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Radial Systems Including DGs Allocation with Distribution Loss

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ABSTRACT:

Due to the liberalization of the electricity market and the introduction of distributed generation (DG), the importance ofdistribution loss allocation (LA) has increased. This paper presents a new method for distribution power LA in radial systems. The proposed method, which is based on the results of power flow and considers active and reactive power flows of lines for LA, is composed of three steps. In the first step, starting from the source nodes (i.e., the nodes whose generation is more than their load), the power loss allocated to all nodes is calculated and then the power loss allocated to the loads connected to each node is obtained. In the next step, the total power loss is allocated to the nodes in order to calculate the power loss allocated to the DGs based on the results of this step. In contrast to the previous step, in this step, allocating power losses to the nodes starts from sink nodes, which are the nodes whose load is more than their generation. In the final step, normalization is executed. The application of the proposed method is illustrated on two distribution feeders, and the results are compared with other methods.

***Index Terms*—Distributed generation, loss allocation, radial distributionsystems.**

INTRODUCTION:

The Increasein deployment of distributed generation(DG) and the shift of distribution loads from customermode to prosumers have altered distribution systems from passiveto active mode. As a result, some of the transmission networksissues have been generalized to distribution systems aswell . One of these issues is loss allocation (LA), which specifiesthe fraction of total distribution loss that each load or DGis responsible for. Although there are many transmission LA methods in the literature, distribution LA is still a new topic and most of the distribution system operators still do not have a standard policy. Most of the methods implemented for distribution LA, have been mainly proposed for transmission LA, which are listed marginal method, which calculates the marginal loss coefficients (i.e., the changes in total loss due to a change in active/ reactive node injection), based on the results of power flow; these coefficients are then used to obtain the share of DGs and loads in total loss; the results of this method needs reconciliation in order to compensate for over-recovery of loss direct loss coefficients method, presented in which finds a direct relation between the losses and nodal injections both this method and marginal method are based on the results of Newton–Raphson power flow and, hence, have the flaws of application of this type of power flow in specific distribution systems where the number of nodes is large, the lines' resistance is negligible to their reactance, or consists of very long or very short lines.

Existing System:

1. Z-bus method which is not applicable to distribution systems containing only overhead lines, since the Y-bus matrix is singular for such systems, due to the fact that the shunt admittance of such lines is negligible .

2) The method based on a modified bus admittance matrix .

3) Succinct method which considers active and reactive flows for LA and is proved by Carpaneto *et al.* to be incapable of providing reliable results under particular circumstances .

4) Branch current decomposition method (BCDM) , in which the loss allocated to each node is calculated based on the current of its upward branches .

Proposed System:

This paper proposes an LA method that can be applied to radialmediumvoltagedistribution systemswithDGs. Themethodstarts by assigning zero power losses to a specific group of nodes.Then, the power loss allocated to other nodes is calculated basedon the power loss of the lines connecting the zero assigned nodesand these nodes. Since this method results in over-recovery oftotal loss,normalization is executed at theend tocompensate.Themethod is simple and is based on the results of power flow.

The method is composed of three steps as follows.
1) Calculating the loss allocated to the loads:

a) Loss due to active flows:
i) specifying the active source nodes, which are the nodes whose active generation exceeds their active demand;
ii) assigning zero active loss to the active source nodes;
iii) calculating the loss assigned to nodes other than the source nodes, due to active flows;
iv) calculating the loss allocated to the loads due to active flows.

b) Loss due to reactive flows:
i) specifying the reactive source nodes, which are the nodes whose reactive generation exceeds their reactive demand;
ii) assigning zero loss to the reactive source nodes;
iii) calculating the loss allocated to other nodes due to reactive flows;
iv) calculating the loss allocated to the loads due to reactive flows.

c) Total loss: by summing up the loss allocated to loads due to active and reactive flows.
2) Calculating the loss allocated to the DGs:

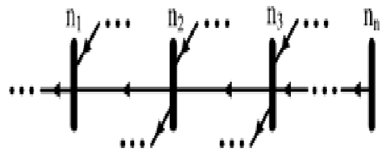

Fig. 3. Part of a sample distribution feeder.

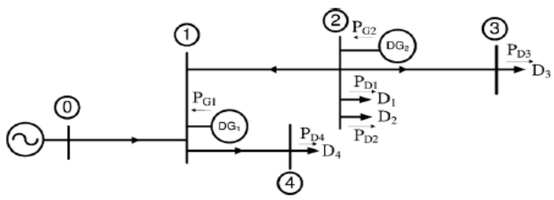

Fig. 4. Sample distribution feeder.

CASE STUDY

In this section, the proposed LA method is implemented on a sample rural distribution system, whose single-line diagram is shown in Fig. 6. This system comprises 17 nodes, 12 loads, 3 DGs, and 16 distribution lines. Table I presents the power-flow results as well as the distribution lines' resistance

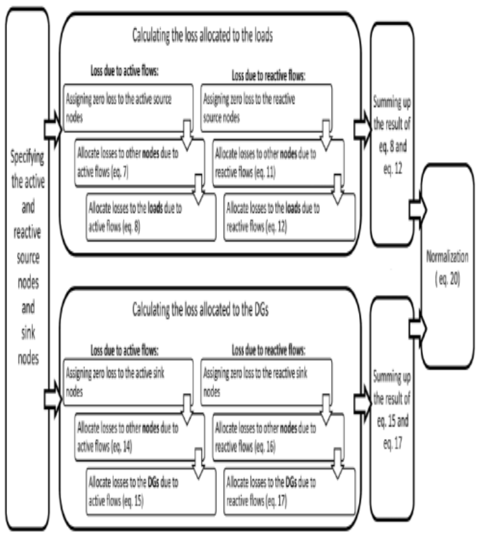

Fig. 5. Steps of the proposed LA method.

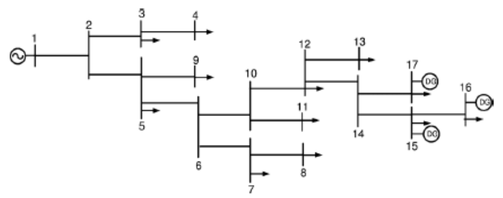

Fig. 6. Test distribution feeder.

the loss allocated to each node due to active flows is the summation of two terms:

1) a fraction of the loss allocated to the nodes that send active power to the node

2) the loss of the lines connecting the node to the nodes that send active power to it. As a result, one can conclude that the loads located at the end of long feeders usually allocate high losses. This can be seen in Table II, as the load connected to node 11 is allocated to high losses. In contrast, the loads located in places near high generation points, such as node 5, are allocated low proportions of loss. In other words, one of the advantages of the proposed method is considering system topology in LA. This is fair compared to the results of the pro rata method, which ignores users' location for LA.

The results of the proposed method not only depend on the location, but the method also users' considers the users' demand/generation. This can be seen as the loss allocated to node 8 is large.

• The marginal method involves calculating the Jacobian matrix, which is an extra calculation burden needed for this LA method. Likewise, the Z-bus method is based on calculating the Z-bus matrix, which is time consuming for huge distribution systems. In contrast, the proposed method does not need any further calculation except the results of power flow.

• The methods, such as Z-bus and succinct, which were originally derived for transmission LA, allocate a fraction of total loss to the slack bus. Since the loss allocated to the slack bus should be zero in distribution LA, the results of such methods need to be modified, in order to distribute the loss allocated to the slack bus among other nodes . In contrast, since the proposed method was originally for radial distribution systems, it does not need such modifications.

CONCLUSION

This paper presents a novel LA method for radial distribution systems, in which the loss allocated to each node is dependent on the loss allocated to its adjacent nodes and the loss of the lines connected to the node. The proposed method has the followingproperties, which are explained in to be the desirable properties of every LA method:

• The method is consistent with the results of power flow.

•The losses allocated to the loads/DGs depend on the amount of energy they consume/produce.

• The location of each load and DG is a key factor in the amount of loss allocated to them.

• The method is easy to understand.

• The implementation of the method is straightforward and does not need complicated programming or extensive computational effort. In order to allocate energy losses throughout a day, the method must be executed separately for each hour, which is time-consuming. Hence, the authors are working on a stochastic method, which could find equivalent loads based on their variation during a particular time span with an equal energy loss effect to replace the value of loads.

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