A Paper on Electrical Power Distribution

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ABSTRACT: ***Voltage is an essential factor for power generation, transmission and distribution but the stability of the voltage and system is a difficult and challenging topic. The study of voltage stability and practical knowledge of voltage stability both are difficult work. This paper refers to the voltage stability criteria in electrical power systems also, the study of electrical power distribution. Problems arise with the electrical power distribution and their load characteristics. Electrical power transmission and distribution needs upgrading to form a link between generating station, transmission and distribution. Equipment used for the transmission is of higher rating also malfunction because of aging effect and less maintenance, less maintenance and aging effect cause many problems like blackout of area or zone, sparking etc and that can affect any person because nowadays every person depended on economic delivery. So this paper consist of complete study and improvement in distribution of the electric energy more efficiently also arranged a surge arrester and sudden voltage rise compensator near the distribution plant because it can protect damaging of the instrument also it has very much scope in future.***

KEYWORDS: ***Power system, Fault, Distribution, Generation, Transmission, Load, Power factor, Reactive power, Active power.***

INTRODUCTION

Increasing loads or more specifically the need for electricity level increases according to the advancement in technology but the aging effect of the device means a device has been used for many years without repairing or without maintenance. These kinds of equipment are responsible for system failure and responsible for the risk of blackouts of the area or zone. Nowadays society and people depend on fast and cheap or under-budget delivery of electricity or power supply. For now the transmission and distribution system of electrical power systems has increased so much to fulfill the desired power to the system and grow in the field of transmission and distribution. To fulfill the need of the system technology is enhanced in that way so that it can start utilizing renewable energy resources like solar, wind, thermal power and tidal energy [1]. Mainly important and significant or accurate use of the energy resources renewable energy generation placed far from major load centers that cannot be complete without significant additions to the transmission system. To improve this distribution and transmission systems mainly they are not compatible and can't be able to fulfill the demand at load site and that problem might be possible rather than this it can be economical. Enhancement of electric transmission and distribution systems could alter all of these concerns [2].

On power generation, power transmission and equipment failure etc., there are so many research papers have been published regarding these issues and for their remedies, among all research papers one research paper titled "electric power systems research" by Ying-Yi Hong discloses about the electrical power quality problems and throws a chart. In the electrical power system it is divided into five parts which is distribution, power market, end-user, Generation and transmission. Generation is characterized into four parts which is stability, dynamics, transient and distributed generation, transmission is divided into three part which is HVDC (high voltage direct current),thermal standards and facts, distribution is classified into four parts which is voltage operation, network reconfiguration, power quality, micro grid and multi agent, power market divided into three parts which is load service entity, smart distribution and contract design and end user classified into three parts which is demand response, frequency control and critical peak pricing. Figure 1 illustrate electric power system in terms of generation and transmission.

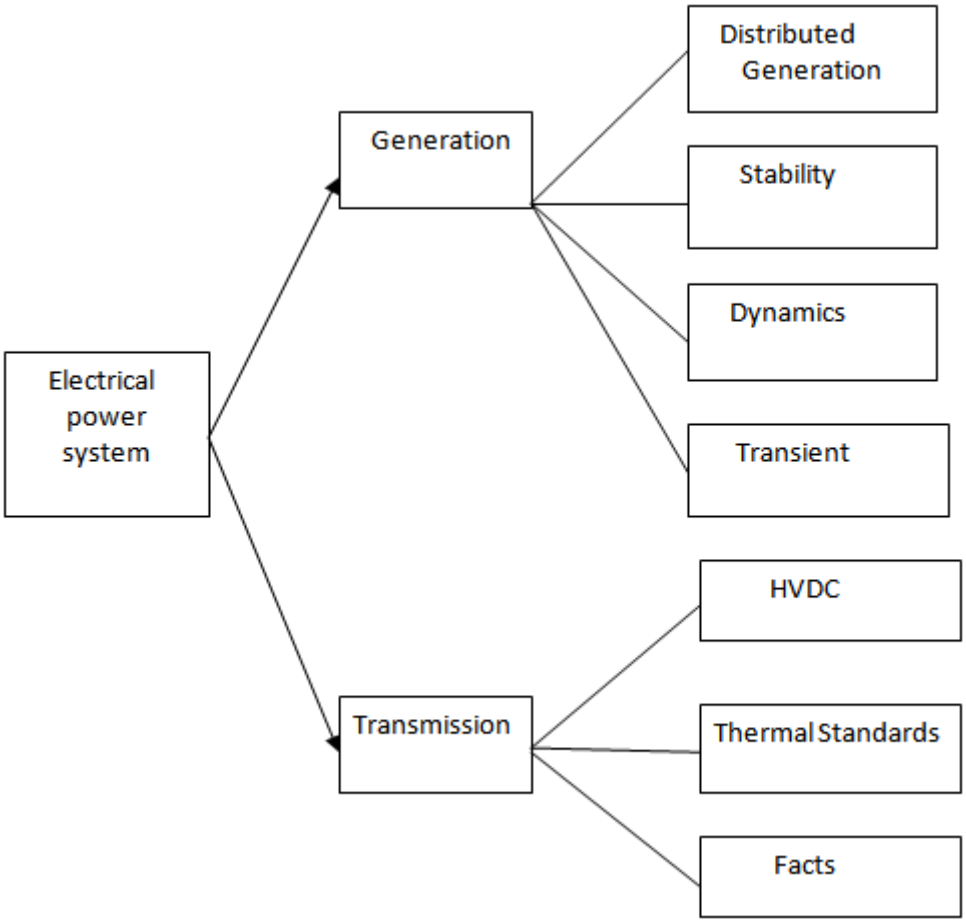

Figure 1: Electrical power system (Generation and Transmission)

This research paper studies the scenario of current transmission and distribution systems and discusses the ability for enhancing them (to create a modern grid in which technology is used to make it more versatile and advanced). The main thing is to improve the technology involved in the distribution and transmission process so that it can provide potential performance also economic means low cost and very impactful [3]. The study and design of power distribution did in a manner that it can give more accurate and efficient output, study of the equipment needed in power distribution like distribution transformer, cables, overhead and underground transmission line. Also distribution of the electrical energy is very challenging work because it should also maintain voltage stability which is itself a hard work and field of research. Electric energy first generate at generating station and then produce energy passes to substation from which overhead and underground transmission line carry the electrical energy to long place after that distribution transformer used to distribute the power first it step down the voltage to the normal usable voltage and then distribute the energy in the house or for domestic use. Figure 2 illustrate the electric power system in terms of distribution and power market.

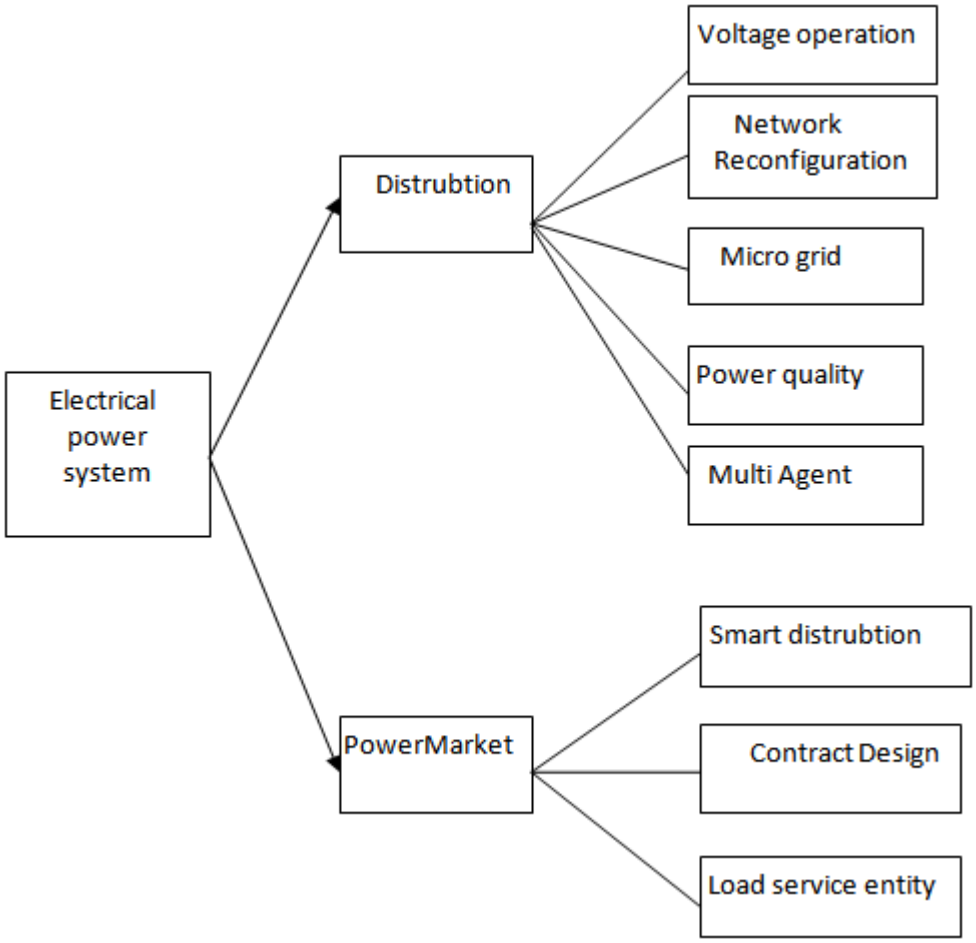

Figure 2: Electrical power system (Distribution & Power Market)

Figure 3: Overhead V/s Underground Transmission line

Figure 3 illustrate the actual image of overhead and underground transmission line. Overhead transmission line used to supply or transmit the generated energy from generating station to load site, fault detection in overhead transmission line is easy and has low cost but underground cable is versatile and very efficient but it is very expensive. Also fault detection requires more time and more money. Chances of overhead transmission line is higher than that of underground transmission line [4].

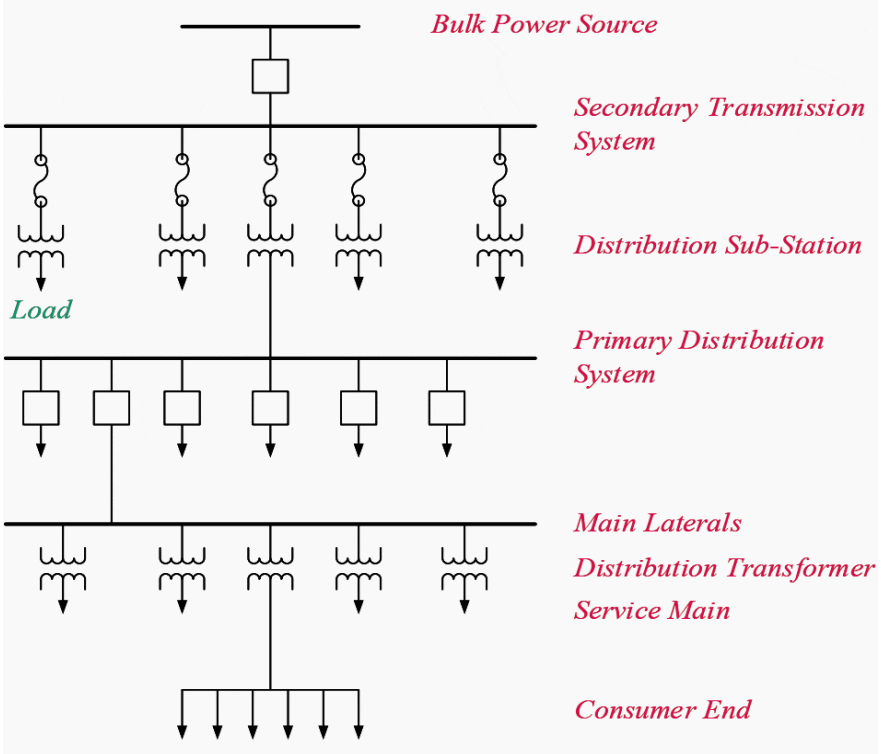

Figure 4: Distribution Transformer

Figure 4 shows distribution transformer, distribution transformer used to distribute power to the system and that power depends upon the voltage level of the transformer. Household equipment require 230V while industrial equipment require 430 volts [5].

Research Questions

- What are the equipment used to protect devices during distribution failure?
- Why does the distribution of the equipment need good quality and maintained equipment?
- How sensors can make distribution of energy easy?

LITERATURE REVIEW

In the field of electrical energy there have been many problems such as harmonics, eddy current, short circuit current, open circuit current, hysteresis, power distribution, power generation, power transmission and equipment failure etc. So many research papers have been published regarding these issues and for their remedies, among all research papers one research paper titled "electric power systems research" by Ying-Yi Hong discloses about the electrical power quality problems and throws a chart [6]. In the electrical power system it is divided into five parts which is distribution, power market, end user, Generation and transmission. Generation is characterized into four parts which is stability, dynamics, transient and distributed generation, transmission is divided into three part which is HVDC (high voltage direct current),thermal standards and facts, distribution is classified into four parts which is voltage operation, network reconfiguration, power quality, micro grid and multi agent, power market divided into three parts which is load service entity, smart distribution and contract design and end user classified into three parts which is demand response, frequency control and critical peak pricing.

A research paper titled electric power transmission and distribution systems : costs and their allocation by Drew Bottaro discussed the need for transmission and distribution equipment, transmission lines, transmission substation, primary distribution line, distribution substation, line transformer ,meter and result of regression analysis. The study of costs of transmission and distribution equipment in which discussed about the overhead and underground distribution system with the help of distribution transformer in both cases, study and analysis of cost of transmission line, cost analysis of primary distribution line, transmission substation cost, costs of other equipment categories, operation and maintenance expenses for distribution and

administration expense. Analysis of these expense is important to build a versatile power grid line which do not damage easily[7].

METHODOLOGY

1. Design:

The study and design of power distribution did in a manner that it can give more accurate and efficient output, study of the equipment needed in power distribution like distribution transformer, cables, overhead and underground transmission line. Also distribution of the electrical energy is very challenging work because it should also maintain voltage stability which is itself a hard work and field of research. Electric energy first generate at generating station and then produce energy passes to substation from which overhead and underground transmission line carry the electrical energy to long place after that distribution transformer used to distribute the power first it step down the voltage to the normal usable voltage and then distribute the energy in the house or for domestic use [8].

2. Sample:

Apparent power (kVA)	**Nominal current(A) at 237V**	**Nominal current(A) at 430V**
100	244	130
160	395	224
315	1534	867
630	1920	1523
1250	2240	1820
1600	2550	2020
2000	3320	2800

Power distribution transformers have different values of current at different voltage ratings like in house 230V of supply passes whether for industrial purpose 430V supply given because there is three phase equipment also connected in the industrial area [9].

3. Instrument:

3.1.Distribution Transformer:

Figure 5: An Actual Image of Distribution Transformer

An actual image of distribution transformer is shown in Figure 5. A distribution transformer is a transformer used to provide or distribute the final changed or step down voltage (voltage transformation) in the electric panels, industry, domestic use and for power distribution systems, it steps down the voltage coming from transmission line and used for the distribution purpose in the distribution lines to the amount of voltage used by the customer [10].

3.2.Transmission cable:

Figure 6: Overhead Transmission line

Figure 6 shows image of overhead transmission line, overhead transmission line transmit maximum voltage like 133kv, 66kv and many more voltage, size of the cable depends upon the amount of voltage passing through the overhead transmission line, when higher voltage passes through the overhead transmission then current is minimum so due to minimum current transmission size of the conductor is small and insulation level is high due to which transmission line cables are thin, and easy hand able [11].

3.3.Underground transmission cable:

Figure 7: Underground cable

Underground cable is more versatile than overhead transmission line (Figure 7), because faults produced in underground cable are less in comparison to overhead lines. Also underground cables do not affect due to the environment but it is very expensive and also it has low power loss [12].

4. Data Collection:

Table 1 consists of a distribution transformer data of operation. Distribution transformers connected with the steel pole outside the home or industry to provide step down voltage for household and industrial applications [13].

Table 1: Distribution transformer data of operation

KVA LOADING AND WORST PERFORMING NODES WITHIN EACH RESIDENTIAL NETWORK ARE SHOWN. TABLE IS SORTED BY INCREASING PEV PENETRATION.

Distribution Transformer ID	PEV Penetration	Winding Loss [W]	Core Loss [W]	Total Loss [W]	V_{sec} [pu]	I_{sec} [pu]	$kVA_{loading}$ [pu]	V_{worst}* [pu]	Worst** Node
DT 23	2%	1258	483	1741	0.9704	0.6476	0.6284	0.9155	23-R52
DT 24	4%	1359	482	1841	0.9693	0.6730	0.6523	0.9198	24-R14
DT 25	6%	1493	481	1974	0.9677	0.7055	0.6827	0.8676	25-R14
DT 26	8%	1598	480	2078	0.9665	0.7298	0.7054	0.9074	26-R33
DT 27	10%	1746	479	2225	0.9653	0.7628	0.7363	0.8537	27-R52
DT 28	12%	1874	478	2352	0.9644	0.7903	0.7622	0.8608	28-R33
DT 19	13%	2038	467	2505	0.9528	0.8243	0.7854	0.8887	19-R52
DT 20	15%	2193	466	2659	0.9517	0.8551	0.8138	0.8422	20-R52
DT 21	17%	2350	466	2816	0.9506	0.8850	0.8413	0.8562	21-R29
DT 10	19%	2586	456	3042	0.9403	0.9284	0.8730	0.8174	10-R14
DT 11	21%	2763	454	3217	0.9374	0.9597	0.8996	0.8370	11-R29
DT 12	23%	2943	452	3395	0.9349	0.9905	0.9260	0.8342	12-R29
DT 13	25%	3163	450	3613	0.9327	1.0268	0.9577	0.8065	13-R52
DT 14	27%	3351	449	3800	0.9311	1.0569	0.9841	0.8046	14-R52
DT 15	29%	3573	448	4021	0.9299	1.0913	**1.0148**	0.8038	15-R52
DT 16	31%	3688	456	4144	0.9383	1.1087	**1.0403**	0.8136	16-R52
DT 17	33%	3848	455	4303	0.9368	1.1326	**1.0610**	0.8225	17-R14
DT 18	35%	4230	454	4684	0.9349	1.1874	**1.1101**	0.8052	18-R48
DT 22	37%	4265	464	4729	0.9456	1.1923	**1.1274**	0.8230	22-R48
DT 29	38%	4284	482	4766	0.9640	1.1950	**1.1520**	0.8228	29-R52
DT 30	40%	4518	481	4999	0.9631	1.2271	**1.1818**	0.8234	30-R52
DT 31	42%	4872	480	5352	0.9614	1.2743	**1.2251**	0.8062	31-R52
	$\sum P_{losses}$	**63993**	**10261**	**74254**					

*) V_{worst} is the worst voltage deviation out of all nodes connected to the selected distribution transformer

**) Worst node is the node location corresponding to V_{worst}

RESULTS & DISCUSSIONS

Power generation and distribution is a challenging task for engineers, because in power distribution chances of fault is high. For distribution of electrical energy generated a distribution transformer is needed and that transformer will step down the voltage level according to the need of load. Near the distribution transformer a surge arrester and compensator connected with the transformer for the protection from overvoltage or sudden voltage increase. Electrical power transmission and distribution needs upgrading to form a link between generating station, transmission and distribution. Equipment used for the transmission is of higher rating also malfunction because of ageing effect and less maintenance, less maintenance and ageing effect cause many problems like blackout of area or zone, sparking etc and that can affect any person because nowadays every person depended on economic delivery. So this paper consist of complete study and improvement in distribution of the electric energy more efficiently also arranged a surge arrester and sudden voltage rise compensator near the distribution plant because it can protect damaging of the instrument also it has very much scope in future.

CONCLUSION

From the study of power system distribution, it is clear that overhead transmission has many chances of fault while underground transmission cable has less chance of fault but fault detection is easy in overhead transmission line also it is cheaper than underground transmission line. Surge arrester used to limit the overvoltage bypassing the limiting current, surge arrester limit the overvoltage and protect the electrical network from lighting or from any other surge. Surge arrester connected in parallel with the load. A compensator used to be arranged with the power distribution transformer to compensate for the overvoltage or over current so that our device does not get damaged. Compensator connected with the power system to regulate the voltage coming through the transmission line. This paper gives cost analysis of the transmission line and study of equipment and their maintenance rate so that transmission of electrical energy in an efficient way.

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