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Comparison for Loss and Cost Reduction in Power System Distribution by Utilization of Larger Conductor Size and Voltage Upgrading

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Abstract: The reduction of distribution line losses and costs reduction is one of the most important sections in electrical power distribution system. Throughout the world, electrical power are becoming as one of the need in the growth of any country and as the area spreading of power increasing day by day the losses occurred transmission and distribution of power from generating station to consumer consumption location also increasing. Due to the distribution system line losses, the consumer cannot use the fully electrical power energy. So, now a days every one also thinking and focusing on the elimination of both kind of constant and variable losses and competition for reducing losses in transmission and distribution lines is being introduced to increase efficiency of the electric power in the industries. In the transmission and distribution of electrical power there are many different types of losses which takes place during the transmission and distribution of electrical power some of them are taken as constant and some are variable losses and the value of variable losses can be increase or decrease as per the handling or maintenance of transmission and distribution system. The main aim is to identify all the losses in the transmission and distribution system. Distribution power losses can be divided in two groups. These are technical losses and non-technical losses. To reduce these losses, can be used different types losses reduction techniques. In this journal, the distribution losses are reduced by using voltage upgrading method and changing the larger conductor size. So, the distribution losses are reduced half of the existing system and cost of lost can be saved for annual in millions kyats.

Keywords: power distribution system, losses reduction, cost saving, voltage upgrading, larger conductor size

1. INTRODUCTION

Electrical distribution systems are an essential part of electrical system. In order to transfer electrical power from an alternating current or direct current source to the place where it will be used, some type of distribution network must be utilized. However, the method used to distribute power from where it is produce to where it is used can be quite simple. More complex power distribution systems are used, however, to transfer electrical power plant to industries, homes, and commercial building [2]. Electric power distribution is the portion of the power delivery infrastructure that takes the electricity from the highly meshed, high-voltage transmission circuits and delivers it to customers. Primary distribution lines are “medium-voltage” circuit, normally thought of as 600 V to 35 kV. At the distribution substation, a substation transformer takes the incoming transmission level voltage (35 to 230 kV) and step it down to several distribution primary circuit, which fan out from the substation. Close to each end user, a distribution transformer takes the primary distribution voltage and step it down to a low-voltage secondary circuit, commonly 400/230 V [3]. The distribution segment continues to carry electricity from the point where transmission leaves off, that is, at the 66/33 kV level. The standard voltages on the distribution side are therefore 66 kV, 33 kV, 22 kV, 11 kV and 400/230 volts, besides 6.6 kV, 3.3 kV and 2.2 kV. Depending upon the quantum of power and the distance involved, lines of appropriate voltages are laid [1]. Since distribution systems account for up to 90% of all losses reduction problems, improving loss reduction of distribution system is the key to improving system stability. To make effective improvements, a basic understanding of distribution system functions, subsystems, equipment, and operation is required. The main distribution equipment comprises HT and LT lines, transformers, substation, switchgears, capacitors, conductors and meters. Distribution systems consist of distribution substations, primary distribution systems, distribution transformers, and secondary distribution systems [4].

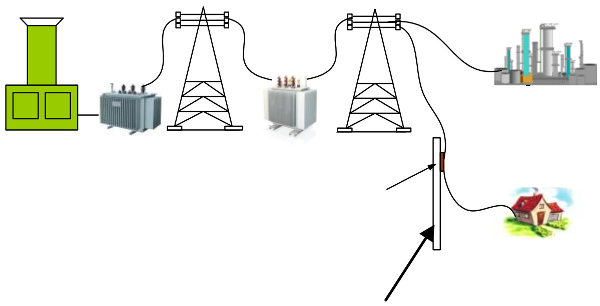

Figure.1 Electrical Power Distribution Network

The distribution of electrical power in Myanmar is normally in the form of alternating current (AC) and constant frequency of 50-Hz.The three-phase power is generally used for commercial and industrial factory. The single-phase power is used for residential such as small appliances and residential equipment. The Figure.1 illustrates the electrical power distribution system. Normally, power system is transferred electric power to customers along transmission and distribution lines without power losses and heating equipment. However, 20% of the total electrical energy is lost between generators and consumers and most of these losses occur in the distribution system.

2. LOSSES IN DISTRIBUTION SYSTEM

The key role of an electrical distribution system is to deliver electricity to specific client sites. Distribution of electric power to various clients is completed with much minimum voltage point. The distribution of electric power from bases to the end levels is complemented with power losses at all times. Power losses arise in distribution systems due to Joule's effect which can calculation for as much as 13% of the produced energy. Such major quantity of losses has a straight effect on the economic subjects and the total efficacy of supply utilities [5]. Distribution power losses can be shared into two

1. Technical losses.
2. Non-technical losses

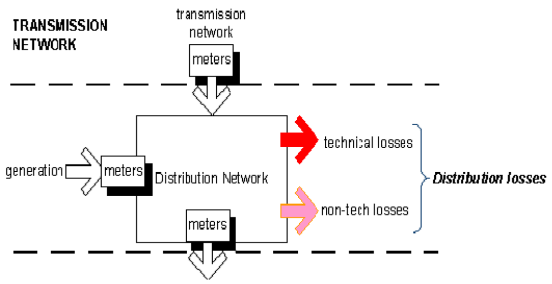

Figure.2 Losses in Distribution System

3. LOSS REDUCTION TECHNIQUES

In recent year, these has been a continuous need to accommodate higher loads and overcome delays in the construction of new generating facilities arising from environmental concerns and higher investment costs. Various losses arise in the power system foe overload conditions and voltage drop. There are three basic methods to reduce system losses in the distribution system. Among various loss reduction techniques in distribution system, the most common losses reduction techniques are:

1. Demand Side Management,
2. Distribution transformer Load Management,
3. Reconfiguration,
4. Capacitors Installation,
5. Reconductoring and
6. Voltage Upgrading.

Generally, loss reduction techniques on the transmission network are not as effective as those on the distribution network. Hence, this thesis focuses only on the reduction of power losses and voltage profile to improve in distribution networks. In the end, this study introduces an optimization technique based on exhaustive method for voltage upgrading and reconductoring method to reduce the network losses to minimum. Simulated results are drawn to show the accuracy of the technique. Generally, loss reduction techniques on the transmission network are not as effective as those on the distribution network. Hence, this thesis focuses only on the reduction of power losses and voltage profile to improve in distribution networks. In the end, this study introduces an optimization technique based on exhaustive method for voltage upgrading and reconductoring method to reduce the network losses to minimum. Simulated results are drawn to show the accuracy of the technique.

3.1 Demand Side method

The effectiveness of the demand side management program depends on the participation of the customer. Using certain household appliances at off-peak times may not be convenient for some customers. Furthermore, the producers of electricity are likely to only have a kWh rate and on kW rate for the demand. The municipal utilities have recently experienced a lowered demand charge. So, from the economic savings perspective, there is less motivation for the promotion of demand side management programs.

3.2 Distribution Transformer Load Management

Distribution transformer load management involves balancing the load between phases and resizing over-and under-utilized transformers to reduce losses. Ideally, phase currents and voltage of all distribution transformers would need to be monitored in order to practice distribution transformer load management properly. However, for most utilities, such measurements are only available at the substation level. To monitor every pole and pad mounted transformer downstream from the substation would prove to be costly. At the very least, distribution transformer load management can be practiced at the planning stages of a distribution system by sizing transformers for maximum energy efficiency.

3.3 Reconfiguration

Network reconfiguration is a process of changing the topological structures of distribution feeders by changing the opened or closed of the sectionalizing and tie switches. Most electric distribution systems are normally operated radically; however, there are usually several interconnecting tie switches available, especially on the underground medium voltage (6 to 35kV) networks. An effective reconfiguration strategy takes advantages of the large degree of load diversity that exist on some distribution systems. With the introduction of remote control of switches, online configuration management becomes an important part of distribution automation. As the operating condition change, the network is reconfigured for two purposes:

1. To reduce the system energy losses and
2. To relieve the overloads in the network.

It will refer to the first problem as network reconfiguration for loss reduction and to the second as reconfiguration for load balancing [6].

The advantages of system reconfiguration are:

1. High quality of supply,
2. Considerable reduction in line losses and consequent saving in energy cost and
3. Power can be supply to additional loads without any further investment on infrastructure.

The disadvantage of system reconfiguration

1. Involve approximation and
2. Exact switching is essential for effectiveness

3.4 Capacitor Installation

Capacitors are extensively used in distribution system s one solution to reactive power compensation, power loss reduction and voltage regulation problems. For capacitor placement general considerations are:

1. The number and location,
2. Type (fixed or switched) and
3. The size.

Capacitor banks can be the series or parallel combinations. They can be installed in distribution system or in substations on different voltage levels. Distribution capacitor can be pole mounted or pad mounted. The optimal placement of the capacitor is 2/3 of the distance from the substation to the end of the line [7].

The advantages of reactive power compensation are:

1. Improve voltage stability,
2. Simple in construction,
3. Reduces line losses,
4. Frees up feeder capacity and
5. Lower cost.

The disadvantages of Reactive Power Compensation are:

1. Compensator Cost,
2. In case of fixed VAR compensator, correct switching is necessary according to load condition,
3. More difficult to control reliably and
4. Size and placement important.

3.5 Network Reconductoring

Network reconductoring is the technique in present conductor on the feeder is replaced by conductor of optimum size for optimum dimension of feeder. This technique is used when present conductor is no more optimum because of quick growth of load. This technique is good for the emerging nations where annual account growing rates are great and the conductor is selected to reduce the preliminary financial investment. Moreover, feeder upgrade with heavier conductor can only be economically justified for older networks that are operating close to their design capacity.

3.6 Voltage Upgrading

This technique is most effective and efficient in minimizing the technical losses and refining the power quality in distribution system. In this technique, transformation of previous Low Voltage Distribution System to High Voltage Distribution System is done. This technique aims at extending high voltage lines as nearer to the load as possible and replacing large transformer with various small rating transformers. By using high this method, we can reduce the losses as current is low in high voltage system. By increasing the primary distribution system voltage, the same amount of power can be delivered at lower currents, thus lowering losses. In the past decade, many utilities have upgraded their primary distribution system voltage. As result of a recent voltage conversion, the utility estimates much of savings for each year [8]. Voltage upgrading is one of the system reconfiguration techniques. Voltage level improvement for the distribution system depends on many factors:

1. Maximum power demand (i.e., maximum load current),
2. Voltage profile during normal operating conditions and large motor starting,
3. Maximum fault current,
4. Power losses and
5. Capital cost [9].

4. RESULT AND DISCUSSION

In this section the results obtained from the simulation model by substituting the data. There are four conditions for comparison of loss reduction and cost optimizing.

4.1 Studies on Existing System

Table 1. Line Data of Kyauktan Distribution System

Feeder Name	Type	Line Length (km)	Conductor size (mm^2)	Total Connected Load	Primary Voltage (kV)
Pu Zune Kan	ACSR	31.76	70	6.28	6.6
Outside of the Township	ACSR	15.76	95	7.88	6.6
Inside of the Township	ACSR	5.61	95	5.53	6.6

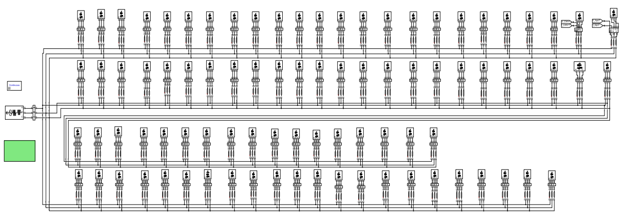

Figure 3 Simulation Model for Kyauktan Distribution System

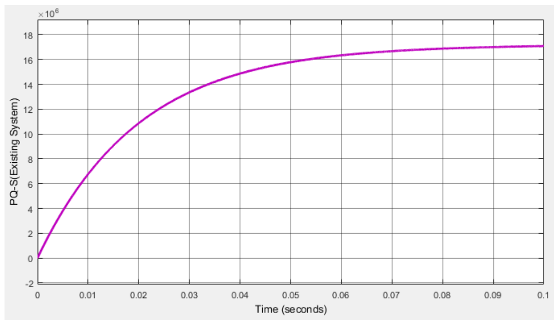

Figure .4 Simulation Result for PQ-S of Existing System

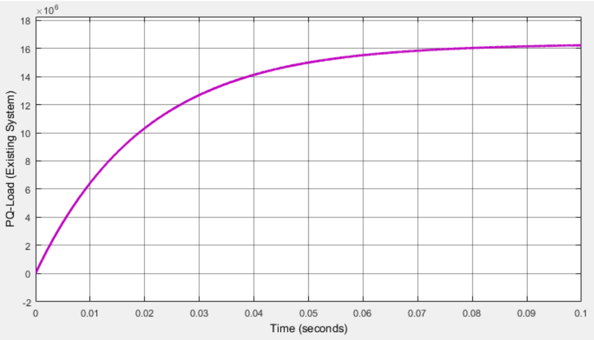

Figure .5 Simulation Result for PQ-Load of Existing System

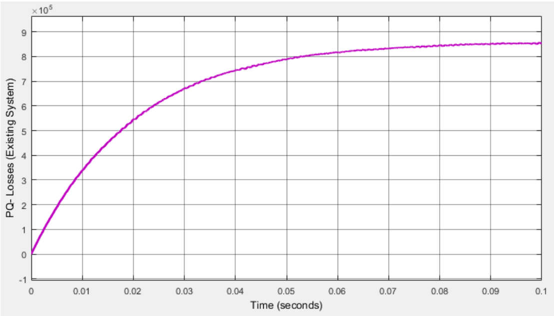

Figure .6 Simulation Result for PQ-Losses of Existng System

4.2 Losses Reduction by Using Voltage Upgrading Method

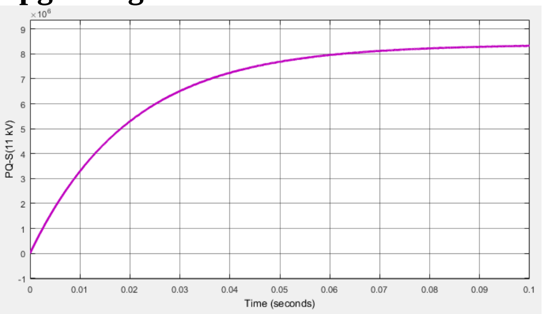

Figure .7 Simulation Result for PQ-S of 11-kV System

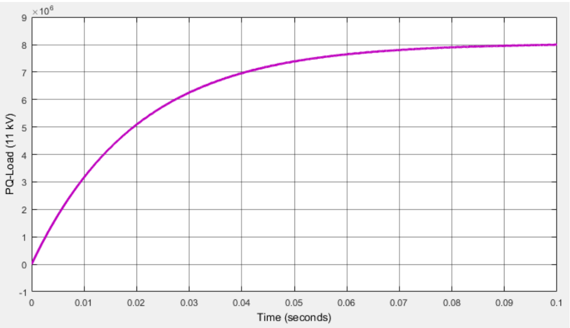

Figure .8 Simulation Result for PQ-Load of 11-kV System

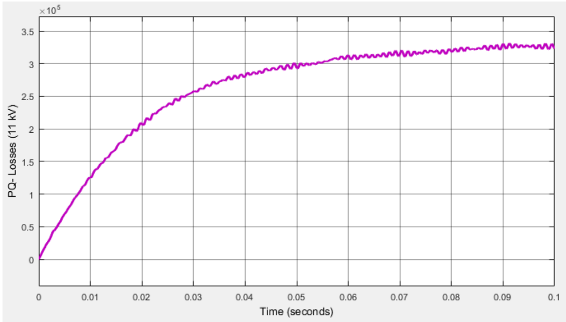

Figure .9 Simulation Result for PQ-Losses of 11-kV System

4.3 Losses Reduction by Using Larger Conductor Size

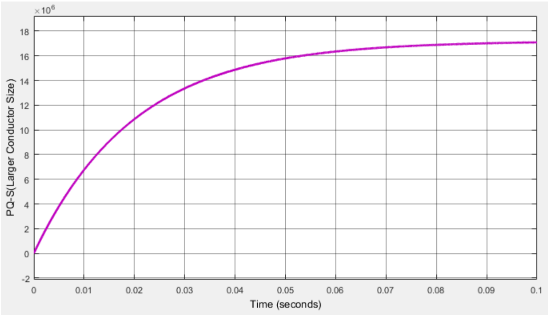

Figure .10 Simulation Result for PQ-S by Using Larger Conductor Size

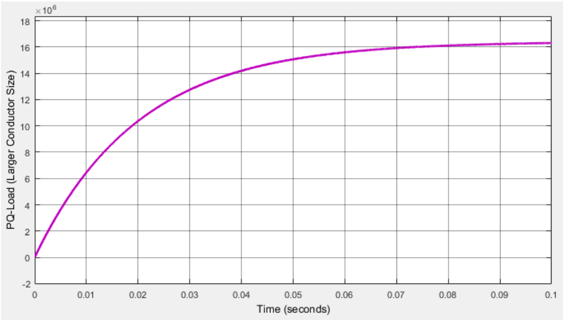

Figure .11 Simulation Result forPQ-Load by Using Larger Conductor Size

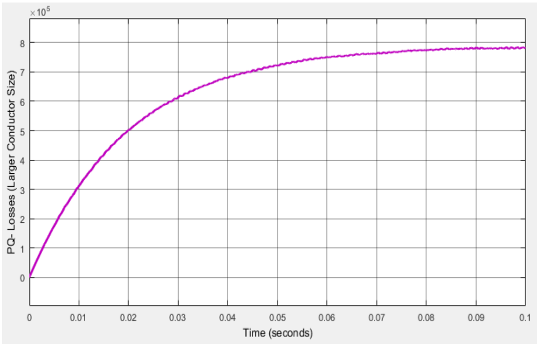

Figure .12 Simulation Result for PQ-Losses By Using Larger Conductor Size

4.4 Losses Reduction by Using Larger Conductor Size with 11-kV

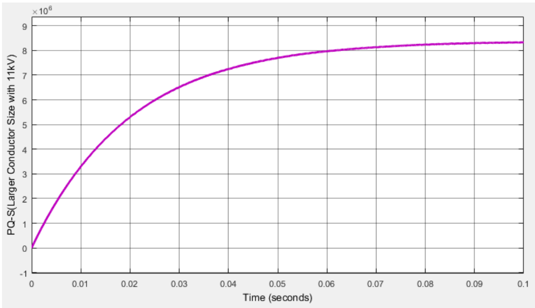

Figure .13 Simulation result for PQ-S by Using Larger Conductor Size with 11-kV

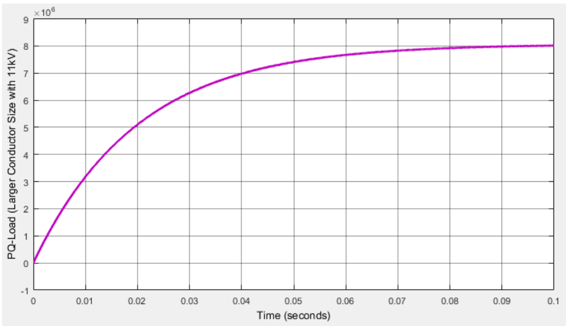

Figure.14 Simulation result for PQ-Load by Using Larger Conductor Size with 11-kV

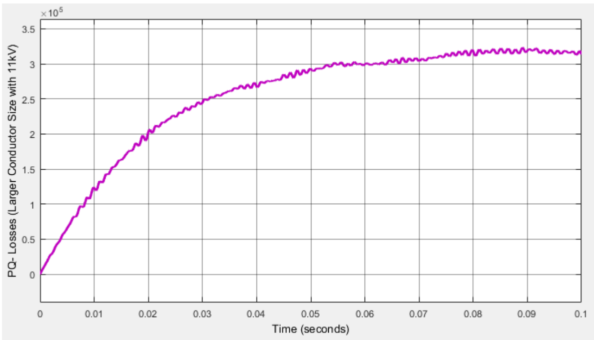

Figure.15 Simulation result for PQ-Losses by Using Larger Conductor Size with 11-kV

4.5 Comparison for the result of Losses Reduction

Table 2. Comparison for the result of Loss Reduction

	Existing System	Voltage Upgrading (11-kV System)	Larger conductor Size	Larger Conductor Size with 11-kV
Source(MW)	17.08	8.32	17.1	8.325
Load (MW)	16.2	8.00	16.3	8.01
Loss (MW)	0.852	0.325	0.782	0.317
Loss (%)	5.26	4.06	4.79	3.96

According to the simulation result, using the larger conductor size with 11-kV is the best result for loss reduction and only the voltage upgrading is nearly the best result. So, choosing only the voltage upgrading method for loss reduction is the best.

4.6 Comparison for the Result of Annual Cost Saving

Table 3. Comparison for the result of Annual Cost saving

	Existing System	Voltage Upgradin g(11-kV System	Using Larger Conduct -or Size	Using Larger Conductor Size with 11-kV
Loss (MW)	0.852	0.325	0.782	0.317
Cost of loss for each hour(MMK)	29820	11375	27370	11095
Cost of loss per day (MMK)	715680	273000	656880	266280
Cost of loss per annual(MM K in millions)	261.22	99.64	239.76	97.19
Cost of saving Compared to Existing System(MM K in millions)	0	161.58	21.64	164.03

According to the simulation result, when losses are reduced, it is equivalent to a reduction in demand. Evaluation of cost of losses in power distribution system will provide energy cost of saving for annual. The improvement of voltage will provide cost saving for annual more than the using of larger conductor size but the using of larger conductor size with 11-kV will provide cost saving for annual is nearly the improvement of voltage upgrading. So, only the voltage upgrading method for cost saving for annual is the best.

5. CONCLUSION

In Kyauktan Township, the distribution loss% of the power distribution utilities is very high. The power utilities are facing power shortage, huge amount of losses in millions of cores, poor and unreliable power etc. Power system losses comprises of technical losses, non-technical losses & revenue losses. The reasons for the technical losses are lack of inadequate distribution capacity, too many transformation stages, improper load distribution and extensive rural electrification etc. For the proper and accurate measurement of power losses in the power distribution utilities, we have to identify and found different power losses like technical and non-technical losses. This is the today's need of our developing country is more important where total distribution loss % are high. The power distribution utilities should estimate the losses where the data for computing the technical and non-technical losses are generally not available. In this paper, three loss reduction scenarios are presented as voltage upgrading, using larger conductor size and combination of these. Results are also shown from loss and cost saving point of views. Applying the methods presented in this paper, the losses in the practical distribution system can really be reduced.

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