

### Distribution Business Analysis of 11kv Feeders

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#### Abstract

Now a day's distribution system is one of the major systems in the power distribution. Now it acts like a business. In the distribution system losses are the parameters. In order to reduce the losses in the distribution we should know the distribution parameters like demand, collection and balance of the distribution system. Distribution business study gives the major components like (Average revenue demand) ARD and (Average revenue realized) ARR of the distribution

**Keywords:** Business, Distribution, Efficiency, Feeder

#### Introduction

Distribution system is part of power system network, which distributes electrical power from general utilization to the consumers. From generating station to the receiving station power is brought by using transmission from secondary substation power is brought up to the consumer's. Meter board by an electric conductor called distribution. The good distribution system should have following requirements.

1. System should be reliable i.e., should not be failure of power if it all there is power failure it should be for minimum time.
2. The rated voltage should be maintained constant.
3. Regulation should not be more than  $\pm 6\%$ .
4. The line should not be over loaded.
5. The line losses should be minimum and line efficiency should be maximum about 90%.
6. The system should be cheap and economical.
7. The insulation resistance used for insulators should be high there should not be leakage in insulators.

#### Feeder, Distributor and Service Mains

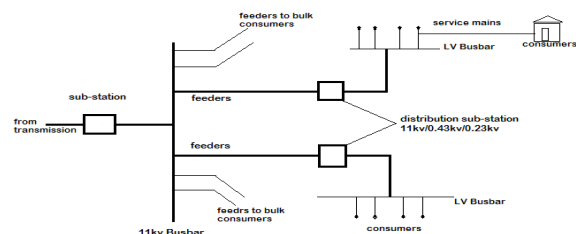
The distribution line can be further sub divided into three parts mainly feeder, distributor and service mains. Fig.1 shows single line diagram of a distribution system.

**Feeder:** feeders are transmission lines or conductors which connects substation and distribution substation or localized generating station to the area where electrical power is to be distributed. Generally

loading current of a feeder is uniform along the complete length since no tapings are taken from the feeder. The feeder's carries current in large quantity and design of feeder is mainly based on the current to be carried. The voltage drop in a feeder is compensated by using voltage regulating equipment at the substation. The feeder lines can be overhead or underground.

**Distributors:** distributors are the line or conductors which run along the street to street to supply electrical power to the consumers. The number of tapping are taken from the distributors for supplying energy to the consumer, hence in the distributor is not uniform it varies along its length while designing distributor lines voltage drop is considered as a main factor. The size of conductor used and length of distributor should be such that the consumer's voltage should not vary  $\pm 6\%$  of its rated voltage.

**Service mains:** the service mains are the connecting link between nearby distributor and consumer. For service mains insulated cable is used and it can be over head messenger wire or underground.



**Fig1. Single line diagram of distribution system**

**Classification of distribution system:** The distribution system is classified in many ways

**A. According to the type or nature of current**

a) D.C Distribution system

Generally electrical power is generated, transmitted and distributed in the form of A.C due to many advantage but in some cases like dc motor, electrochemical work, battery charging etc. For such application strictly dc supply is required where dc distribution is used. For this AC is rectified and converted into DC by motor generated set or rotary converter or mercury arc rectifier in a converting sub-station. From converting sub-station it is distributed by 2 wire or 3 wire system.

**2 wire system distribution system:** This distribution system consists of two win wires which are supplied by DC source. The outgoing wire is a positive wire and ret wire is a negative wire as shown in fig. 18.2 this system has low efficiency which cannot be used for transmission. The loads like lamps, motors etc. are connected parallel between positive and negative wires. It is generally used for one standard value of voltage.

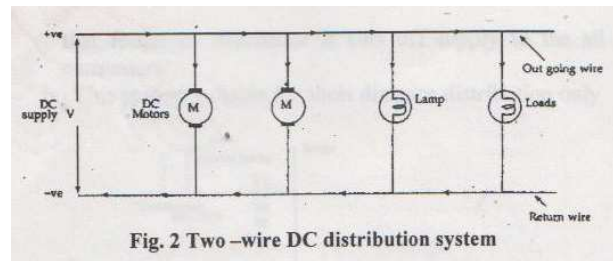


Fig. 2 Two –wire DC distribution system

**3 wire distribution system:** This system consists of three wire in which two wires are outer and one neutral wire is earthed at the substation or middle wire. The three wires are supplied from DC source and two voltage can be obtained by this method. The voltage of say V volt is available between two outer will be 2 volt. i.e double of the voltage between outer and neutral. And high voltage loads like motors etc. are connected between two outers. Fig.3 shows 3 wire DC distribution system.

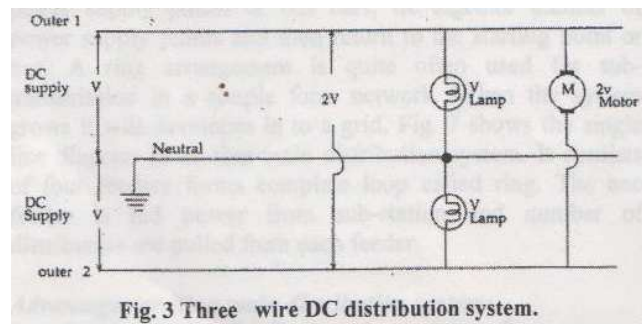


Fig. 3 Three wire DC distribution system.

b) A.C Distribution system

Most of the electrical power is generated, transmitted and distributed in the form of AC due to advantage of AC compared to DC. In ac system transformer can be used which are most efficient and economical for changing the voltage level of system. In AC system if high voltage is used then current will be reduced for same amount of power transmission due to the reduced current, voltage drop will be less and regulation will improve. At the same time line will be reduced due to which efficiency of transmission line will increases. The AC distribution is further classified in two parts namely

i. Primary distribution

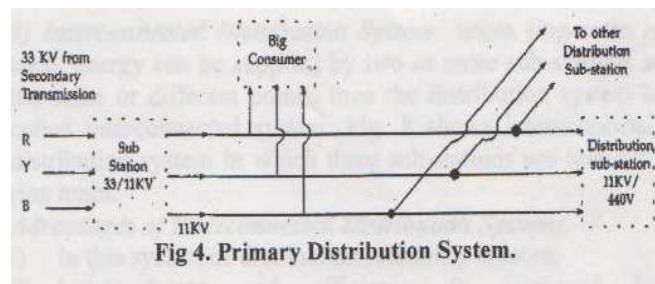


Fig 4. Primary Distribution System.

Primary distribution is a part of AC power system network. In this system line carries voltage somewhat higher than utilization voltage and handled large block of electrical power compared to low voltage consumer the voltage rating of primary distribution depends upon distance of transmission and amount of power transmitted. The common voltages in this system are 11kv, 6.6kv, and 3.3kv. The primary distribution is carried out by 3 phase 3 wire system. A fig 4 show layout of primary distribution system at sub-station voltage from 33kv is reduced to 11kv is distributed to various distribution sub-station. The big consumer can take supply directly from primary distribution line.

ii. Secondary distribution:

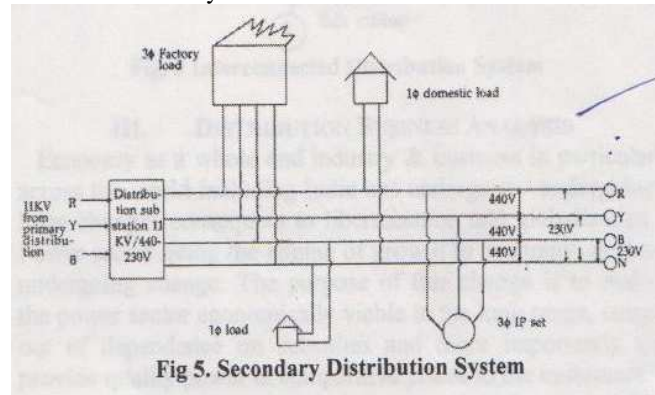


Fig 5. Secondary Distribution System

Secondary distribution is the part of AC power system network. Secondary distributions are those lines which distributes electrical energy in location where direct consumer can use this energy. The secondary distribution lines are pulled from distribution sub-station of 11kv/0.4kv and are run along the side of each and every road of the locality. The voltage rating of secondary distribution is 440V between the lines and 230V between line and neutral. The single phase domestic loads are connected between any one phase and neutral.

The three phase loads are connected across three phases either in star or delta. The secondary distribution is carried by 3 phase 4 wire system. Fig 5 shows layout of secondary distribution system.

#### B. According to the scheme of connection:

According to way of connection scheme the distribution system is classified in three ways.

- a) **Radial distribution system:** in radial system of distribution numbers of separate feeders are radiated from common single sub-station. Hence it is called radial system. This type of distribution system is used for low voltage at the center of the load. In this system all the feeders fed one end only. Fig 6 shows the single line diagram of simple radial distribution system.

##### Advantages of radial distribution system:

1. This distribution system is simple in construction and circuit arrangement.
2. The initial cost of radial distribution system is low.

##### Disadvantages of radial distribution system:

1. When load variation takes place, there is serious voltage fluctuation at the far end of the distributor.
2. The distributor near by the sub-station i.e. feeding point will be heavily loaded.
3. The consumer attached to one feeder depends only on the reliability of that feeder, if any fault takes place in that feeder or distributor it cuts off supply to the all consumers.
4. This system is suitable only for short distance distribution.

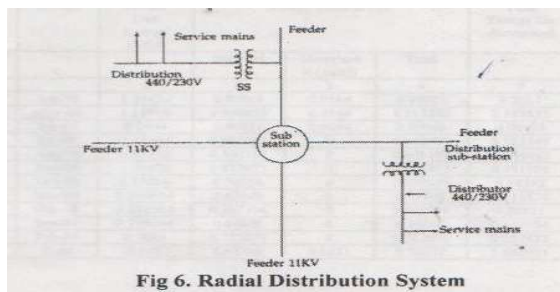


Fig 6. Radial Distribution System

#### b) Ring main distribution system:

In ring main distribution system primaries of all distribution transformers forms a closed loop. The ring is the circuit or circuits which starts from power supply points or bus bars tie together no. of power supply points and then return to the starting point or bus. A ring arrangement is quite often used for sub-transmission in simple form network. When the system grows it develops in a grid fig.7 shows the single line diagram of AC ring main distribution system. It consists of four feeder's forms complete loop called ring. The one feeder is fed from sub-station and number of distributors is pulled from each other

##### Advantages of ring main distribution system

1. In ring main distribution the voltage fluctuation at consumer terminals will be less
2. This distribution system is more reliable because each distributor is fed from two feeders. If fault takes place in any one feeder the supply can be maintained from another feeder.

##### Disadvantages of ring main distribution system:

1. The construction and arrangement of ring main distribution system is complicated.
2. This system of distribution is costly at initial stage.
- 3.

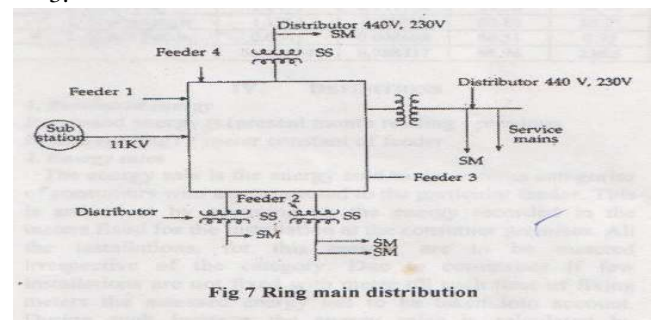


Fig 7 Ring main distribution

- c) **Interconnected distribution:** when ring main is used, energy can be supplied by two or more sub-station at the same or different points, and then the distribution system is called as interconnected system. Fig 8 shows interconnected distribution system in which three sub-stations are linked to ring main.

##### Advantages of interconnected distribution system

1. In this system of distribution reliability is more.
2. Load factor and efficiency is increased by interconnection.

A particular area fed from one station during peak load hours can be fed from other generating station.

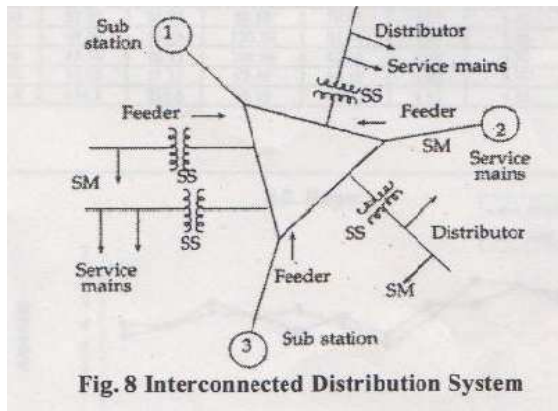


Fig. 8 Interconnected Distribution System

- C. According to the no. of wires**
- Two wire distribution system
  - Three wire distribution system
  - Four wire distribution system
- D. According to the constructional arrangement.**
- Overhead distribution system
  - Underground distribution system
- E. According to service requirements**
- General lighting and power
  - Industrial power
  - Railway and traction
  - Street lighting

### Distribution Business Analysis

Economy as a whole and industry and business in particular across the world and including India has undergone / undergoing huge changes consequent to liberalization. Power sector being engine of growth to economy, is also undergoing change. The purpose of this change is to make the power sector economically viable in the long range, come out of this dependence on subsidies and more importantly to provide quality power at competitive prices to the customers.

Generation and transmission are location specific, concentrated in small area and easily accountable. Distribution of electrical power is business that is spread over a vast area dealing with large number of customers of different categories over varying geographical areas. It also involves large number of people working in the business utility leading to dilution of focus if it is not handled properly at each level of the business for efficient accounting. 11kv feeder is considered as primary business unit in the business of distribution. Distribution business analyses carried out on each feeder discloses all the parameters connected with distribution business.

### Definitions

#### 1. Purchased energy

Purchased energy = (present month reading – previous month reading) \* meter constant of feeder

#### 2. Energy sales

Energy sales are the energy sold to the various categories of consumers who are connected to the particular feeder. This is arrived at by summing up the energy recorded in the meters fixed for the installation at the consumer's premises. All the installations for this reason are to be measured irrespective of the category. Due to constraints if few installations are not fixed with meters till such time of fixing meters the assessed energy sales is calculated by summation of metered energy and un-metered [assessed] energy.

#### 3. Un-accounted energy

Un-accounted energy = energy purchased – energy billed (metered + un-metered)

This un-accounted energy represents the energy lost due to technical and commercial loss.

#### 4. Billing efficiency

Billing efficiency = energy billed / energy purchased  
All the installations should have meters for measuring the energy accurately at the consumer premises can't be measured due to reason like door lock or faulty meters, average consumption should be taken and bills raised.

#### 5. Collection efficiency

Collection efficiency = revenue / revenue demand  
Collection efficiency should be at least 100% every month. Installations of defaulters are to be disconnected promptly in order to realize the revenue which is due to the company.

#### 6. Business efficiency

Business efficiency = billing efficiency \* Collection efficiency

The business efficiency is the efficiency at which we are operating the business of distributing the energy.

#### 7. Aggregate technical and commercial loss.

AT and C loss in % = 100 – Business efficiency in %  
It is the view that the clearest measure of overall efficiency of the difference between units input into the system and the units for which payment is collected. Losses of any kind technical, non-technical or non-realization of payment ultimately amount to loss in revenue. Efficiency gains must embrace all these aspects.

#### 8. Average revenue demand

A.R.D = Revenue demand in Rs. / energy purchased in units

It represents the average revenue for a feeder during the month.

### 9. Average revenue realized

A.R.R = Revenue collection in Rs. /energy purchased in units.

It represents the average revenue collected for a particular feeder during the month. Ideally the average revenue realized should always be equal to average revenue demand. These analyses to be carried out every month on each feeder. It has to be consolidated quarterly, half yearly, and yearly. This will indicate the technical and commercial health of the concerned unit fully and properly.

### Remedies Reducing Loss

- Un interrupted power supply.
- Replacing old age conductors
- Replacing electromechanical meters by HP meters
- Theft cases booking.
- Load on feeder should within permissible limit.

### Conclusion

- Feeder is business unit.
- Consider AE / section officer in feeder manager to make business more profitable losses should be reduced.
- Distribution system be strengthened
- Information technology should be implemented
- HRD training given to all employs of HESCOM
- Loss level should be reduced.
- Quality and uninterruptable power should be given to the consumers.

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**Table1. 11kv feeder distribution analysis, month wise of J.C Nagar feeder**

Sl. no.	Month	Feeder unit Energy MU	Energy sale in MU			Total energy unaccounted	Billing efficiency	Extract from DCB			Collection efficiency	Business efficiency	ARD	ARR	ATC Loss
			Metered	Unmetered(Assd)	Total			Dem	Coll	Bal					
			1	2	3			4	5	6					
1	Apr-08	1.1947	0.97869	0.0144	0.99306	0.2017	83.12	47.68	41.95	20.03	87.98	73.13	3.99	3.51	26.87
2	May-08	1.1990	0.998875	0.0144	1.01324	0.11858	84.50	47.50	46.98	20.55	98.91	83.58	3.96	3.92	16.42
3	Jun-08	0.9944	0.89529	0.0144	0.90966	0.08474	91.48	48.86	44.91	24.51	91.90	84.07	4.91	4.52	15.93
4	Jul-08	1.0134	0.832097	0	0.83209	0.18134	82.11	44.10	44.40	24.24	100.68	82.66	4.35	4.38	17.34
5	Aug-08	0.9511	0.860187	0	0.8061	0.14493	84.76	35.74	43.86	16.09	122.72	104.02	3.76	4.61	-4.02
6	Sep-08	1.0040	0.852975	0	0.85297	0.15110	84.95	4389	40.26	19.72	91.73	77.92	4.37	4.01	22.08
7	Oct-08	0.8509	0.70554	0	0.07055	0.14542	82.91	30.20	26.51	23.41	87.79	72.78	3.55	3.12	27.22
8	Nov-08	0.6860	0.67448	0	0.67448	0.11157	85.81	38.26	33.89	28.85	88.58	76.01	4.87	4.31	23.99
9	Dec-08	0.8360	0.567794	0	0.56779	0.26821	67.92	40.71	49.01	18.85	120.39	81.76	4.87	5.86	18.24
10	Jan-09	0.7983	0.64866	0	0.64866	0.14973	81.25	45.10	45.54	18.41	100.98	82.04	5.65	5.70	17.96
11	Feb-09	0.7844	0.727073	0	0.72707	0.05732	92.69	41.74	39.02	21.13	93.48	86.65	5.32	4.97	13.35
	<b>Total</b>	<b>10.412</b>	<b>8.68766</b>	<b>0.0431</b>	<b>8.73077</b>	<b>1.68192</b>	<b>83.85</b>	<b>463.8</b>	<b>456.3</b>	<b>235.8</b>	<b>98.39</b>	<b>82.50</b>	<b>4.51</b>	<b>4.45</b>	<b>17.50</b>

**Table2. 11kv feeder distribution business analysis feeder wise**

Sl. no	Name of 11 Kv feeder	Feeder input energy (MU)	Total energy Unaccounted	Billing efficiency	Extract from DCB			Collection Efficiency	Business Efficiency	ARD	ARR	ATC loss
					Dem	Coll	Bal					
					1	2	3					
1	J.C.Nagar	0.798394	0.149734	81.25	45.10	45.10	18.41	100.98	82.04	5.65	5.70	17.96
2	Railway	0.6036	0.033170	94.48	26.02	31.29	9.95	120.23	113.60	4.31	5.18	-13.60
3	Ganesh peth	0.57964	0.085158	85.31	26.47	27.25	39.68	102.95	87.82	4.57	4.70	12.18
4	Durga bail	0.74532	0.070915	90.49	35.84	35.04	31.16	97.77	88.47	4.81	4.70	11.53
5	Siddarud	0.4779	0.034407	92.80	16.10	20.66	26.42	128.31	119.07	3.37	4.332	-19.07
6	Hubli city	1.1471	0.177138	84.56	34.79	35.27	49.64	101.38	85.72	3.03	3.07	14.28
7	Arvindnagar	1.1964	0.228950	80.86	50.23	50.72	64.35	100.95	81.65	4.20	4.24	18.35
8	M.R Feeder	0.0645	0.008698	86.56	0.95	0.86	9.44	90.53	78.32	1.47	1.33	21.68
		<b>5.612854</b>	<b>0.788317</b>	<b>85.96</b>	<b>235.5</b>	<b>246.6</b>	<b>249.1</b>	<b>104.72</b>	<b>90.02</b>	<b>3.93</b>	<b>4.16</b>	<b>9.98</b>

