2

Economics of Power System

2.1. Inflation

Inflation is a broad increase in prices. In practical terms, inflation means goods and services are being valued as more desirable than money, which affects economic activity. For example, periods of high inflation are generally marked by increases in average income. Either too few goods offered for sale, or too much money in circulation can cause inflation. Prior to the elimination of the gold standard, persistent inflation was relatively rare. In the US, for example, inflation for the entire period from revolution through to 1914 was 4%. The move from currencies backed by hard assets to floating currencies backed by the 'full-faith and credit' of governments has nearly eliminated deflation by removing impediments on printing more currency. Consequently, excessive inflation has become the primary concern central banks throughout the world.

Inflation is usually measured by the consumer price index (CPI) and the producer price index (PPI). Over the time, as the cost of goods and services increase, the value of money is going to fall because a person will not be able to

purchase as much goods with that amount of money as he previously could. While the annual rate of inflation has fluctuated greatly over the last half century, ranging from nearly zero inflation to 23% and above, the economic actively tries to maintain a specific rate of inflation, which is usually 2-3% but can vary depending on the circumstances.

Inflation is measured by observing the change in the price of a large number of goods and services in an economy (usually based on data collected by government agencies and marketing promoters). The prices of goods and services are combined to give a price index measuring an average price level (the average price of a set of products). The inflation rate is the percentage rate of increase in this index; while the price level might be seen as measuring the size of a balloon; inflation refers to the increase in its size. There is no single true measure of inflation, because the value of inflation will depend on the weight given to each good in the index. Examples of common measures of inflation are as follows:

The Consumer Price Index (CPI): This measures the price of a selection of goods purchased by a typical consumer. In many industrial countries, yearly percentage changes in these indexes are the most commonly reported inflation figure. These measures are often used in wage and salary negotiations, since employees wish to have a nominal pay raise that equals or exceed the rate of increase of the CPI. Sometimes, labor contracts include cost of living escalators that imply nominal pay raises automatically that occur due to CPI increase, usually at a slower rate than actual inflation and after inflation has occurred.

The Cost of Living Index (CLI): It is the theoretical increase in the cost of living of an individual, which consumer price indexes are supposed to approximate. Economists argue over whether a particular CPI over or under estimates the CLI. This is referred to as 'bias' within the CPI. The CLI may be adjusted for 'purchasing power parity' to reflect the differences in prices for land or other local commodities which differ widely from world prices.

The Producer Price Index (PPI): This measures the price received by a producer. This differs from the CPI in that price subsidization, profits, and taxes may cause the amount received by the producer to differ from what the consumer paid. There is also typically a delay between an increase in the PPI and any resulting increase in the CPI. Many believe that this allows a rough-and-ready prediction of CPI inflation for the next day, which is based on PPI inflation of today.

The Wholesale Price Index (WPI): This measures the change in price of a selection of goods at wholesale, which is typically prior to sales taxes. This index is very similar to the PPI.

The Commodity Price Index (CmPI): This index measures the change in price of a selection of commodities. In the case of gold standards the sole commodity used was gold. The CmPI in such case therefore refers to the price of gold, which fluctuates with the gold price.

The Gross Domestic Product (GDP) Deflator: This index is based on calculations of the gross domestic product and is the ratio of the total amount of money spent on nominal GDP to the inflation-corrected measure of GDP (constant-price or real GDP). It is the broadest measure of the price level. Deflators are also calculated for components of GDP such as personal consumption expenditure.

Since each of the above mentioned measure is based on other measures, and a model that brings them together, which economists often dispute on the possibility of existence of bias either in measurement or in the model of inflation. Presently there are those who argue that even more hedonic adjustment should be factored in, including the tendency of people to move to less expensive areas when more expensive ones become out of reach, while others argue that the housing part of the index is dramatically understating the impact of home values

on cost of living, and under accounting for the cost of medications in the cost of living for retirees

2.2. The Role of Inflation in Economy

One effect of small steady inflation is that it is difficult to renegotiate some prices, and particularly wages, downward, so with generally increasing prices it is easier for relative prices to adjust. Many prices are such that they tend to creep upward, so that efforts to attain a zero inflation rate (a constant price level) punish other sectors with falling prices, profits, and employment. Thus, some business executives see mild inflation as 'lubricating the wheels of commerce'. Efforts to attain complete price stability can also lead to deflation (steadily falling prices), which can be very destructive, encouraging bankruptcy and recession or even economic depression. This situation is similar to when goods are out of reach for purchase, either due to fewer amounts of currency notes in circulation or prices of goods are too high.

In the financial community, many regard the hidden risk of inflation as an essential incentive to invest, rather than simply save and accumulate wealth. Inflation, from this perspective, seen as the market expression of the time value of money. That is; if a currency note today is worth more to someone than a year back, then there should be a discount in the economy as a whole for the same currency note in the future. From this perspective, inflation represents the uncertainty about the value of future currency notes.

Inflation, however, above these relatively low amounts is recognized as having increasingly negative effects on the economy. These negative effects are the result of discounting previous economic activity. Since inflation is often the result of government policies to increase the money supply, the government contribution to an inflationary environment is a tax on holding currency. As inflation increases, it increases the tax on holding currency, and therefore

encourages spending and borrowing, which increase the speed with which money is circulated and therefore reinforce the inflationary environment. In its extreme, this can become hyperinflation. The factors associated with inflation have a very drastic effect on the economy and investments, which are as follows:

Uncertainty: Increasing uncertainty may discourage investments and savings.

Redistribution: It will redistribute income from those on fixed incomes, such as pensioners, and shift it to those who draw a more flexible income, for example from profits and most wages which may keep pace with inflation. Similarly it will redistribute wealth from those who lend a fixed amount of money to those who borrow (if the lenders are caught by surprise or cannot adjust to inflation). For example, where the government is a net debtor, as is usually the case, it will reduce this debt redistributing money towards the government. Thus inflation is sometimes viewed as an additional tax.

International trade: If the rate of inflation is higher than that abroad, a fixed exchange rate will be undermined through a weakening balance of trade.

Shoe leather costs: The term is a humorous reference to the cost of replacing shoe leather worn out when walking to the bank. Because the value of cash is eroded by inflation, people will tend to hold less cash during times of inflation. This imposes real costs, for example in more frequent trips to the bank.

Menu costs: Firms must change their prices more frequently, which impose costs, for example with restaurants having to reprint menus.

Hyperinflation: If inflation gets totally out of control that is, in the upward direction, it can totally interfere with the normal workings of the economy, and therefore hurting its ability to supply.

In an economy where some sectors are indexed to inflation, while others are not, inflation acts as redistribution towards the indexed sectors away from the

un-indexed sectors. Again, in small amounts this is a policy choice, acting as a tax on liquidity preference and hoarding, rather than saving. However, beyond this amount, the effect becomes distorting, as individuals begin investing in inflation, which, again encourages inflationary expectations. Because of these reasons for discouraging inflation above the small amounts needed to discount previous actions and discourage hoarding of currency, most central banks define price stability as a major task, with a perceptible, but low, rate of inflation as the target.

2.3. Capital Cost

The initial investment starting from the preparation of plan of the project up to the time the project is commissioned is referred as the capital cost. To name a few; it includes the cost of; material, labour (general and skilled), mapping, surveying, preparation of plans, hiring of consultants, traveling, taxes to be paid, interest on borrowing. It can also include the cost of purchasing papers for preparing plans and reports; including all other items, to the cost of ribbon to be cut at the time of inauguration and commissioning. All insurances costs and depreciations are calculated on the basis of capital cost.

2.4. Loan

Numerous large projects, such as multi-purpose hydroelectric schemes involve huge expenditure, which sometimes is beyond the reach of the government. In order to fulfill these huge financial needs, the government has to borrow a sum from big financial companies (both on the national and on international level), banks or even other governments. In Pakistan, for example, the government borrows finances from financial institutes like; Asian development bank (ADB), World Bank besides finances in aid from organizations such as, USAID (United States Agency for International Development). The sum borrowed to fulfill the needs is referred to as loan. When a person lends some

amount of money to another person, the former is lender and the latter, the borrower. Loan is an arrangement in which a lender gives money or property on lease to a borrower, and the borrower agrees to return the property or repay the money, usually along with interest (which will be discussed in the next section), at some future point(s) in time. A written agreement (promise) to repay the loan is essential and is called a promissory note. Usually, there is a predetermined time for repaying a loan, and generally the lender has to bear the risk that the borrower may or may not repay a loan, though modern capital markets have developed many ways of managing this risk.

Loan can be classified in several ways. If the loan is repayable on the demand of the lender, it is called a demand loan. If repayable in equal monthly payments, it is an installment loan. If repayable in lump sum on the maturity (expiration) of loan, it is referred to as a time loan. Financial institutes and banks further classify loans into other categories such as; consumer, commercial, and industrial loans, construction and mortgage loans, and secured and unsecured loans.

2.5. Interest

Interest has many forms and is a subject of extreme controversy and strictly forbidden in Islamic religion. In general terms, interest is referred to an amount over and above on the money being lended to the borrower for a defined term, referred to as lending term. The lender is a person lending the money, whereas the borrower is a person to whom the money is lended. The lender is thus deprived of an opportunity from a certain amount, which he may have used for some purpose. On the other hand the borrower takes an advantage of spending the borrowed money to fulfill his needs. Thus the lender imposes certain inducements on the borrower to compensate for inconveniences. The inducement is in the form of an extra amount to be paid in addition to the amount borrowed by the lender on completion of the lending term. This extra amount is

interest and is paid by the borrower through mutual agreement at the time of borrowing. Interest rates are usually in the form of some percentage of the lended amount. The interest rate may vary from time to time depending upon the inflation and devaluation of the currency notes. Financial companies calculate this amount on the basis of inflation, devaluation, services, monitoring, taxes and nominal profit. Higher interest rates may also form an attractive opportunity for investors but discourage borrowers. Interest is classified as simple and compound. Simple or plain interest is based on a fixed increase in the borrowed or invested amount, whereas the compound interest is based on accumulated amount. Simple interest is a fixed amount to be paid on the basis of the principal amount borrowed. If r is the interest on the borrowed amount and B is the amount borrowed, then the returned amount R after a defined term is then simply:

$$R = B + rB = B(1 + r) \qquad 2.1$$

Compound interest is on the basis of accumulated amount after a defined term (usually on yearly basis). Thus if r is expressed as percentage interest then the accumulated amount A on the principal amount P after a defined term will be:

$$A = P + r\,P = P(1 + r) \qquad 2.2$$

To determine the sum accumulated on a principal amount P at the end of a given period of n years. If the accumulated amount at the end period is A and the interest rate is r. Then at the end of first year the amount is:

$$A_1 = P + rP = P(1 + r)$$

At the end of second year:

$$A_2 = P(1 + r) + rP(1 + r) = (1 + r)[P + rP]$$

Or $A_2 = P(1 + r)^2$

At the end of third year:

$$A_3 = P(1 + r)^3$$

At the end of *nth* year: Therefore:

$$A = P(1 + r)^n \qquad 2.3$$

The interest rate to be agreed will depend on the final value and principal value from equation 2.3 will be given by:

$$(1 + r)^n = \frac{A}{P}$$

$$(1 + r) = \left(\frac{A}{P}\right)^{\frac{1}{n}}$$

Or $$r = \left(\frac{A}{P}\right)^{\frac{1}{n}} - 1 \qquad 2.4$$

Besides providing loans, many banks and financial institutes have investments schemes on the basis of compound interest on the accumulated sum. To determine the sum accumulated at the end of a given period of years for a series of investments of equal magnitude made yearly is obtained as follows: Let the *P* be the principle amount of investment made at the end of each year for a period of *n* years. Then the accumulation of the first year investment with interest rate *r* is:

$$A_1 = P\,(1 + r)^{n-1}$$

Accumulation of the second year of investment is:

$$A_2 = P(1+r)^{n-2}$$

Accumulation of the third year of investment is:

$$A_3 = P(1+r)^{n-3}$$

Accumulation of the second last year of investment is:

$$A_{n-1} = P(1+r)$$

Accumulation of the last year of investment is:

$$A_n = P$$

Adding all the accumulated amounts from year one to the last:

$$A = P(1+r)^{n-1} + P(1+r)^{n-2} + P(1+r)^{n-3} + \ldots + P(1+r) + P \quad 2.5$$

Writing the above expression of equation 2.5 in ascending order:

$$A = P[(1 + (1+r) + (1+r)^2 + \ldots + (1+r)^{n-2} + (1+r)^{n-1}]$$

$$A = P\sum_{k=0}^{n-1}(1+r)^k$$

The series sum up to:

$$A = P\frac{[1-(1+r)]^{n-1+1}}{1-(1+r)}$$

$$A = P\left[\frac{(1+r)^n - 1}{r}\right] \qquad 2.6$$

Or

$$P = A\left[\frac{r}{(1+r)^n - 1}\right] \qquad 2.7$$

Example 2.1: Determine the amount that will be repaid at the end of 15 years to a company, which lends Rs 2,00,000 to a borrower at 5% interest, compounded annually.

Given that:

P = Rs 2,00,000

r = 0.05

n = 15 years

Therefore the amount to be repaid is calculated by using:

$$A = P(1+r)^n = 200000(1 + 0.05)^{15}$$

A = **Rs 4,15,786**

Example 2.2: Determine the amount to be invested in a company to receive Rs 1 million after 20 years based on an interest rate of 7.5% compounded annually.

Given that:

A = Rs 10,00,000

r = 0.075

n = 20 years

Using: $$P = \frac{A}{(1+r)^n} = \frac{10,00,000}{(1+0.075)^{20}} = \textbf{2,35,413.15}$$

Thus an amount of **Rs 2,35,413.15** can earn Rs 1 million after 20 years at a compound interest of 5%.

Example 2.3: A financial company provides a loan of Rs 10 million to a power generating company. The recovery of the borrowed amount is agreed after the 5th year. What interest rate the company has to impose in order to compensate for 4% inflation, 5% services and taxes and a company profit of 6.5% per annum and the repayable amount.

Given that

P = Rs 10,000,000

n = 5

The interest rate r is fixed by the company on the basis of inflation, taxes and profit, which is obtained by summing up these components:

$r = 0.04 + 0.05 + 0.065 = 0.155$ or 15.5%

The amount loaned is Rs 10×10^6. During the period till recovery, the value of this returned amount R after 5 years can be calculated by using equation 2.3 in the form of:

$$R = P(1 + r)^n$$

$$R = 10 \times 10^6 (1 + 0.155)^5 = \text{Rs } 20,554,642.20$$

Example 2.4: A power generating company needs to invest an amount for its security. Determine the amount to be invested at the end of each year in a financial company for 10 years to accumulate Rs 100,00,000 on an interest rate of 5%.

Given that:

A = Rs 100,00,000 = Rs 10×10^6

$r = 0.05$

$n = 10$ years.

The amount P to be deposited each year for 10 years of investment with the company to accumulate amount A will be:

$$P = A\left[\frac{r}{(1+r)^n - 1}\right]$$

$$P = 10 \times 10^6\left[\frac{0.05}{(1+0.05)^{10} - 1}\right]$$

$$P = \text{Rs } 7,95,045.75$$

Example 2.5: Calculate the total accumulated amount after 15 years by investing Rs 200,000 yearly by a small electrical distribution company with a financial company at an interest rate of 5%.

Given that:

P = Rs 200,000

$r = 0.05$ and $n = 15$ years

Using $A = P\left[\frac{(1+r)^n - 1}{r}\right] = 200000\left[\frac{(1+0.05)^{15} - 1}{0.05}\right] = 43,15,713$

The accumulated amount after 15 years will be Rs 43,15,713.

2.6. Depreciation

A non-cash expense that reduces the value of an asset as a result of wear and tear, age, or obsolescence is referred to as depreciation and is denoted by *D*. Most assets loose their value over a span of time (in other words, they depreciate), and must be replaced when the end of their useful life is reached. The value of the asset at the end of its useful life is referred to as a scrap value and is generally denoted by *S*. There are several accounting methods that are used to calculate the depreciation cost of an asset over the period of its useful life. Because it is a non-cash expense, depreciation lowers the reported earnings of a company while increasing free cash flow. Depreciation is also referred to the decline in the value of a given currency in comparison with other currencies. For instance, if the rupee depreciates against the US dollar, buyers would have to pay more rupees in order to obtain the original amount of dollars before depreciation occurred. The depreciation depends on the inflation and interest rates and also on the value of the shares of the company in financial market or stock exchange. The calculation of depreciation is based on the scrap value. If *P* is the initial cost or capital value of an equipment and *S* is the scrap value. Then the depreciation over *n* number of use service life of the equipment is:

$$D = \frac{P - S}{n} \qquad 2.8$$

2.7. Salvage Value

Salvage value of the equipment or machinery is the estimated residual value of a depreciable asset or property at the end of its economical or useful life.

The salvage value can therefore be considered as equal to the scrap value. Initially used by shipping companies, the term salvage also refers to both the act of rescuing cargo in peril at sea, and to the liability for expenses and monetary reward owed to the rescuer by the owner of the carrier.

In general, it is the value of a piece of equipment or other property after it has been functionally rendered useless for the purpose for which it was intended. In the case of a totally wrecked automobile, for example, it is the depreciated value of whatever usable parts that can be resold in used condition, plus the value, for example, per kilogram of the remaining scrap metal. In maritime law its compensation for a service voluntarily given to a vessel in peril that removes it from danger by the sea. In insurance law, the first definition applies; with the condition that the amount of salvage is deducted from what is paid to the insured.

In all methods for determining depreciation (except the double declining balance depreciation method) salvage value is deducted from the purchase price of asset. When the cost of an asset is less, its accumulated depreciation equals its salvage value; then no more depreciation may be considered.

Example 2.6: A 100kVA distribution transformer costs Rs 2,30,000 and has an estimated useful service life of 25 years. Find the annual depreciation amount, assuming that the scrap value of the transformer to be Rs 20,000.

Given that:

$P = 2,30,000$

$S = 20,000$

$n = 25$ years

Depreciation: $D = \frac{P-S}{n} = \frac{2,30,000-20,000}{25}$ = **Rs 8,400 annually.**

Example 2.7: A 10 MVA generator of a power generating company costs Rs 10 million, has a useful service life of 30 years is depreciated by 3% annually. It is estimated that cost of the same rating equipment due to inflation and recession will increase by 25% after 30 years. Calculate the scrap value of the equipment and the additional amount needed by the company to replace the same rating generator at the end of its useful life.

Given that:

$P = 10 \times 10^6$

n = 30 years of useful life.

Since the equipment is depreciated by 3% annually, the depreciated amount each year will be:

$D = 0.03 \times 10 \times 10^6$ = Rs 3,00,000

Using: $D = \frac{P-S}{n}$

Or $S = P - nD$

$S = 10\times10^6 - 30\times300000$= **Rs 10,00,000**

At the end of the useful life of the equipment, the company has to replace it by spending an amount, keeping in view the inflation. Beside the amount as the scrap value, the company will require an additional amount of:

$10\times10^6 + 0.25(10\times10^6)$ = Rs 12,500,000

12500000–1000000= **Rs 11,500,000**

This additional amount can be recovered through tariff to the consumers during the course of useful life of the generator.

Example 2.8: A 50Hz, 10 MVA generator of a power generating company costs Rs 10 million, has a useful service life of 25 years. It is estimated that the power demand after the end of its useful life will have risen to 18 MVA. The estimated cost of the generator provided by the manufacturer after 25 years will be Rs 800,000 per MVA. The scrap value of the equipment is estimated to be Rs one million. Calculate the annual depreciation and salvage amount if the power company intends to make an annual profit of 10% of the capital cost. Determine the cost of electricity unit to the consumer if 60% percent of generation is used on the average at a power factor of 0.85 lagging and the company spends Rs 12,00,000 on fuel and 50,00,000 as running expenditure per year.

Given that:

$P = 10 \times 10^6$

$S = 1 \times 10^6$

n = 25 years of useful service life.

Using: $D = \frac{P-S}{n}$

$$D = \frac{(10-1)\times 10^4}{25} = 0.36 \times 10^6$$

Annual cost of depreciation of the equipment = **Rs 3,60,000.**

For 60% of generation utilized on the average, the number of units dispatched by the company:

$$E = 10 \times 10^3 \times 0.85 \times 0.6 \times 8760 = 44.676 \times 10^6 \text{ kWh}$$

Amount spent annually on up keeping = C_1 = Fuel cost + Running expenditure.

$$= 1.2 \times 10^6 + 5 \times 10^6$$

$$= 6.2 \times 10^6$$

Profit per annum of the company is 10% of the capital cost, which is:

$$\text{Profit} = C_2 = 0.1 \times 10 \times 10^6 = 1 \times 10^6.$$

After the end of its useful life, the generator has to be replaced by a new one with rating of 18 MVA (since the demand would have risen to this value after 25 years). The cost of generator of 18 MVA rating will cost: 18 x 800000 = Rs 14.4 x 10^6. The salvage amount will be this amount (Rs 14.4 x 10^6) minus the scrap value:

$$C_3 = (14.4 - 1) \times 10^6 = 13.4 \times 10^6$$

Total cost: $C = C_1 + C_2 + C_3 = (6.2 + 1 + 13.4) \times 10^6 = \text{Rs } 20.6 \times 10^6$

$$\text{Cost of electricity} = \frac{20.6\times 10^6}{44.676\times 10^6} = \textbf{Re 0.46 = 46 p/kWh.}$$

2.8. Taxes

A tax is an involuntary fee paid by individuals or businesses to a government. Taxes may be paid in cash or kind (although payments in kind may not always be allowed or classified as taxes in all systems). The means of taxation and the uses to which the funds raised through taxation are generally a matter of hot dispute in politics and economics. The resource taken from the public through taxation *P* is always somewhat greater than the amount *G*, which can be used by the government. The difference is called compliance cost *C*, and includes for example the service cost and other expenses incurred in complying with tax laws and rules.

$$C = P - G$$

2.9

Taxes are most often levied as a percentage, called the tax rate of a certain value, the tax base (how much income and assets one has, earns, spends, inherits, etc). An ad-valorem tax is one where the tax base is the value of a good, service, or property. Sales taxes, tariffs, property taxes and value added taxes are different types of ad-valorem tax. An ad-valorem tax is typically imposed at the time of a transaction such as; sales tax or value added tax (VAT) but it might be imposed on an annual basis (property tax) or in connection with another significant event (inheritance tax or tariffs). The alternative to ad-valorem taxation is a fixed rate tax, where the tax base is the quantity of something, regardless of its price. An important feature of tax system is as follows:

1. Flat: The percentage does not depend on the base, hence the tax is proportional to how much you earn, have, or spend.
2. Regressive: The more you have the lower the tax rate.
3. Progressive: The more you have the higher the tax rate.

Progressive taxes tends to reduce the tax burden of people with smaller incomes, since it take a smaller percentage of their income. Taxes are also sometimes referred to as:

1. Direct.
2. Indirect.

In economics, direct taxes refer to those taxes that are paid by the people or organizations on which they are imposed. For example, the person who earns the income pays income tax. By contrast, the cost of indirect taxes is borne by someone other than the person responsible for paying them. For example, taxes on gasoline if included in the price of the items, so even though the seller sends the payments to the government, the buyer is the real payer. Indirect taxes are

sometimes described as hidden taxes because the purchaser of goods or services may not be aware that a proportion of the price is going to the government. Thus, a tax on the sale of property would be considered an indirect tax, whereas the tax on simply owning the property itself would be a direct tax.

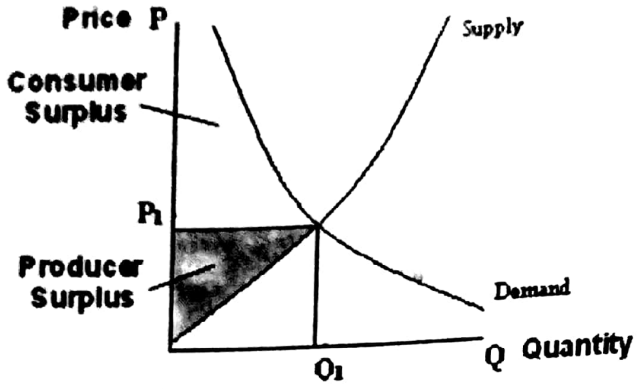


Figure 2.1: Equilibrium without Tax

Figure 2.1 indicates goods without any government interference. These goods could represent anything from televisions to labour. At this equilibrium, quantity Q_1 of the goods are sold at price P_1. The consumer and producer surplus are both high.

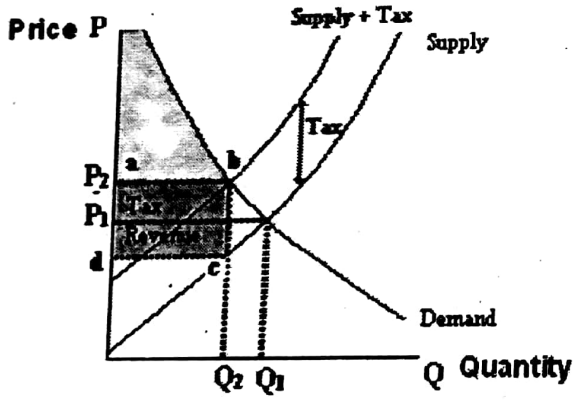


Figure 2.2: Equilibrium with a tax

Figure 2.2 shows the introduction of a very simple tax. The tax is charged whenever a consumer wishes to purchase a product. The price thus rises to P_2, and since fewer consumers wish to purchase the product at the higher price, the

quantity produced falls to Q_2. The government receives the amount of the tax for each unit sold, and this amounts to the region shown as *abcd*. This is the amount of revenue the government receives from the tax. As shown in figure 2.2, in this situation the price of the product to consumers' only increases by half the amount of the tax, the other half of the tax is borne by the producer. Thus both consumer and producer surpluses shrink by equal amounts. For many products this is not the case. Who bears the cost of the tax is determined by the elasticity of the product. For inelastic goods like cigarettes, and petroleum products (gasoline, kerosene, diesel and lubricating oils) the consumer pays almost all of the tax. Almost all taxes are a percentage of the cost of the goods and are therefore progressive. This is especially true with income taxes. A tax is not a simple transfer of wealth from producers and consumers to government. A permanent loss of surplus available to society occurs, shown as region *abc* in figure 2.3. This inefficiency loss is often called dead weight loss or the excess burden of taxation. This shrinkage of the surplus available to society is a reason why many economists dislike taxes.

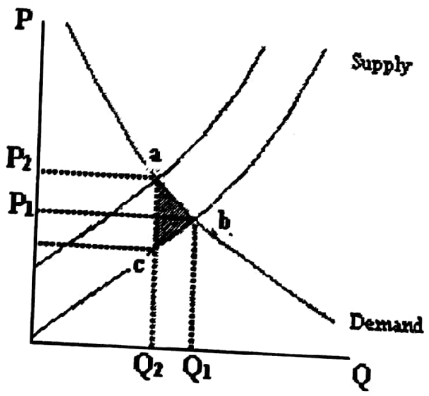


Figure 2.3: Net Societal Loss

2.9. Types of Taxes

With the rapid development in industrial and commercial sectors and the further demand for more and more products, a variety of taxes have been introduced to help financial and economic stability. The subject of finance is a complex relationship between money circulation, spending and production. A

simple way of looking at the taxes is whatever we pay; we are re-paid in some other form. In the following sections, some of the several type of taxes are discussed briefly

2.9.1. Income Tax

Income tax is commonly a progressive tax because the tax rate increases with increasing income. For this reason, it is generally advocated by those who think that taxation should be borne more by the rich than by the poor, even to the point of serving as a form of social redistribution. Income tax may be collected from legal persons (companies) as well as natural persons (individuals). Some critics characterize this tax as a form of punishment for economic productivity. Other critics claims that taxation of income is inherently socially intrusive because enforcement requires the government to collect large amounts of information about business and personal affairs, much of which could be considered proprietary. Where income tax is not collected at source, it may become easier to cheat by lying about one's affairs. Income tax fraud is a problem in most, if not all, countries implementing an income tax. Either one fails to declare income, or declares nonexistent expenses. Failure to declare income is especially easy for non-salaried work, especially if paid in cash. The government may then require that employers report the amounts they pay to employees. Tax fraud is common way of dodging the authority by not showing the actual amount of goods sold or the company's loss figures are exaggerated.

Income tax, in addition to income, generally takes into account a variety of factors. Certain expenses, such as work-related expenses, donations to charities etc, may be tax-deductible; that is, they are subtracted from the taxable revenue. Exemptions, rebates etc, income tax codes tend to be complicated. Tax enforcement authorities, such as Federal Board of Revenue (FBR) in Pakistan fight tax fraud using various methods, nowadays with the help of computer databases prepared by National Data-Base Regulatory Authority (NARDA).

2.9.2. Capital Gains Tax

A capital gain tax is the tax levied on the profit realized upon the sale of an asset. In many cases, the amount of a capital gain is treated as income and is subject to the marginal rate of income tax.

2.9.3. Poll Tax

A poll tax, or capitation tax, is a tax that levies a set amount per individual. Poll taxes are regressive, since they take the same amount of money and hence a higher proportion of income for poorer individuals as for richer individuals. Poll taxes are difficult to cheat. A poll tax may also be called as a payroll tax.

2.9.4. Excises

An excise is a type of ad-valorem tax that is imposed at the time of a purchase or sale transaction (sales tax or value added tax) or in connection with importation across a political border. The tax base may be the purchase price or the declared value, or some standard estimate of a fair price. For example, the sales tax on used automobile purchases in several countries is determined with reference to a published list of prices. The purchase price may be disregarded.

Excises on particular commodities are frequently hypothecated. For example, a fuel excise is often used to pay for public transportation, especially roads and bridges and for the protection of the environment. A special form of hypothecation arises where an excise is used to compensate a party to a transaction for alleged uncontrollable abuse; for example, a blank media tax is a tax on recordable media such as CD-ROM, whose proceeds are typically allocated to copyright holders. Critics claims that such taxes blindly tax those who make legitimate and illegitimate usages of the products; for instance, a person or corporation using CD-ROMs for data archival should not have to subsidize the producers of popular music. Excises (or exemptions from them) are also used to modify consumption patterns. For example, a high excise duty on

cigarettes is used to discourage their use, relative to other goods. Another example is a carbon tax, which is a tax on the consumption of carbon-based non-renewable fuels, such as petrol, diesel-fuel, jet fuels and natural gas.

2.9.5. Sales Tax

Sales taxes are a form of excise levied when a commodity is sold to its final consumer. They are generally held to discourage retail sales. The question of whether they are generally progressive or regressive is a subject of much controversial debate. It is customary to exempt food, utilities and other necessities from sales taxes, since people spend a higher proportion of their incomes on these commodities, so such exemptions would make the tax more progressive. A common practice of cheating on sales tax is to ask a merchant or service provider for a cash discount. The merchant pockets the cash and writes off the merchandise to shrinkage and the state fails to get the tax.

2.9.6. Value Added Tax (VAT)

A value added tax (sometimes called a goods and services tax, as in Australia and Canada) applies the equivalent of a sales tax to every operation that creates value. For example, machine manufacturer imports sheet steel, will pay the VAT on the purchase price, remitting that amount to the government. The manufacturer will then transform the steel into a machine, selling the machine for a higher price to a wholesale distributor. The manufacturer will collect the VAT on the higher price, but will remit to the government only the excess related to the "value added" (the price over the cost of the sheet steel). Most countries levies VAT on luxury items and electronic goods, such as automobiles, television sets etc. Economists have argued that this minimizes the market distortion resulting from the tax, compared to a sales tax. However, VAT is held by some to discourage production; for example on firearms, liquor, cigarettes etc. Personnel computers, for example may be exempted from VAT in order to encourage its use in education sectors.

2.9.7. Property Taxes

A property tax is usually levied on the value of property owned, usually real estate. Property taxes may be charged on a recurrent basis, or upon a certain event. A common type of property tax is an annual charge on the ownership of real estate, where the tax base is the estimated value of the property or in case of leased or rented property, the base may be percentage of rented or leased income. The two most common types of event driven property taxes are stamp duty, charged upon change of ownership, and inheritance tax, which is imposed in many countries on the estates of the deceased. In many countries, a contract needed to have a stamp affixed to make it valid. The charge for the stamp is either a fixed amount or a percentage of the value of the transaction.

2.9.8. Wealth (Net- worth) Tax

This refers to the net value of assets, the ones owned solely by individual or company or group of companies. The government of many countries will require declaration of the taxpayer's balance sheet (assets and liabilities), and from that ask for a tax on net worth (assets minus liabilities), as a percentage of the net worth, or a percentage of the net worth exceeding a certain level. The tax is in place for both "natural" and in some cases legal "persons".

2.9.9. Toll Tax

Toll tax is a charged for a privilege or facility, especially for passage across a bridge or along a road. Toll tax is generally levied on expressways, motorways, freeways and superhighways on which tolls are collected at exit points. Commercial vehicles, freight trucks and private vehicles are charged differently.

Example 2.9: An individual draws a salary of Rs 45,000 per month has to pay Rs 1000 as annual tax with vehicle registration renewal fee on his car and donated Rs 5000 as charity to a

government registered orphanage. The tax base is 3% on the first Rs 300,000 and 4.5% above this amount. If Rs 1200 per month as income tax is deducted at source, calculate the gross tax and net tax to be paid by the individual.

Annual income of the individual = $C_1 = 45000 \times 12 =$ Rs 5,40,000

Taxable income: $C_2 = C_1 - 5000 = 540000 - 5000 =$ Rs 5,35,000

Tax deducted from income per year at source: $T_1 = 1200 \times 12 =$ Rs 14,400

Tax paid with vehicle registration renewal fee: $T_2 =$ Rs 1000

Gross tax: $T_3 = 0.03 \times 300000 + 0.045(535000 - 300000) =$ **Rs 19,575**

Net tax: $T_4 = T_3 - T_2 - T_1$

$= 19575 - 1000 - 14400 =$ **Rs 4,175**

2.10. Insurance

The normal activities of daily life carry the risk of enormous financial loss. Many companies and persons are willing to pay a small amount for protection against certain risks. The term insurance describes any measure taken for protection against risks. Insurance is a contract, or policy, whereby, for a stipulated consideration, one party (the insurer or underwriter) promises to compensate the other (the insured or assured) for loss on a particular subject of interest by specified perils or risks. Insurance are of two types: general and life. General insurance refers to all types of insurance other than life insurance, which pays for loss or damages to physical property, and for loss or injury to another party. General insurance divides into personal lines, for individuals, and commercial lines, for business owners. In insurance, the insured makes payments called "premiums" to an insurer, and in return is able to claim a payment from the insurer if the insured suffers a defined type of loss. This relationship is usually drawn up in a formal legal contract, also known as a policy. The policy will specify the perils insured against, limits of insurance and deductible. The contract will set out in detail the exact circumstances under which a benefit payment will be made and the amount of the premiums. When insurance takes the form of a contract in an insurance policy, it is subject to

requirements in statutes, administrative agency regulations, and court decisions. As such all power station equipments and personnel must be ensured against damage by fires, accidents and loss.

Insurance attempts to quantify risk by pooling together a large number of risks. This makes use of the law of large numbers. As applied to insurance, this means that the greater the number of similar risks, the greater accuracy with which insurers can estimate the overall risk. The business of insurance is sustained by a complex system of risk analysis. Generally, this analysis involves anticipating the likelihood of a particular loss and charging enough in premiums to guarantee that insured losses can be paid. Insurance companies collect the premiums for a certain type of insurance policy and use them to pay the few individuals who suffer losses that are insured by that type of policy. When an insured suffers a loss or damage that is covered in the policy, the insured can collect on the proceeds of the policy by filing a claim, or request for coverage, with the insurance company. The company then decides whether or not to pay the claim. The recipient of any proceeds from the policy is called the beneficiary. The beneficiary can be the insured person or other persons designated by the insured. A contract is considered to be insurance if it distributes risk among a large number of persons through an enterprise that is engaged primarily in the business of insurance. Warranties or service contracts for merchandise, for example, do not constitute insurance, since they are not issued by insurance companies, and the risk distribution in the transaction is incidental to the purchase of the merchandise. Warranties and service contracts are thus exempt from strict insurance laws and regulations.

Insurance companies also earn investment profits, because they have the use of the premium money from the time they receive it until the time they need it to pay claims. This money is called the float. When the investments of float are successful, they may earn large profits, even if the insurance company pays out in claims every penny received as premiums. In fact, most insurance companies pay out more money than they receive in premiums. The excess amount that

they pay to policyholders is the cost of float. An insurance company will profit if they invest the money at a greater return than their cost of float.

2.11. Tariff

Charge to the consumer is on the basis of certain set of rules known as tariff. In a power system, the company structures electricity tariff or simply tariff for consumers for buying electricity from a company and the options and facilities other than electricity consumption made available. An electricity tariff highlights electricity pricing, which is a schedule of prices that relate to the receipt of electricity from a specific supply company. In areas where there is more than one electricity supply company authorized to offer commercial or residential services, there is also the chance that the exact price or tariff charged by each competing supply company will vary slightly. The price range for the electricity tariff is structured so that it complies with any local government agency charged with the oversight of utility pricing within that jurisdiction. Regulatory agencies, such as National Electric Power Regulatory Authority (NEPRA) in Pakistan often require that power companies provide detailed documentation regarding those costs of operation as a means of justifying a request for a price increase.

Several different factors help determine the electricity tariff that apply in a given locality. Cost of operating and maintaining the facilities of power generation and supply must be considered. The raw materials and type of equipment used in the power generation process have a direct impact on the costs that the supply company has to bear while producing power for sale to consumers. Besides the type of equipment and materials used to generate electric power, the number of available consumers within a given area may also affect an electricity tariff. In areas where much of the territory covered by the power company is sparsely populated, the supply company will be expecting a lower return on each unit of power produced. In order to ensure that the operation is profitable enough for the company to remain in business, the electricity prices will be comparatively higher.

Sometimes government subsidies are often granted to offset the difference. As the population of the area grows and the supply company acquires more customers, those subsidies are sometimes reduced incrementally as the need for government assistance decreases.

In some areas of the country, seasonal shifts in temperature have a profound effect on electricity tariff. For example; during months when the weather is relatively mild and consumers require less power for heating or cooling, the rates may either increase or decrease, based on the policies of the company and standards set by the regulatory authority. During the months when the weather conditions require heating and cooling, a similar change in the pricing may take place, with some power supply companies reducing pricing due to the increased demand and others increasing the pricing for the same reason.

An important factor that can affect the electricity tariff is the type of consumer that is served by the power supply company. In many countries, there is one pricing schedule for commercial and industrial consumers and a different schedule for residential consumers. A power supply company may also take into consideration the type of industry of a given business when determining the rates or pricing that a particular commercial or industrial consumer is charged. For example, electricity at relatively cheaper rates should be provided to food industry and textile mills in order to ensure that food and textile items are available at reduced prices. Otherwise, higher rates of electricity to such industries would encourage the commercial community to increase their prices and or reduce their production. On the other hand, there are industries, which reduces the overall power factor of the system, such as those using large induction motors or induction type furnaces for scrap melting, may be charged at a relatively higher rates. Typically, the objective of the supply company is to set an electricity tariff that provides the business community with reasonable amount of profit and maintaining a coordination of 'give and take' relationship between different consumers, while remaining in compliance with all laws and standards set by regulatory authorities. Electricity tariff must not be exploited to produce a

"tug of war" situation between the consumers and government. Adequate margin for variation in fuel price must be addressed in tariff. Other liabilities, such as license fee of television, except for the facilities provided by the electric supply company, must not be included in electricity tariff. On the other hand withholding tax may be included in tariff, which is paid to the government. However, charging consumers with relatively higher rates during peak hours can be worked out suitably in order to improve the load factor or in areas of limited generation. Compensation must be provided in areas where system load factor can be improved while power factor maintained within allowable limits.

An energy tariff may be imposed on the sale or purchase of oil, coal, and gas for generation of electric power. Energy products can be taxed at significantly different rates from country to country. Even within the same country, energy tariff rates can vary widely from province to province. In order to promote sustainable energy, some countries have policies t. offer individuals and entities energy tariff credits for using renewable energy resources in order to reduce the use of conventional fuels and prefer clean energy for better environment. Tax breaks are given to companies for using renewable energy equipment or adopting sustainable business practices. For example, individuals or communities using solar, wind, or bio-fuels as energy sources may receive tax credits in some countries. Some countries attempt to reduce the use of non-renewable energy sources by levying energy tariffs on non-renewable energy products, such as petroleum or natural gas.

Regulations, customs tariffs, and restrictions often apply to energy products that are imported or exported between countries. Before importing or exporting energy products between countries, importers and exporters must understand whether any import tariffs or export tariffs will apply to the transaction. An energy export tariff is a type of customs tariff imposed on energy products brought into a country. An energy import tariff, on the other hand, may be imposed on energy sources benefiting a country. These types of tariffs are

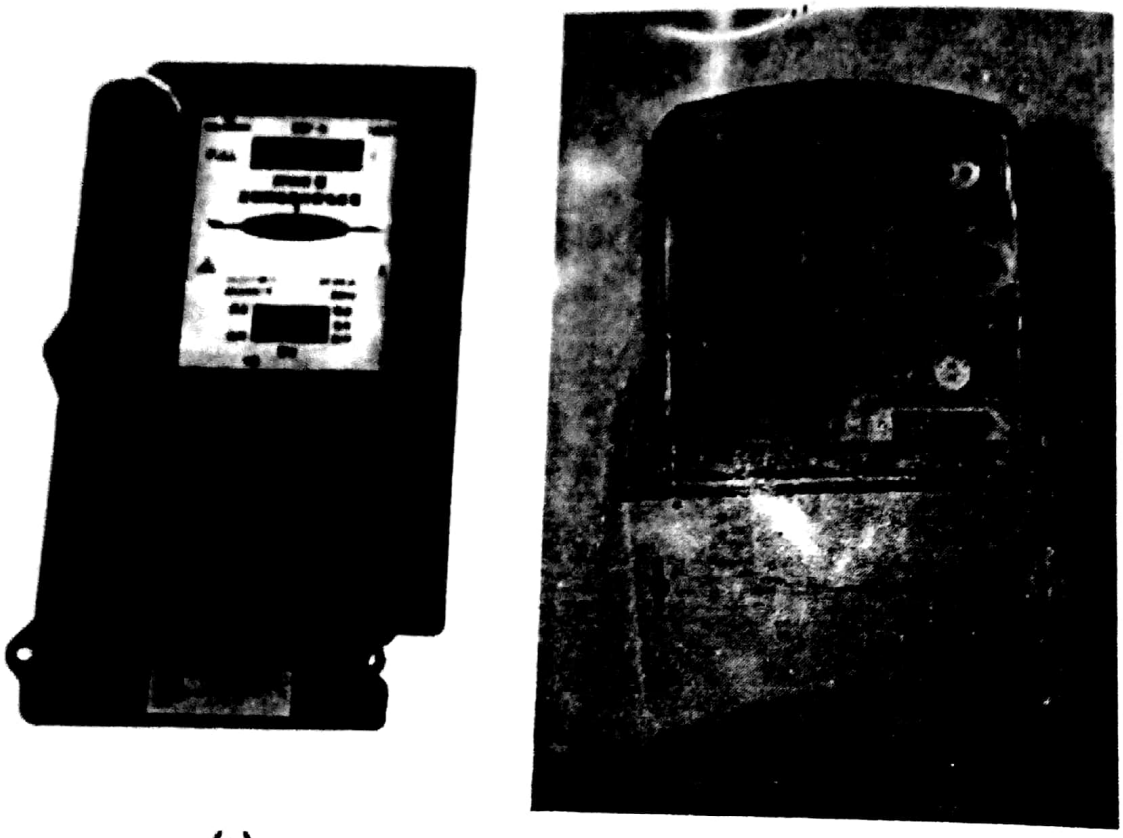
often either trade-specific or product-specific. In order to comply with import and export laws, importers and exporters may need to obtain country-specific certifications, licenses, or documentation. Preferential duty rates may apply to some energy products, depending on whether any preferential trade agreements exist between the countries involved in the energy import or export transaction. In the international energy trade market, many countries use a standardized tariffs schedule when assessing energy tariff rates. These kinds of schedules can help simplify trade tax calculations. Additionally, a standardized tariff schedule can help ensure the correct rates are levied on energy products by allowing countries to classify energy products using internationally standardized names and numbers.

2.12. Types of Tariff

In a power system, tariff is charged in the form of bill on monthly or term basis. Tariff may be a plain, two or three part. Except for a simple plain tariff, the two and three part tariff consists of two components; variable component, based on the actual unit being consumed and a fixed component, based on installed load capacity or maximum demand or both. In a plain tariff it is the cost of electricity units in terms of kWh (1 unit = 1 kWh) actually used by a consumers' are charged in the bill and therefore only consists of variable component. The units in terms of kWh are registered by the energy meter installed at consumer premises. Figure 2.4 shows typical energy meters.

Sometimes a supply company may offer a flat rate tariff in certain areas in which case the consumers are charged a fixed amount irrespective of the amount of electricity units they consume. This is not very common in Pakistan, but the Tribal Electric Supply Company (TESCO) of Pakistan charges some groups of consumers on a flat rate in order to discourage theft and to payback to the government. The cost of the electricity supply to the consumers may be broadly divided into fixed costs and running costs. The fixed costs are those, which have to be met irrespective of the amount of electricity supplied from the

generating station. It includes; interest on capital cost, salaries and wages, rents, taxes, depreciation of plant. On the other hand, running costs depends upon the actual amount of electricity produced and supplied. These include costs of fuel (including lubricating oils) and water, maintenance and up-keeping, replacement of equipment etc.



(a) (b)

Figure 2.4: Energy Meters

A Two-part tariff is another commonly used system, in which the charge to the consumer that is related to fixed and running costs of the supplies. For large power consumers, a two-part tariff is invariably imposed. The fixed component, however, may vary from one consumer to another, and is usually based on the number appliances connected at a consumer premises. Thus a two-part tariff contains a fixed portion, usually based on the KVA rating or kW capacity of the

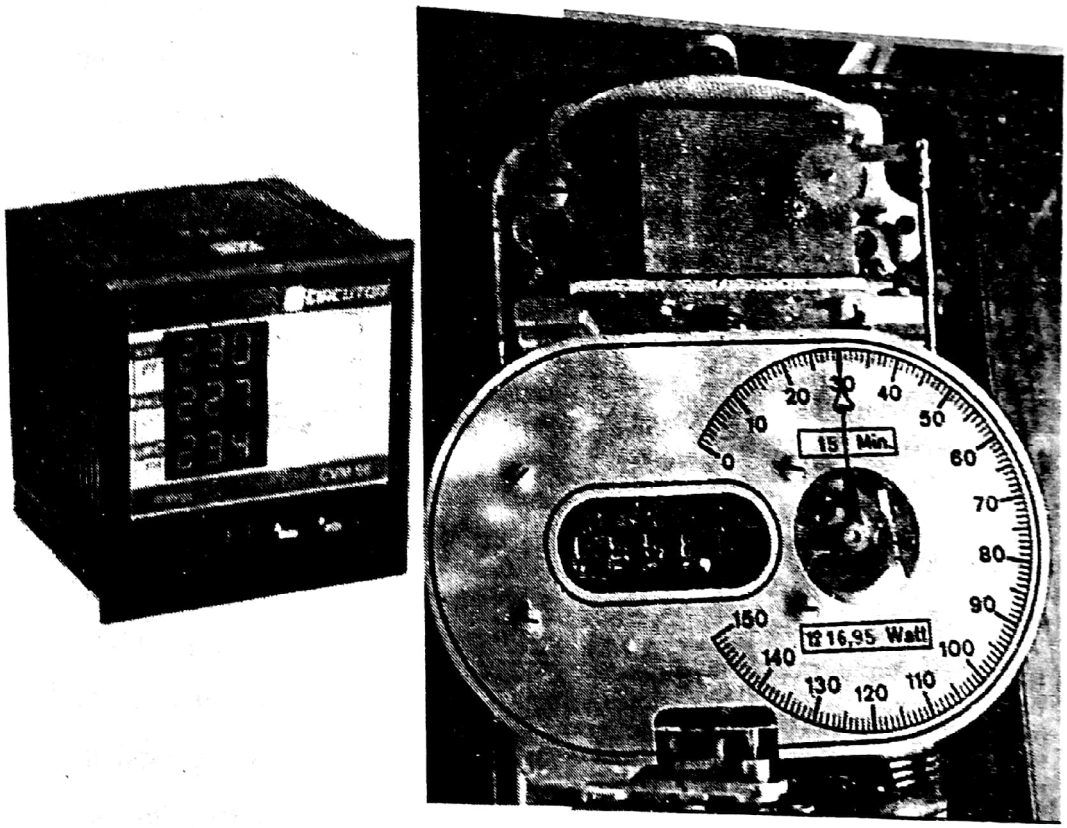
equipments installed at a consumer premises plus the variable portion based on the amount of electricity units consumed. That is:

$$Tariff = Rs\ x\ per\ kVA + Rs\ y\ per\ kWh$$

Or

$$Tariff = Rs\ x\ per\ kW + Rs\ y\ per\ kWh$$

A three-part tariff consists of a fixed part, which is either based on the kVA rating or kW capacity of the installed equipments plus the usual variable portion based on kWh consumption. Besides, it includes a portion based on maximum demand, which varies depending on the habits of use of the equipments by the consumer. Maximum demand figures can be obtained for a consumer by installing maximum demand indicator on the distribution transformer. A photograph of a maximum demand indicator is shown in figure 2.5.



(a) (b)

Figure 2.5: Maximum Demand Indicator (a) Digital (b) Analog

The formulation of a three-part tariff is as follows:

$$Tariff = Rs\ x\ per\ kVA + Rs\ y\ per\ kWh + Rs\ z\ per\ kW\ maximum\ demand$$

The fixed component of the tariff is based on the installed capacity of all the equipment at a consumer premises. The fixed portion based on kVA rating or kW capacity is always payable irrespective of whether a consumer uses or not any equipment to consume electricity. It must be noted that power factor plays an important role in reducing the fixed cost levied on the kVA rating of the installed equipment. Low power factor increases the fixed cost whereas; high power factor reduces the fixed cost in two and three-part tariff.

2.13. Objectives of Tariff

Electricity tariff forms a relationship between the supply company and the consumers. The considerations for setting of tariffs must take in to account an element of providing a reasonable basis for pricing electricity, may be divided into four main groups; socio-economic, political, technical and financial. Inevitably, these four groups cannot be considered independently and more often there are conflicts between two or more of these. The economic principles are inclined to be the most important, and tend to be influenced by theories developed to account for observed or anticipated situations. Since it is not possible to lay down a norm for human behaviour, the designer of tariff is obliged to make various assumptions in formulating tariff, while recognizing the element of doubt that arises from these assumptions. The socio-political aspects, on the other hand, are determined by public opinion, rather than by theory and reasoning. Those matters determined by public opinion may often overrule economic considerations, and are outside the designer's competence. Public opinion is extremely difficult to define and can be influenced by consumer education. In dealing with financial considerations, the designer of tariff is mainly concerned with the practice of recording and supervising the financial aspects of the day-to-

day operation of the electricity supply company, of finding practical methods to ensure that consumers are charged for and pay for their electricity consumption and the like. It is necessary that the electricity tariffs should reflect correctly the cost of production of electricity.

Tariff structure is essentially intended to recover fixed and variable costs in the generation, transmission and distribution of electricity. Particular emphasis is laid on the method of production or generation. Not only do these different methods of generating electricity have widely varying average and marginal costs of production, but they also vary substantially in the proportions of fixed and variable costs. Consequently, the overall cost structure as it affects tariff will change as the proportion between these methods of production changes. For example, the cheapest form of energy is from hydropower, although it requires high capital investment. Gas turbines and diesel generators, on the other hand, do not need such high capital investments. However, their operating costs are extremely high depending on the prize of fuel. If electricity is produced using more gas turbines and Diesel plants and less amount of hydropower, the high operating costs will have to be recovered by means of tariffs. This is why the introduction of fuel adjustment charges is necessary to be incorporated in tariff from time to time. The major objectives of setting tariff to charge consumers are as follows:

1. Recovery of cost of electricity produced at the power station.
2. Recovery of the cost of capital investment in transmission and distribution systems.
3. Recovery of the cost of operation and maintenance.
4. A suitable profit on the capital investment.

2.14. Features of Tariff

Electricity is the need of everypne in present times. In-fact there is no sector without electricity since it provides the most flexible form of energy.

Sometimes, a consumer can get confused and is unable to decide about the tariff with which he is charged. In case of areas where there are a number of electric power supply companies in operation, which company to choose is often a big question? The tariff must have the following salient features:

1. Proper Return.
2. Fairness.
3. Simplicity and Understandability.
4. Reasonable Profit.
5. Attractive.

Example 2.10: The average demand of a consumer is 40 A at 230 volts at unity power factor. His total energy consumption annually is 10,000 kWh. If the unit rate is Rs 2 per kWh for the first 500 hours use of the demand per annum plus Re 1 for each additional units. Calculate the annual bill of the consumer and equivalent flat rate.

Given that:

Energy: E = 10000 kWh

Current: I = 40A

Voltage: V = 230 volts

The power demand of the consumer is: $P = VI\cos\phi$ = 230 x 40 x 1 = 9200 W or 9.2 kW. Electricity consumption for the first 500 hours is: 500 x 9.2 = 4600 kWh. Since the cost of electricity is Rs 2 per kWh of for the first 500 hours, therefore the consumer has to pay:

4600 x 2 = Rs 9200

For the remaining units, that is: (10,000 – 4600) = 5,400, consumer has to pay:

5400 x 1 = Rs 5400

Annual bill is therefore: 9200 + 5400 = **Rs 14,600**

The flat rate equivalent is: $\frac{14600}{10{,}000}$ = **Rs 1.46 per kWh.**

Example 2.11: An electric supply company generates 100 MW and $\cdot\cdot\times 10^6$ units are received annually by a load center with an aggregate demand of 130 MW. The transmission and distribution system losses amounts to 15% based on the units received. The annual expenses of

the company are: Fuel and operating cost: Rs 90,00,000. Fixed charges including interest, depreciation and insurance on the capital amount: Rs 35,00,000 and fixed charges on transmission and distribution of Rs 36,00,000. Assume 90% fuel cost is essential to miscellaneous and maintenance. Work out a two-part tariff on the basis of fixed and operational (running) cost to find the actual cost of electricity.

In a two-part tariff, the fixed cost refers to the cost per kW or kVA and the second part refers to the running or operation and maintenance cost.

Annual Fixed Charges:

Depreciation with insurance and interest = Rs 35,00,000

Cost of transmission & distribution = Rs 36,00,000

Total fixed charges are obtained by summing the above figures. Thus the total fixed charges are: Rs 71,00,000. Therefore:

$$\text{Cost per kW of demand: } = \frac{71{,}00{,}000}{130{,}000} = \textbf{Rs 54.61 / kW / annum}$$

Annual Running Charges:

Operation and maintenance charges = 0.9 x 90,00,000 = Rs 81,00,000

Fuel and operating cost = Rs 90,00,000

Total running cost = 8100000 + 9000000 = Rs 1.71×10^7

Transmission line losses = $0.15 \times 30 \times 10^6 = 4.5 \times 10^6$ kWh

Number of units dispatched = $30 \times 10^6 + 4.5 \times 10^6 = 34.5 \times 10^6$

$$\text{Cost per unit of electricity} = \frac{1.71 \times 10^7}{34.5 \times 10^6} = \textbf{Rs 0.49 / kWh.}$$

To round up, the two-part tariff is = **Rs 55 / kW + Rs 0.50 / kWh per annum.**

Example 2.12: An electricity supply company offers electricity on the basis of fixed charges of Rs 100 plus Rs 3 / kWh or alternatively at a rate of Rs 4.0 / kWh per annum for the first 500 units and Rs 7.0 for the remaining units consumed. Calculate the number of units per annum for which the two tariff options will be the same.

Let us suppose that the number of units received are E kWh. Therefore, the annual charges due to the first option are:

$$C_1 = \text{Rs } (100 + 3E)$$

Annual charges of electricity due to second tariff are:

$$C_2 = \text{Rs}\,[4 \times 500 + (E - 500) \times 7]$$
$$= \text{Rs}\,(7E - 1500)$$

Comparing the two options: $C_1 = C_2$

$$(100 + 3E) = (7E - 1500)$$

Solving the equation for E, we obtain:

$$E = 400 \text{ kWh}.$$

Thus for 400 kWh, the two options would have the same features.

Example 2.13: Calculate the cost of 5×10^6 units of electricity consumed annually by an organization with a maximum demand of 1500 kW on each of the following tariffs:

(a) Two-part tariff: Rs 650 / kW of maximum demand / year + Rs 5 / kWh.

(b) Variable tariff:

For the first 250000 kWh:	Rs 8 / kWh
For the next 750000 kWh:	Rs 6 / kW
For the next 1000000 kWh:	Rs 5 / kW
For the next 150000 kWh:	Rs 4 / kW
For the remaining kWh:	Rs 3 / kWh

Given that:

Annual energy units consumed: $E = 5 \times 10^6$ kWh

Maximum demand: 1500 kWh

Part (a): Cost of electricity: $= 650 \times (1500) + 5 \times (5 \times 10^6)$

$= 975000 + 25000000 =$ **Rs 2,59,75,000**

Part (b):

For the first 250000 kWh:	$= \text{Rs } 250000 \times 8 = 2 \times 10^6$
For the next 750000 kWh:	$= \text{Rs } 750000 \times 6 = 4.5 \times 10^6$
For the next 1000000 kWh:	$= \text{Rs } 1000000 \times 5 = 5 \times 10^6$
For the next 1500000 kWh:	$= \text{Rs } 1500000 \times 4 = 6 \times 10^6$

Remaining units: $5 \times 10^6 - (0.25 + 0.75 + 1 + 1.5) \times 10^6 = 1.5 \times 10^6$

Cost of remaining units: $= 1.5 \times 10^6 \times 3 = \text{Rs } 4.5 \times 10^6$

Total cost $= (2 + 4.5 + 5 + 6 + 4.5) \times 10^6 = 22 \times 10^6 =$ **Rs 2,20,00,000**