation. Some of the important effects of variable load on a power station are :
(i) Need of additional equipment and generation units .
(ii) Increase in production cost.
The variation of load on the power station with respect to time.

SYSTEM LOAD

From system's point of view, there are 5 broad category of loads:
1. Domestic
2. Commercial
3. Industrial
4. Agriculture
5. Others - street lights, traction.

Domestic:
Lights, fans, domestic appliances like heaters, refrigerators, air conditioners, mixers, ovens, small motors etc.
1. Demand factor = 0.7 to 1.0;
2. Diversity factor = 1.2 to 1.3;
3. Load factor = 0.1 to 0.15

Industrial:

Small scale industries: 0-20kW

Medium scale industries: 20-100kW

Large scale industries: above 100kW

Industrial loads need power over a longer period which remains fairly uniform throughout the day.

For heavy industries:

1. Demand factor = 0.85 to 0.9;
2. Load factor = 0.7 to 0.8

Agriculture:

Supplying water for irrigation using pumps driven by motors

1. Demand factor = 0.9 to 1;
2. Diversity factor = 1.0 to 1.5;
3. Load factor = 0.15 to 0.25

Other Loads:

a) Bulk supplies,
b) street lights,
c) traction,
d) government loads

System Load Characteristics

a) Connected Load
b) Maximum Demand
c) Average Load
d) Load Factor
e) Diversity Factor
f) Plant Capacity Factor
g) Plant Use Factor

Plant Capacity Factor: It is the ratio of actual energy produced to the maximum possible energy that could have been produced during a given period.

Plant Use Factor: It is the ratio of kWh generated to the product of plant capacity and the number of hours for which the plant was in operation.

$$\text{Plant use factor} = \text{Station output in kWh} \,/\, \text{Plant capacity} * \text{Hours of use}$$

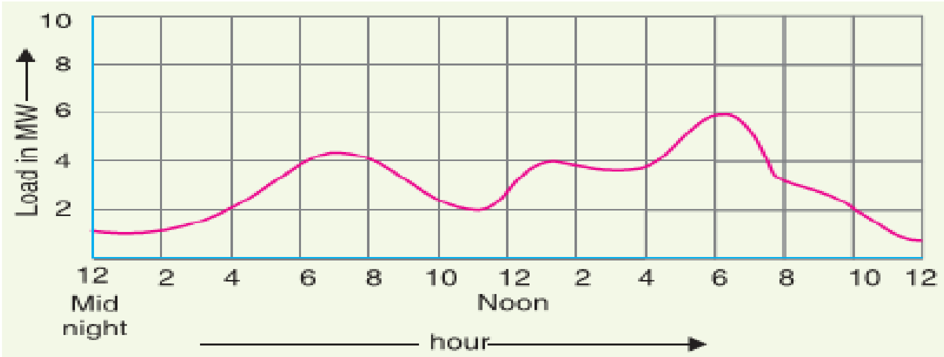
When the elements of a load curve are arranged in the order of descending magnitudes.

ECONOMIC OF GENERATION

Load curves

The curve showing the variation of load on the power station with respect to time

- The curve drawn between the variations of load on the power station with reference to time is known as load curve.
- There are three types, Daily load curve, Monthly load curve, Yearly load curve .



Types of Load Curve:

▪Daily load curve–Load variations during the whole day

▪Monthly load curve–Load curve obtained from the daily load curve .

▪Yearly load curve-Load curve obtained from the monthly load curve

Daily load curve: The curve drawn between the variations of load with reference to various time period of day is known as daily load curve.

Monthly load curve : It is obtained from daily load curve.

Average value of the power at a month for a different time periods are calculated and plotted in the graph which is known as monthly load curve.

Yearly load curve : It is obtained from monthly load curve which is used to find annual load factor.

Base Load: The unvarying load which occurs almost the whole day on the station

Peak Load: The various peak demands so load of the station

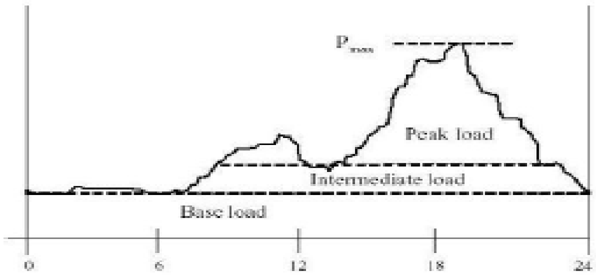


Fig .2 Daily Load Curve

$$\text{Daily average load} = \frac{\text{No. of units (kWh) generated in a day}}{\text{24 hours}}$$

$$\text{Monthly average load} = \frac{\text{No. of units (kWh) generated in a month}}{\text{Number of hours in a month}}$$

$$\text{Yearly average load} = \frac{\text{No. of units (kWh) generated in a year}}{\text{8760 hours}}$$

Load duration curve:
When the elements of a load curve are arranged in the order of decreasing magnitudes.

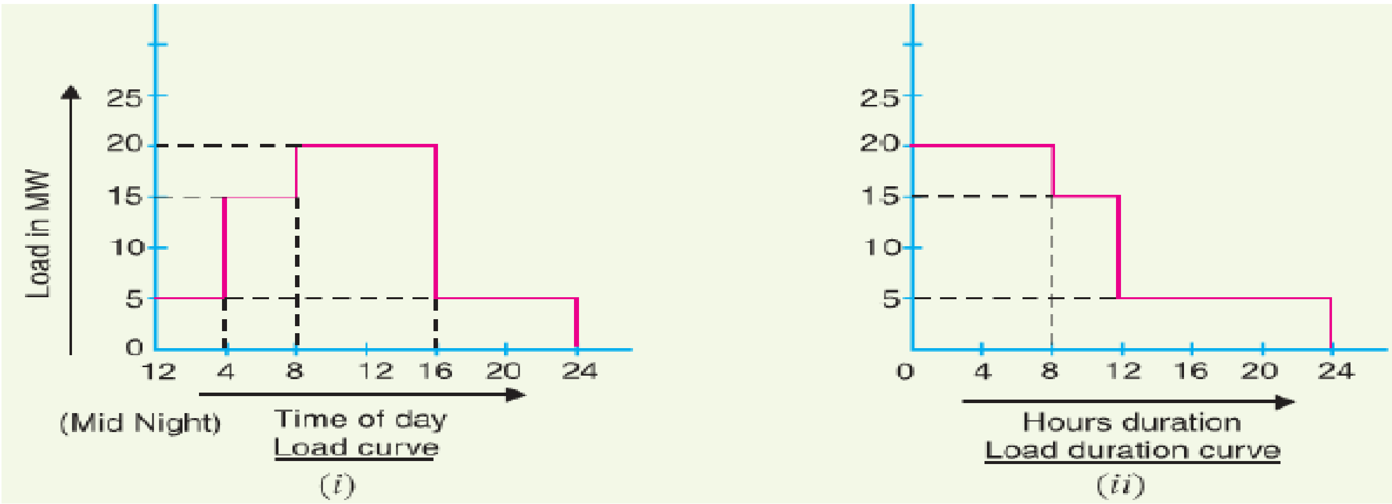


Fig 3 Load Duration Curve

The load duration curve gives the data in a more presentable form

- The area under the load duration curve is equal to that of the corresponding load curve
- The load duration curve can be extended to include any period of time

IMPORTANT TERMINALOGIES

Connected load: It is the sum of continuous ratings of all the equipments connected to supply systems.

Maximum demand: It is the greatest demand of load on the power station during a given period.

Demand factor : It is the ratio of maximum demand to connected load.

Demand factor= (max demand)/ (connected load)

Average demand The average of loads occurring on the power station in a given period (day or month or year) is known as average demand

Daily average demand = (no of units generated per day) / (24 hours)

Monthly average demand = (no of units generated in month) / (no of hours in a month)

Yearly average demand = (no of units generated in a year) / (no of hours in a year)

Load factor: The ratio of average load to the maximum demand during a given period is known as load factor.

$$\text{Load factor} = \frac{\text{Average load}}{\text{Max. demand}}$$

If the plant is in operation for T hours,

$$\text{Load factor} = \frac{\text{Average load} \times T}{\text{Max. demand} \times T}$$

$$= \frac{\text{Units generated in T hours}}{\text{Max. demand} \times \text{T hours}}$$

Diversity factor: The ratio of the sum of individual maximum demand on power station is known as diversity factor.

$$\text{Diversity factor} = \frac{\text{Sum of individual max. demands}}{\text{Max. demand on power station}}$$

Plant Capacity factor: This is the ratio of actual energy produced to the maximum possible energy that could have been produced during a given period.

$$\text{Plant capacity factor} = \frac{\text{Actual energy produced}}{\text{Max. energy that could have been produced}}$$

$$= \frac{\text{Average demand} \times T}{\text{Plant capacity} \times T} \text{**}$$

$$= \frac{\text{Average demand}}{\text{Plant capacity}}$$

$$\text{Annual plant capacity factor} = \frac{\text{Annual kWh output}}{\text{Plant capacity} \times 8760}$$

The plant capacity factor is an indication of the reserve capacity of the plant. A power station is so designed that it has some reserve capacity for meeting the increased load demand in future. Therefore, the installed capacity of the plant is always somewhat greater than the maximum demand on the plant.

Reserve capacity = Plant capacity −Max. demand

Plant use factor: It is the ratio of units generated to the product of plant capacity and the number of hours for which the plant was in operation.

$$\text{Plant use factor} = \frac{\text{Station output in kWh}}{\text{Plant capacity} \times \text{Hours of use}}$$

Suppose a plant having installed capacity of 20 MW produces annual output of 7·35 ×10⁶kWh and remains in operation for 2190 hours in a year. Then,

$$\text{Plant use factor} = \frac{7\cdot35\times10^6}{(20\times10^3)\times2190} = 0\cdot167 = 16\cdot7\%$$

Units Generated per Annum

It is often required to find the kWh generated per annum (annually) from maximum demand and load factor. The procedure is as follows :

$$\text{Load factor} = \frac{\text{Average load}}{\text{Max. demand}}$$

$$\text{Average load} = \text{Max. demand}\times\text{L.F.}$$

$$\text{Units generated/annum} = \text{Average load (in kW)}\times\text{Hours in a year}$$

$$= \text{Max. demand (in kW)}\times\text{L.F.}\times8760$$

Example 3.1. *The maximum demand on a power station is 100 MW. If the annual load factor is 40% , calculate the total energy generated in a year.*

Solution.

$$\text{Energy generated/year} = \text{Max. demand}\times\text{L.F.}\times\text{Hours in a year}$$

$$= (100\times10^3)\times(0\cdot4)\times(24\times365)\text{ kWh}$$

$$= \mathbf{3504\times10^5\ kWh}$$

Example 3.2. *A generating station has a connected load of 43MW and a maximum demand of 20 MW; the units generated being 61·5 × 10⁶ per annum. Calculate (i) the demand factor and (ii) load factor.*

Solution.

(i)
$$\text{Demand factor} = \frac{\text{Max. demand}}{\text{Connected load}} = \frac{20}{43} = \mathbf{0\cdot465}$$

(ii)
$$\text{Average demand} = \frac{\text{Units generated / annum}}{\text{Hours in a year}} = \frac{61\cdot5\times10^6}{8760} = 7020\text{ kW}$$

$$\therefore\quad \text{Load factor} = \frac{\text{Average demand}}{\text{Max. demand}} = \frac{7020}{20\times10^3} = \mathbf{0\cdot351}\text{ or }\mathbf{35\cdot1\%}$$

Example 3.3. *A 100 MW power station delivers 100 MW for 2 hours, 50 MW for 6 hours and is shut down for the rest of each day. It is also shut down for maintenance for 45 days each year. Calculate its annual load factor.*

Solution.

Energy supplied for each working day

$$= (100\times2)+(50\times6) = 500\text{ MWh}$$

$$\text{Station operates for} = 365-45 = 320\text{ days in a year}$$

$$\therefore\quad \text{Energy supplied/year} = 500\times320 = 160{,}000\text{ MWh}$$

$$\text{Annual load factor} = \frac{\text{MWh supplied per annum}}{\text{Max. demand in MW}\times\text{Working hours}}\times100$$

$$= \frac{160{,}000}{(100)\times(320\times24)}\times100 = \mathbf{20\cdot8\%}$$

Example 3.4. *A generating station has a maximum demand of 25MW, a load factor of 60%, a plant capacity factor of 50% and a plant use factor of 72%. Find (i) the reserve capacity of the plant (ii) the daily energy produced and (iii) maximum energy that could be produced daily if the plant while running as per schedule, were fully loaded.*

Solution.

(i) $$\text{Load factor} = \frac{\text{Average demand}}{\text{Maximum demand}}$$

or $$0{\cdot}60 = \frac{\text{Average demand}}{25}$$

$$\therefore \quad \text{Average demand} = 25 \times 0{\cdot}60 = 15 \text{ MW}$$

$$\text{Plant capacity factor} = \frac{\text{Average demand}}{\text{Plant capacity}}$$

$$\therefore \quad \text{Plant capacity} = \frac{\text{Average demand}}{\text{Plant capacity factor}} = \frac{15}{0\cdot 5} = 30 \text{ MW}$$

$$\therefore \quad \text{Reserve capacity of plant} = \text{Plant capacity} - \text{maximum demand}$$
$$= 30 - 25 = \mathbf{5\ MW}$$

(ii) $$\text{Daily energy produced} = \text{Average demand} \times 24$$
$$= 15 \times 24 = \mathbf{360\ MWh}$$

(iii) Maximum energy that could be produced

$$= \frac{\text{Actual energy produced in a day}}{\text{Plant use factor}}$$

$$= \frac{360}{0\cdot 72} = \mathbf{500\ MWh/day}$$

Load Curves and Selection of Generating Units

The load on a power station varies from time to time. A single generating unit is not economical operation to meet this varying load because a single unit will have very poor efficiency during the periods of light loads on the power station.

From this reason , in actual practice, a number of generating units of different sizes are installed in a power station.

The selection of the number and sizes of the units is decided from the annual load curve of the station. and are selected in such a way that they correctly fit the station load curve.

Once this underlying principle is achieved, it becomes possible to **operate the generating** units at or near the point of maximum efficiency.

The principle of selection of number and sizes of generating units with the help of load curve is illustrated in Fig. 3.11. In Fig. 3.11 (i), the annual load curve of the station is shown.

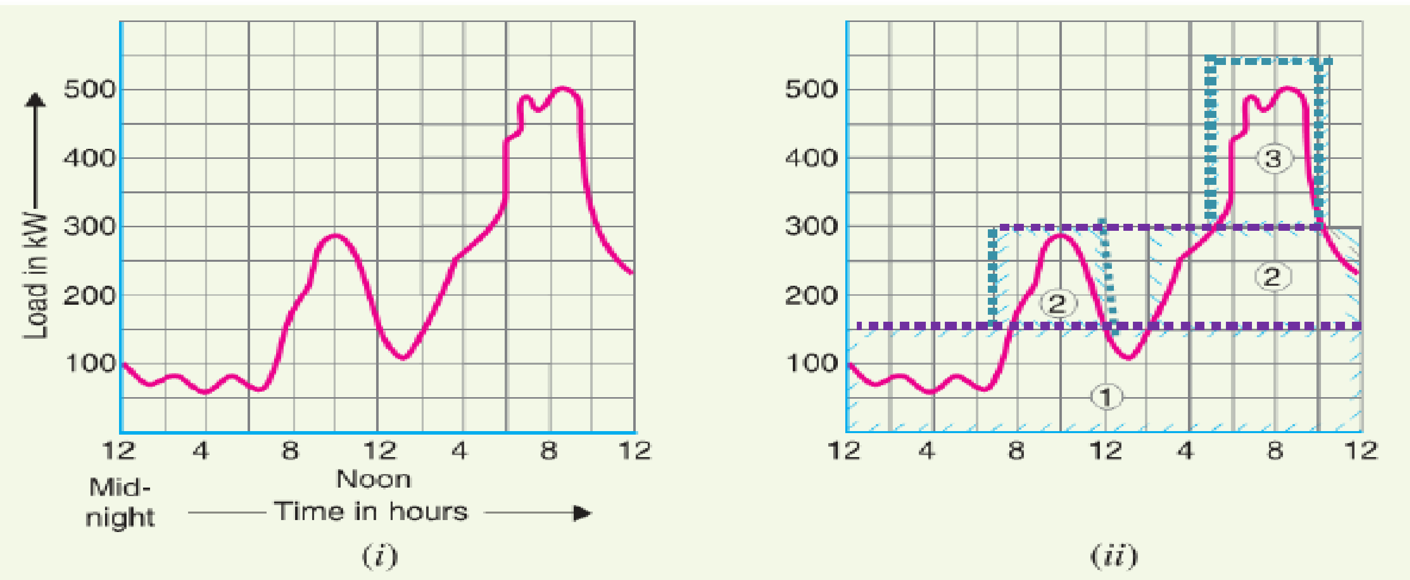


Fig. 3.11

It is clear form the curve that load on the station has wide variations ; the minimum load being some-what near 50 kW and maximum load reaching the value of 500 kW. It hardly needs any mention that use of a single unit to meet this varying load will be highly uneconomical.

As discussed earlier, the total plant capacity is divided into several generating units of different sizes to fit the load curve. This is illustrated in Fig. 3.11(ii) where the plant capacity is divided into three units numbered as 1, 2 and 3.

The color outline shows the units capacity being used. The three units employed have different capacities and are used according to the demand on the station. In this case, the operating schedule can be as under

Time	*Units in operation*
From 12 midnight to 7 A.M.	Only unit no.1 is put in operation.
From 7 A.M. to 12.00 noon	Unit no. 2 is also started so that both units 1 and 2 are in operation.
From 12.00 noon to 2 P.M.	Unit no. 2 is stopped and only unit 1 operates.
From 2 P.M. to 5 P.M.	Unit no. 2 is again started. Now units 1 and 2 are in operation.
From 5 P.M. to 10.30 P.M.	Units 1, 2 and 3 are put in operation.
From 10. 30 P.M. to 12.00 midnight	Units 1 and 2 are put in operation.

By selecting the proper number and sizes of units, the generating units can be made to operate near maximum efficiency. This results in the overall reduction in the cost of production of electrical energy.

Important Points in the Selection of Units

While making the selection of number and sizes of the generating units, the following points should be kept in view :

(i) The number and sizes of the units should be selected to meet annual load curve of the station.

(ii) The units should be preferably of different capacities to meet the load requirements.

(iii) The capacity of the plant should be made 15% to 20% more than the maximum demand to meet the future load requirements.

(iv) There should be a spare generating when the repairs units is carried out.

(v) The selection of a large number of units of smaller capacity in order to fit the load curve very accurately should be avoided.

It is because the investment cost per kW of capacity increases as the size of the units decreases.

Base Load and Peak Load on Power Station

The changing load on the power station makes its load curve of variable nature. Fig. 3.13. shows the typical load curve of a power station. It is clear that load on the power station varies from time to time. The load on the power station can be considered in two parts, namely;

(i) Base load

(ii) Peak load

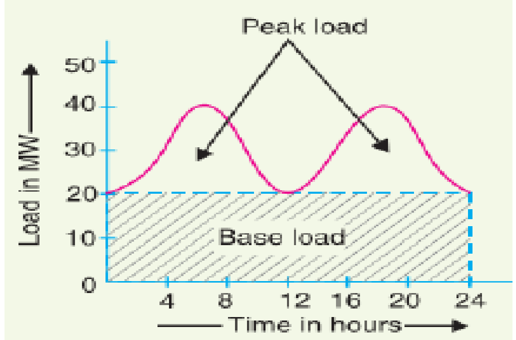


Fig. 3.13

Base load:-

The unvarying load which occurs almost the whole day on the station is known as base load.(in fig. 3.13, it is 20 MW that supplied by the station at all times of day and night throughout 24 hours).

Peak load:-

The various peak demands of load over and above the base load of the station is known as peak load.(in fig. 3.13, the peak demands of load excluding base load. These peak demands of the station generally form a small part of the total load and may occur throughout the day).

Method of Meeting the Load

The total load on a power station consists of two parts

(i) base load

(ii) peak load.

In order to achieve overall economy, the best method to meet load is to interconnect two different power stations.

- The more efficient plant is used to supply the base load and is known as base load power station.
- The less efficient plant is used to supply the peak loads and is known as peak load power station.

To illustrate that consider the interconnection of steam and hydro plants is to meet the load. When water is available in sufficient quantity as in summer and rainy season, the hydro-electric plant is used to carry the base load and the steam plant supplies the peak load and when the water is not available in sufficient quantity as in winter, the steam plant carries the base load, whereas the hydro-electric plant carries the peak load.

Interconnected Grid System

The connection of several generating stations in parallel is known as interconnected grid system.
The various problems facing the power engineers are considerably reduced by interconnecting different power stations in parallel.

Some of the advantages of interconnected system are listed below :
(i) Exchange of peak loads: An important advantage of interconnected system is that the peak load of the power station can be exchanged. If the load curve of a power station shows a peak demand that is greater than the rated capacity of the plant, then the excess load can be shared by other stations interconnected with it.
(ii) Use of older plants :The interconnected system makes it possible to use the older and less efficient plants to carry peak loads of short durations.
(iii) Ensures economical operation :The interconnected system makes the operation of concerned power stations quite economical.
It is because sharing of load among the stations is arranged in such a way that more efficient stations work continuously throughout the year at a high load factor and the less efficient plants work for peak load hours only.

(iv) Increases diversity factor : The load curves of different interconnected stations are generally different. The result is that the maximum demand on the system is much reduced as compared to the sum of individual maximum demands on different stations. In other words, the diversity factor of the system is improved, thereby increasing the effective capacity of the system.
(v) Reduces plant reserve capacity: Every power station is required to have a standby unit for emergencies. However, when several power stations are connected in parallel, the reserve capacity of the system is much reduced. This increases the efficiency of the system.
(vi) Increases reliability of supply : The interconnected system increases the reliability of supply. If a major breakdown occurs in one station, continuity of supply can be maintained by other healthy stations.

Electricity Tariff Systems

Definition: The amount of money frame by the supplier for the supply of electrical energy to various types of consumers is known as an electricity tariff. In other words, the tariff is the methods of charging a consumer for consuming electrical energy. The tariff covers the total cost of producing and supplying electric energy plus a reasonable cost.

The actual tariffs that the customer pay depends on the consumption of the electricity. The consumer pay varies according to their requirements. The industrial consumers pay more tariffs because they use more power for long times than the domestic consumers.

The electricity tariffs depends on the following factor

- Type of load
- Time at which load is required.
- The power factor of the load.
- The amount of energy used.

The total bill of the consumer has three parts, namely, fixed charge D, semi-fixed charge *Ax* and running charge *By*.

$$C = Ax + By + D$$

where, C – total charge for a certain period (say one month)
x – maximum demand during the period (kW or kVA)
y – Total energy consumed during te period (kW or kVA)
A – cost per kW or kVA of maximum demand.
B – cost per kWh of energy consumed.
D – fixed charge during each billing period.

This is known as three-part electricity tariff, and it is mainly applied to the big consumers.

Factors Affecting the Electricity Tariffs

The following factors are taken into accounts to decide the electricity tariff:

- **Types of Load –** The load is mainly classified into three types, i.e., domestic, commercial, or industrial. The industrial consumers use more energy for a longer time than domestic consumers, and hence the tariff for the industrial consumers is more than the domestic consumers. The tariff of the electric energy varies according to their requirement.

- **Maximum demand –** The cost of the electrical energy supplied by a generating station depends on the installed capacity of the plant and kWh generated. Increased in maximum capacity increased the installed capacity of the generating station.
- **The time at which load is required –** The time at which the maximum load required is also important for the electricity tariff. If the maximum demand coincides with the maximum demand of the consumer, then the additional plant is required. And if the maximum demand of the consumers occurs during off-peak hours, the load factor is improved, and no extra plant capacity is needed. Thus, the overall cost per kWh generated is reduced.
- **The power factor of the load –** The power factor plays an important role in the plant economics. The low power factor increases the load current which increases the losses in the system. Thus, the regulation becomes poor. For improving the power factor the power factor correction equipment is installed at the generating station. Thus, the cost of the generation increases.
- **The amount of energy used –** The cost of electrical energy is reduced by using large amounts of energy for longer periods.

Types of Electricity Tariff

Some of the most important types of tariff are as follows;

1. Flat Demand Rate tariff
2. Single Tariff
3. Straight-line Meter rate tariff
4. Block meter Rate tariff
5. Two-part tariff
6. Maximum Demand Tariff
7. Power factor tariff
8. Seasonal rate tariff
9. Peak load tariff
10. Three-part tariff

The different types of tariffs are explained below in details

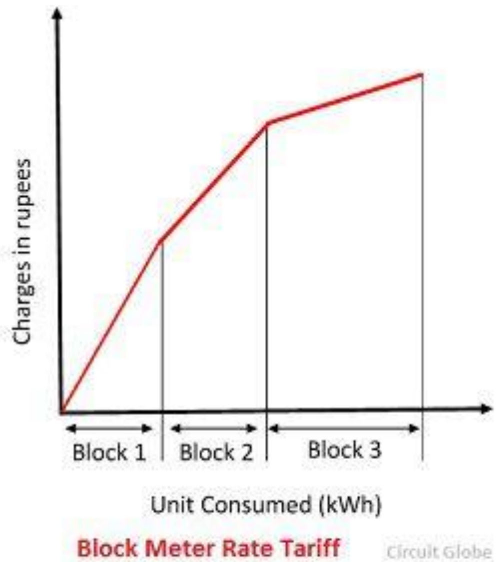
1. **Flat demand rate tariff** – The flat demand rate tariff is expressed in the form, $C = Ax$ Here the bill depends only on the maximum demand. It is independent of the energy consumed. This system is used in street lighting, sign lighting, signal system, and irrigation tube wells. In all such systems, the amount of connected load and hours of their use is unknown, and the rate of charge is made accordingly. Thus, metering is not required in this system of the tariff.

2. Single Tariff: No categories. Constant $/kWh

3. Straight-line meter rate tariff – This type of tariff is given by the relationship $C = By$. In this system, the bill depends only upon the amount of energy consume. The different types of consumers are charged at different rates.

The rate for each type of consumption is decided by taking into consideration the load factor and diversity factors of the load. For examples, the rate for light load and fan load is higher than that for power load. For this purpose, separate energy meters are to be installed for light and power load.

4. Block meter rate tariff (Sliding Rate) – In this system, the energy consumption is distinguished into blocks, and the per unit price is fixed in each block. The price per unit in the first block is the highest, and it decreases for the succeeding blocks.



The price and the energy consumption are divided into three blocks. The first few units of energy at a certain rate, the next at a slightly lower rate and the remaining unit at a still lower rate.

5. Two-part tariff – In two-part tariff, the total charge from the consumer is divided into two components. The first component is the fixed charge which depends upon the maximum demand. The second component is the running charge which depends upon the energy consumed.

$$C = Ax + By$$

$$C = A(kW) + B(kWh)$$

The factor A and B may be constant and vary according to some sliding.

6. Maximum Demand Tariff: As two part tariff but the first part depends on the actual maximum demand and it may vary from month to month.

7. Power factor tariff – The tariff in which the power factor of the consumer load is taken into consideration is called power factor tariff. The power factor tariff is mainly classified into two types.

a. kVA maximum demand tariff – This is also a two-part tariff.

$$Total\ charges = A(kVA) + B(kWh)$$

In this system, the consumer is compelled to improve the power factor of his load since low power factor will increase the KVA.

b. kWh and kVArh tariff –

$$Total\ charges = A_1(kWh) + B_1(kVArh)$$

Since kVArh decreases with the increases in power factor. This type of tariff will induce the consumer to improve the power factor.

c. Sliding Scale or Average power factor tariff – In such type of tariff the average power factor, say 0.8 lagging may be taken as the reference. If the power factor of the consumer is below this reference value, a suitable additional charge is realised from the consumer for each step. Similarly, if the power factor is above the reference value, the suitable discount is allowed to the consumer for each step rise.

8. Seasonal rate tariff – This tariff specifies a higher price per kWh used during the season of the year in which the system peak occurs. This is known as the on-peak season. The price per kWh unit is lower during the season of the year in which the usage is low. This is known as the off-peak season.

9. Peak-load tariff – This peak load tariff is similar to the seasonal rate tariff. It specifies higher prices per kWh used during the peak period of the day and lower prices during the off-peak period of the day.

The seasonal rate and peak load tariff both are designed to reduce the system peak load and hence reduce the system idle standby capacity.

10. Three-part tariff – The three-part tariff is in the form of and it is applied to the big consumer.

$$C = Ax + By + D$$

Tariff Systems in Renewable Energy Technology

Feed-in tariffs (FITs) and net metering, also known as net energy metering (NEM), are both methods designed to accelerate investments in renewable energy technologies (e.g. solar panels and wind turbines) by allowing energy producers (e.g. homeowners) to be compensated for the energy they feed back into the grid.

Net Metering

Most electricity meters are bi-directional and can measure current flowing in two directions. This allows you to easily bank excess electricity from your solar panels for future credit. Net metering can be implemented easily without special equipment or any prior notification.

Net metering only requires one power meter, while feed-in tariffs require two. Unlike feed-in tariffs and power purchase agreements, the credits you accumulate through net metering are always at full retail value.

Feed-In Tariff

Feed-in tariffs require one extra power meter in order to measure outflow of electricity from your home independently. This enables electricity consumption and electricity generation to be priced separately. Feed-in tariff schemes are typically based on a 15-20 yearlong contract where prices are pre-defined which effectively reduces your earnings over time. For every kWh you generate you get paid.

Unlike net metering, feed-in tariffs do require prior arrangement and notification.

Types of feed-In tariffs:

- Gross feed-in tariffs

The customers have been allowed to send *all* of their generated renewable energy into the grid at the premium rate (Two meters).

- Net feed-in tariffs

The solar energy would flow first into any household appliances, with *only the excess energy* going into the grid at the premium rate (Net meter).

Tariff levels:
- Depending on location
- Depending on plant size
- Depending on fuel type