Tariff

Cost of Energy

Introduction:

- The electrical energy produced by a power station is delivered to a large number of consumers. The tariff is the rate at which electrical energy is sold naturally becomes attention inviting for electric supply company.

Objectives of tariff:

1- Recovery of cost of producing electrical energy at the power station.

2- Recovery of cost on the capital investment in transmission and distribution systems.

3- Recovery of cost of operation and maintenance of supply of electrical energy, metering equipment…

4- A suitable profit on the capital investment.

Desirable characteristics of a tariff:

1) Proper return – the tariff should be such that it ensures the proper return from each consumer. In other words, the total receipts from the consumers must be equal to the cost of producing and supplying electrical energy plus reasonable profit.

Fairness: the tariff must be fair so that different types of consumers are satisfied with the rate of charge of electrical energy.

Simplicity: the tariff should be simple so that an ordinary consumer can easy understand it.

Reasonable profit: the profit element in the tariff should be reasonable.

Attractive: the tariff should be attractive so that a large number of consumers are encouraged to use electrical energy.

Types of Tariff:

1- Single tariff: when there is a fixed rate per unit of energy consumed, it is called a simple tariff.

Disadvantages:

- There is no discrimination between different types of consumers since every consumer has to pay equitably for the fixe charges.
- The cost of unit delivered is high

Types of Tariff:

2- Flat rate tariff: when different types of consumers are charged at-different uniform per unit rates, it is called a flat rate tariff.

The advantage of such a tariff is that it is fairer to different types of consumers and is quite simple in calculations.

Disadvantages:

1) Separate meters are required; this makes the application of such a tariff expensive and complicated.

2) A particular class of consumers is charged at the same rate.

3-Block rate tariff:

- when a given block of energy is charged at a specified rate and the succeeding blocks of energy are charged at progressively reduced rates, it is called a block rate tariff.

- **The advantage** of such a tariff is that the consumer gets an incentive to consume more electrical energy. This increased the load factor of the system and hence the cost of generation is reduced. This type of staff is being used for majority of residential and small commercial consumers.

4-Two-part tariff

when the rate of electrical energy is charged on the basis of maximum demand of the consumer and the units consumed, it is called a two-part tariff.

In two-part tariff, the total charge to be made from the consumer is split into two components viz. fixed charges and running charges. The fixed charges depend upon the maximum demand of the consumer while the running charges depend upon the number of units consumed by the consumer. Thus, the consumer is charged at a certain amount per kw of maximum demand plus a certain amount per kwh of energy consumed.

Total energy = (b x kw + c x kwh)

b- Charge per kw of maximum demand. c- Charge per kwh of energy consumed

4-Two-part tariff

Advantages:

i) It is easy to understand by the consumers.

It recovers the fixed charges which depend upon the maximum demand of the consumer but are independent of the units consumed.

Disadvantages:

1- The consumer has to pay the fixed charges irrespective of the fact whether he has consumed or not consumed the electrical energy.

2- There is always error in assessing the maximum demand of the consumer.

5- Maximum demand tariff

- It is similar to two-part tariff with the only difference that the maximum demand is actually measured by installing maximum demand meter in the premises of the consumer

6- Power factor tariff

The tariff in which power factor of the consumers load is taken into consideration is known as power factor tariff.

KVA maximum demand tariff – it is a modified form of two part tariff. In this case, the fixed charges are made on the basis of maximum demand in KVA and not in kw.

Kwh and KVAR tariff – both active power (kwh) and reactive power (KVAR) supplied are charged separately.

7- Three-part tariff

when the total charge to be made from the consumer is split into three parts, fixed charge, semi-fixed charge and running charge, i.e.

Total charge = (a + b x kw + c x kwh) where:

a- Fixed charge made during each billing period. It includes interest and depreciation.

b- Charge per kw of maximum demand. c- Charge per kwh of energy consumed.

Example 1:

A consumer has a maximum demand of 200 kw at 40% load factor. If the tariff is 100$ per kw of maximum demand plus 0.01$ per kwh, find the overall cost per kwh.

Solution:

Units consumed/year

max. Demand x L.F. x Hours in a year

(200) x (0.4) x 8760 = 700.800 kwh

Annual charges

Annual M.D. charges + Annual energy charges.

(100 x 200 + 0.1 x 700800) = 90.080$

-: Overall cost/kwh

= 90.080 = 0.1285= 12.85 cent of

700.800

Example 2:

The maximum demand of a consumer is 20A at 220v and his total energy consumption is 8760 kwh. If the energy is charged at the rate of 20 cent of per unit for 500 hours use of the maximum demand per a year plus 10 cent of per unit for additional units, calculate:

1) annual bill.

Solution:

$$\text{Max demand} = \frac{220 \times 20 \times 1}{1000} = 4.4\text{kw}$$

Unit consumed in 500 hrs.

= 4.4x500 = 2200 kwh Charges for 2200kwh = 0.2 x 2200 = 440$ Remaining Units = 8760 – 2200 = 6580 kwh Charges for 6560 kwh = 0.1x6560 = 656$

-: Total annual bill = 440 + 656 = 1096$

Example 3:

An electric supply company having a maximum load of 75 MW generates $18x10^7$ kwh per year and the supply consumers have an aggregate demand of 75MW. The annual expenses including capital charges are:

For fuel = $90x10^5$\$

Fixed charges concerning generation= $28x10^5$\$

Fixed charges concerning transmission and distribution= $32x10^5$\$

Assuring 90% of the fuel cost is essential to running charges and the loss in transmission and distributio9n as 15% of kwh generated, deduce a two part tariff to find the actual cost of supply to the consumers.

Example 3(Solution):

- **Annual fixed charges**: for generation = $28x10^5$\$, for transmission and dist. = $32x10^5$\$

for fuel (10% only) = $0.1x90x10^5 = 9x10^5$\$

Total annual fixed charge = $(28+32+9)x10^5 = 69x10^5$\$

This cost has to be spread over the aggregate maximum demand of all the consumers i.e. 75 mw.

cost per kw of maximum demand: = $\frac{69x10^5}{75x10^3}$ = 92\$

- **Annual running charges:**

Cost of fuel (90) = $0.9x90x10^5 = 81x10^5$\$

Units delivered to consumers = 85% of units generated = $0.85x18x10^7 = 15.3x10^7$ kwh

This cost is to be spread over the units delivered to the consumers. -: cost/kwh = $\frac{81x105}{15.3x10^7}$ = 0.053\$ = 5.3 cent of

Tariff is 92\$ per kw of maximum demand plus 5.3 cent per kwh.

Example 4:

Determine the load factor at which the cost of supplying a unit of electricity from a diesel and from a steam station is the same, if the annual fixed and running charges are as follows:

Station	Fixed charges	Running charges
Diesel	300$/kw	0.25$/kwh
Steam	1200$/kw	0.0625$/kwh

Example 4(Solution):

Solution:

Suppose energy supplied in one year is 100 kwh, Let L be the Load factor at which the cost of supplying a kwh of electricity is the same for diesel and steam station.

1) **Diesel station**:

Average power = $\frac{100 \text{ kwh}}{8760 \text{ h}}$ = 0.0114 kw

Max. demand = $\frac{0.0114}{L}$ kw

Fixed charges = 300 x $\frac{0.0114}{L} = \frac{3.42}{L}$

Running charges = 100 x 0.25 = 25$

-: Fixed and running charges for 100 kwh

= $\left(\frac{3.42}{L} + 25\right)$ *

Example 4(Solution):

2-Steam station

Fixed charges = $1200 \times \frac{0.0114}{L} = \frac{13.68}{L}$ \$

Running charges = 100 x 0.0625 = 6.25 \$ -: Fixed and running charges for 100 kwh

$= \left(\frac{13.68}{L} + 6.25\right)$ **

As the two charges are same, therefore, equating …* and **

$$\frac{3.42}{L} + 25 = \frac{13.68}{L} + 6.25$$

Or $\frac{10.26}{L} = 18.75$

L = 10.26/18.75 = 0.5472 = 54.72%

Example 5:

Calculate annual bill of a consumer whose maximum demand is 100kw, P.f = 0.8 lagging and load factor = 60%. The tariff used is 75$ per KVA of maximum demand plus 0.15$ per kwh consumed.

Solution:

Unit consumed/year = max. demand x L.F. x Hours in a year

100 x 0.6 x 8760 kwh

$=5.256 \times 10^5$ kwh

Max. demand in KVA = 100/p.f. = 100/0.8 = 125

Annual bill = max. demand charges + Energy charges

$75 \times 125 + 0.15 \times 5.256 \times 10^5 = 9375 + 78.840 = 88215\$$

Example 6:

A factory has a maximum load of 240 kw at 0.8p.f lagging with an annual consumption of 50.000 kwh. The tariff is 50$ per kVZ maximum demand plus 0.1 kwh. Calculate the flat rate of energy consumption. What will be annual saving if p.f. is raised to unity?

Solution:

Max. demand in KVA at a p.f of 0.8

240/0.8 = 300

-: Annual bill = Demand charges + Energy charges

50 x 300 + 0.1 x 50.000 = 20.000$

When p.f is raised to unity, the maximum demand in KVA = 240/1 = 240. Annual bill = 50 x 240 + 0.1 x 50.000 = 17000$

Annual saving = (20.000 – 17.000) = 3000$

Example 7:

The monthly readings of a consumer's meter are as follows: Maximum demand = 50 kW
Energy consumed = 36.000 kwh Reactive energy = 23400 KVAR
If the tariff is 80$ per kw of maximum demand plus 0.08$ per unit plus 0.5 cent of per unit for each 1% of power factor below 86%. Calculate the monthly bill of the consumer.

Solution:

Average load = 36000 = 50 kw 24x30

Average reactive power = 23400 = 32.5 KVAR 24x30

Tan Q = KVAR = 32.5 = 0.65 Active power 50

-: P.f = cost = 0.838

P.f surcharge = 36000x0.5 (86 – 83.8) 100

= 388.8$

Monthly bill = (80 x 50 + 0.08 x 36000 + 388.8) = 7268.8$

Example 8:

Two systems of tariff are available for a factory working 8 hours a day for 300 working days in a year.

High-voltage supply at 5 cent of per unit plus 4.5$ per month per KVA of maximum demand.

Low-voltage supply at 5$ per month per KVA of maximum demand plus 5.5 cent of per unit.

The factory has an average load of 200 kw at 0.8 P.f. and a maximum demand of 250 kw at the same p.f. The high voltage equipment costs 50$ per KVA and the losses can be taken as 4%. Interest and depreciation charges are 12%. Calculate the difference in the annual costs between the two systems

Solution:

i) High voltage supply

Max. Demand in KVA = 250/0.8 = 312$

As the losses in h.v. equipment are 4%, therefore, capacity of h.v. equipment = 312.5/0.96 = 325.5 KVA

Capital investment on h.v. equipment = 50$ x 325.5 = 16.275$ Annual interest and depreciation =16275 x 0.12 = 1953$

Annual charge due to maximum KVA demand = 325.5 x 4.5 x 12 = 17.577$

Units consumed/year = <u>200x8x300</u> = 5x10^5

200 = kw kwh/year 0.96

8 = h/day

300 = day/year

Annual charge due to kwh consumption = 0.05 x 5 x 10^5 = 25000$

Total annual cost = 11953 + 17577 + 25000 = 44530$

Solution:

ii)Low voltage supply. There is no loss of energy as no equipment is used.

Max. demand in KVA = 250/0.8 = 312.5

Annual charge due to maximum KVA demand = 312.5 x 5 x 12 =18750$/year

Units consumed/year = 200 x 8 x 300 = 48 x 10^4 kwh

Annual charge due to kwh consumption = 0.055 x 48 x 104 = 26400$

Total annual cost = (18750 + 26400) = 45150$ Difference in the annual costs of two systems = (45150 – 44530) = 620$

- Hence, high voltage supply is cheaper than low-voltage supply by 620$.