CHAPTER 7
CONCLUSION AND FUTURE SCOPE OF WORK

7.1 CONCLUSION

The thesis proposes a DGSI based approach for distributed generation (DG) planning from the perspective of utility. The real power loss minimization is the main objective discussed in view of the utility. The position and size of DG unit are vital aspects in the operation and planning of RDNs. This thesis presents a new innovative methodology i.e. DGSI ranking method for optimum allocation of DG. The projected method is compared with the loss minimization approach and BVSI ranking method. For loss minimization approach, the size of DG found as large value which lead to more investment cost. The investors in economically backward countries concern about the huge investment. With BVSI ranking approach the size of DG got reduced but the losses were increased. Hence, the DGSI ranking approach is proposed which reduces the losses effectively with reduced DG size. Here the economic analysis addressed is a long-term planning with the idea of maximizing the cost profit. The performances of optimum allocation of single DG in RDNs for real power loss minimization are evaluated by using the above three methods for the four types of DG. The DGSI ranking method is extended for the multiple DGs allocation in the RDNs due to it superiority over the other two methods. The DGSI based single DG placement algorithm for multiple DGs allocation is applied where the DGs are installed one by one after certain time extent. The evolutionary computational methods such as SADE and WIPSO algorithm are used for solving the optimum allocation of multiple DGs simultaneously. The multiple DGs allocation is carried out for all the possible combinations of various types of DGs. The proposed methods are validated by testing them on 15 bus, IEEE 33 and IEEE 69 bus RDNs.
The overall results of the proposed research work are summarized below:

### Table 7.1 Comparison of optimal allocation of single DG in RDNs

<table>
<thead>
<tr>
<th>Method</th>
<th>15 bus RDN</th>
<th>IEEE 33 RDN</th>
<th>IEEE 69 RDN</th>
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<tr>
<td></td>
<td>% P&lt;sub&gt;loss&lt;/sub&gt; reduction</td>
<td>V&lt;sub&gt;min&lt;/sub&gt; (p.u)</td>
<td>Investment cost $</td>
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<td>Loss minimisation. method</td>
<td>72.07</td>
<td>0.9807@8</td>
<td>2369200</td>
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<td>BVSI ranking method</td>
<td>37.01</td>
<td>0.9658@15</td>
<td>917300</td>
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<td>DGSI ranking method</td>
<td>69.88</td>
<td>0.9778@8</td>
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Table 7.2 Comparison of Optimal Allocation of Double DGs in RDNs

<table>
<thead>
<tr>
<th>Combinations of DGs</th>
<th>Algorithm</th>
<th>IEEE 33</th>
<th>IEEE 69</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>% Ploss reduction</td>
<td>Vmin (p.u)</td>
</tr>
<tr>
<td>II, II</td>
<td>Single DG placement</td>
<td>80.54</td>
<td>0.9807@25</td>
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<tr>
<td></td>
<td>SADE</td>
<td>83.66</td>
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<td></td>
<td>WIPSO</td>
<td>83.26</td>
<td>0.9811@25</td>
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<tr>
<td>I, IV</td>
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<td>67.57</td>
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<td></td>
<td>SADE</td>
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<tr>
<td></td>
<td>WIPSO</td>
<td>65.94</td>
<td>0.9418@18</td>
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<tr>
<td>II, IV</td>
<td>Single DG placement</td>
<td>68.07</td>
<td>0.9610@18</td>
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<td></td>
<td>SADE</td>
<td>70.12</td>
<td>0.9673@33</td>
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<td></td>
<td>WIPSO</td>
<td>69.94</td>
<td>0.9705@33</td>
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<tr>
<td>III, IV</td>
<td>Single DG placement</td>
<td>64.25</td>
<td>0.9572@18</td>
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<td></td>
<td>SADE</td>
<td>65.98</td>
<td>0.9392@18</td>
</tr>
<tr>
<td></td>
<td>WIPSO</td>
<td>65.45</td>
<td>0.9399@18</td>
</tr>
<tr>
<td>Combinations of DGs</td>
<td>Algorithm</td>
<td>IEEE 33</td>
<td>IEEE 69</td>
</tr>
<tr>
<td>---------------------</td>
<td>------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>% Ploss reduction</td>
<td>Vmin (p.u)</td>
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<tr>
<td>II,II,II</td>
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<td>0.9856@25</td>
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<td>I,IV,II</td>
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<td>0.9801@25</td>
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<tr>
<td></td>
<td>WIPSO</td>
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<td>0.9801@25</td>
</tr>
<tr>
<td>II,III,IV</td>
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<td>0.9803@25</td>
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<td>WIPSO</td>
<td>85.27</td>
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</tr>
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The inferences of this research work are summarized below:

1. For the optimum allocation of single DG, the percentage of real and reactive power loss reduction in the RDNs are greatly increased with the application of loss minimization method. But the DG size requirement is large. By applying the BVSI ranking method, the percentage of real and reactive power reduction are not up to the level of loss minimization method. But the DG size requirement is reduced drastically. The real and reactive power loss savings per MVA installation is improved by using this method. The novel DGSI ranking method has the advantages of the above two schemes. Here, the percentage of real and reactive power loss reduction is improved compared to the BVSI ranking method and the DG size is reduced compared to the loss minimization method. The cost profit factor of DGSI ranking method is the best for the optimum allocation of DG in RDNs compared to the loss minimization method and BVSI ranking method.

2. The optimum location and the size of DG in the RDNs minimize the real and reactive power losses and improve the voltage profile. The Type II DG reduces the real and reactive power losses drastically compared to other DGs since it delivers both real and reactive power to the RDNs. The loss reduction capacity of the Type III DG in the standalone placement is not at appreciable level since it consumes the reactive power from the network. According to type of DG inserted the real power loss reduction and the voltage profile improvement gets varied.

3. Even the type I DG reduces the real and reactive power losses effectively in the RDN and supports the voltage profile well; its cost profit factor is lower than the type III and type II due to its large investment cost. According to the cost analysis the type III DG is superior over the type I and type II DG. Even the type II DG supports the loss minimization
effectively its cost profit factor is lesser than the type III DG due to its minimum life period compared to all other DGs.

4. Single DG placement algorithm based on DGSI ranking for Multiple DGs allocation shows that the percentage of loss reduction is improved according to the combinations of DGs selected. Rather than the number of DGs selected the type of DG and combinations of DGs play a preeminence role in real and reactive power loss reduction. The Type III DG which does not play a significant role in loss reduction reduces the losses to a greater value when it is combined with the type IV DG since the Type IV DG provides the reactive power support to the RDNs.

5. For simultaneous allocation of multiple DGs, SADE and WIPSO algorithm are applied. The percentage of real and reactive power loss reduction are improved by using the WIPSO and SADE compared to the single DG placement algorithm. By comparing the performances of the two algorithms it is understood that the time for computation depends on the network size and the number of DGs selected for insertion. The WIPSO has the fast convergence characteristics and less computational time compared to the SADE. But the optimal solutions obtained using the SADE algorithm are the best since this algorithm has good convergence property. From the results of multiple DGs allocation, it is inferred that the SADE algorithm produces the good optimal solution compared to the single DG placement algorithm and WIPSO algorithm.

6. To minimize the real power loss effectively in the RDN the distribution utility can choose the type II DG for single DG allocation and multiple DGs allocation. But in view of the economic and environmental concerns, it does not provide the good solution for multiple DGs allocation. For multiple DGs allocation the combination of type II, type III and type IV DGs provide the good solution with respect to investment cost, real power loss reduction and voltage profile improvement of the RDNs.
7.2 FUTURE SCOPE OF THE WORK

The following objectives are proposed as future research work in this area:

- To consider the real time constraints such as the time varying load and discrete size of DG units into the proposed algorithms.
- To study the effect of the insertion of DG on contingency analysis.
- To analyse the ancillary services like reactive power support provided by the DGs and its pricing.
- To modify the problem into multi objective by adding the maximisation of cost savings and voltage profile improvement.
- To investigate the integration of DGs and network reconfiguration in the distribution networks.
- To analyse the effect of installation of DGs in the Network with the temporal and seasonal load variations.
- To maximise the cost savings with the integrated planning of DGs with Capacitors for reactive power support in the distribution system.
- To analyse the performance of DG in a weakly meshed system.