ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

Optimal placement and sizing of distributed generation(DG) to improve voltage profile and reducing power system losses by using BFO algorithm

A.Hema sekhar[1], HOD of EEE dept., SVPCET, puttur, A.P, India
K. Kalpana[2], P.G student, SVPCET, puttur, A.p, India.

Manuscript Info

Manuscript History:

Received: 15 May 2015
Final Accepted: 26 June 2015
Published Online: July 2015

Keywords:Distributed Generation(DG),MINLP and BFO

Corresponding Author

k.kalpana[2]
A.Hema sekhar[1]

Abstract

The voltage instability phenomena may occur in distribution networks. The decline of voltage stability level will restrict the increase of load served by distribution companies. Distributed Generation (DG) is increasingly drawing great attention of people. The development of DGs will bring new chances to traditional power systems. DGs connected to distribution networks are potential to improve the system voltage stability. To ensure the quality of power supply in distribution systems, bus voltages should be maintained within limits. Optimization techniques are tools which can be used to locate and size the DG units in the system, so as to utilize these units optimally within certain limits and constraints. In this paper we compared the results of power loss of 33,41 and 69- bus radial distributed systems using algorithms both MINLP and BFO. The proposed method starts by selecting candidate buses into which to install the DG units on the system.

INTRODUCTION

Due to the improvement of people’s living standards, higher and higher requirements have been putting on the quality and reliability of power supply. In this case, not only more energy is demanded, but also the continuity of power supply is emphasized. Over 70% interruptions suffered by end users are caused by faults in distributionsystems.Most of the benefits of employing DG in existing distribution networks have both economic and technical implications and they are interrelated. While all the benefits can be ultimately valuated in terms of money, some of them have a strong technical flavor than others. As such, it is proposed to classify the benefits into two groups—technical and economic.

The major technical benefits are:
- reduced line losses
- voltage profile improvement
- reduced emissions of pollutants
- increased overall energy efficiency
- enhancedsystem reliability and security
- improved power quality
- relieved T&D congestion.

The major economic benefits are:
- deferred investments for upgrades of facilities

- reduced O&M costs of some DG technologies
- enhanced productivity
- reduced health care costs due to improved environment
- reduced fuel costs due to increased overall efficiency
- reduced reserve requirements and the associated costs
- lower operating costs due to peak shaving
- increased security for critical loads.

Voltage instability in distribution systems has been understood for decades and was referred to as load instability inthe distribution system [3]. For example,a voltage instability problem in distribution network, which was widespread to a corresponding transmission system, caused a major blackout in the S/SE Brazilian system in 1997 [4].

As the development in the economy increases , load demand in distributed network goes on increasing. Hence, the distribution networks are operating more close to the voltage instability boundaries. The decline of voltage stability margin is one of the important factors which restricts the increase of load served by distribution companies [5]. Therefore, it is necessary to consider voltage stability with the integration of DG units in distribution systems.

In [14], the effect of DG units' capacity and location on voltage stability enhancement of distribution networks was also investigated. The DG units were allocated and sized based on minimizing overall cost. This paper [14] recommended considering the voltage stability as an objective function when dealing with optimum location of DG units. Recently, the work in [15] and [16] proposed methods to locate distributed generation units to improve the voltage profile and voltage stability of a distribution system. The author in [15] placed DG units at the buses most sensitive to voltage collapse, and resulted in improvement in voltage profile, as well as decline in the power losses. The author in [16] developed the work in [15] to maximize the load ability conditions in normal and contingency situations. The mixed integer nonlinear programming algorithm is obtained from[1].It starts by selecting candidate buses into which to install the DG units on the system, thus improving the voltage stability margin. Then, model the load and the DG generation with the consideration of the probabilistic nature of both the renewable DG units and the load. After that, conduct placement and sizing is formulation using mixed integer non-linear programming (MINLP), with an objective function of improving the stability margin.The stability margin can be defined by the MW distant from the operating point to the critical point. TheBacterial foraging optimization algorithm is obtained from[2]. The results that are using jacobian matrix and without jacobian matrix are compared and almost negligible error has been observed[41].

Before calculating the size of DG , we must calculate the candidate buses into which install the DG power. So primarly we have to calculate the buses. In this algorithm we use the voltage sensitivity phenomenon for finding the sensitive buses.Because this study is focusing on improving the voltage stability of the system, it uses voltage sensitivity analysis to select the candidate buses. The method is conducted by testing the voltage's sensitivity to the change of the DG injected power, and it can be explained as follows. Power systems are typically modeled with nonlinear differential algebraic equations [20]. The system model can be linearized as

$$\begin{bmatrix} \Delta P \\ \Delta Q \end{bmatrix} = \begin{bmatrix} JP\theta & JPV \\ JQ\theta & JQV \end{bmatrix} \begin{bmatrix} \nabla V \\ \nabla \theta \end{bmatrix}$$

With the assumption that the reactive load power (Q) is constant, the incremental change in bus reactive power equalsto zero. Then the above equation becomes,

$$\nabla P = \left(J_{PV} - J_{P\theta} J_{Q\theta}^{-1} J_{QV}\right) \nabla V (2)$$

$$\nabla V = \left(J_{RPV}\right)^{-1} \nabla P \qquad (3)$$

where$J_{RPV}$is a reduced Jacobian matrix, which gives the voltage magnitude variation due to DG power injection variation.

II. MIXED INTEGER NONLINEAR PROGRAMMING ALGORITHM:

Mixed Integer Nonlinear Programming (MINLP) refers to mathematical programming with continuous and discrete variables and nonlinearities in the objective function and constraints. The use of MINLP is a natural approach of formulating problems where it is necessary to simultaneously optimize the system structure (discrete) and parameters (continuous). The general form of a MINLP is

Minimize $f(x, y)$
Subject to $g(x, y) \leq 0$
$x € X$
$y € Y$ integer

The function f(x, y) is a nonlinear objective function and g(x, y) a nonlinear constraint function. The variables x, y are the decision variables, where y is required to be integer valued. X and Y are bounding-box-type restrictions on the variables.

III. BACTERIAL FORAGING OPTIMIZATION ALGORITHM

This procedure called foraging is crucial in natural selection, since the animals with poor foraging strategies are eliminated, and successful ones tend to propagate. Hence, to survive, an animal or a group of animals must develop an optimal foraging policy. Some of the most successful foragers are bacteria like the E Coli, which employs chemical sensing organs to detect the concentration of nutritive or noxious substances in its environment. The bacteria then moves through the environment by a series of tumbles and runs, avoiding the noxious substances and getting closer to food patch areas in a process called Chemo taxis. Besides, the bacteria can secrete a chemical agent that attracts its peers, resulting in an indirect form of communication.

The foraging strategy is illustrated by four processes namely Chemo taxis, Swarming, Reproduction, Elimination and Dispersal.

a. Chemotaxis :Chemotaxis process is the characteristics of movement of bacteria in search of food and consists of two processes namely swimming and tumbling. A bacterium is said to be 'swimming' if it moves in a predefined direction, and 'tumbling' if moving in an altogether different direction.

If the health of the bacteria improves after the tumble, the bacteria will continue to swim to the same direction for the specified steps or until the health degrades.

b. Swarming : Bacteria exhibits swarm behavior i.e. healthy bacteria try to attract other bacteria so that together they reach the desired location (solution point) more rapidly. The effect of Swarming is to make the bacteria congregate into groups and move as concentric patterns with high bacterial density.

c. Reproduction : In this step, population members who have had sufficient nutrients will reproduce and the least healthy bacteria will die. The healthier half of the population replaces with the other half of bacteria which gets eliminated, owing to their poorer foraging abilities. This makes the population of bacteria constant in the evolution process.

d. Elimination and Dispersal : In the evolution process a sudden unforeseen event may drastically alter the evolution and may cause the elimination and/or dispersion to a new environment. Elimination and dispersal helps in reducing the behavior of stagnation i.e. being trapped in a premature solution point or local optima.

Using this algorithm we can find the size of the distributed generation .we get the size of dg depending on the voltage limit of the system

IV.SYSTEMS UNDER STUDY

The following figure shows the single-line diagram of the 33 bus radial distribution system.

The total average active and reactive load amounts are 3715 kW and 2330kVar, respectively.

The voltage and current limits of the above system are as follows;

$$0.90 \leq V_{n,i} \leq 1.00 \tag{4}$$

$$0 \leq I_{n,ij} \leq I_{ijmax} \tag{5}$$

The parameters of thenetwork are taken from [ref].

The following figure shows the single-line diagram of the 41 bus radial distribution system.

The total average active and reactive load amounts are 4635 kW and 3250 kVar, respectively.
The voltage and current limits of the above system are as follows;

$$0.95 \leq V_{n,i} \leq 1.02 \quad (4)$$

$$0 \leq I_{n,ij} \leq I_{ijmax} \quad (5)$$

The parameters of thenetwork are taken from [ref].
The following figure shows the single-line diagram of the 69 bus radial distribution system.

.
The voltage and current limits of the above system are as follows;

$$0.95 \leq V_{n,i} \leq 1.05 \quad (4)$$

$$0 \leq I_{n,ij} \leq I_{ijmax} \quad (5)$$

The parameters of thenetwork are taken from [ref].

V.**RESULTS**

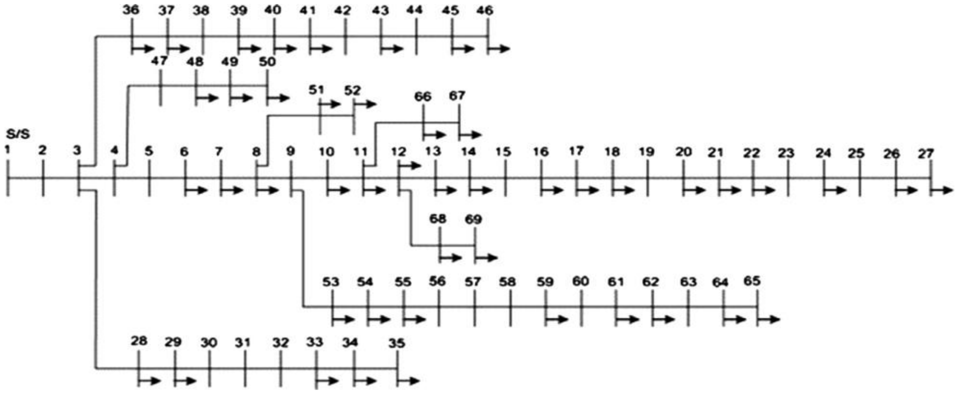

Fig. 1.single-line diagram of the IEEE 69 bus radial distribution system
The total average active and reactive load amounts are 3792.19 kW and 2694.6kVar, respectively

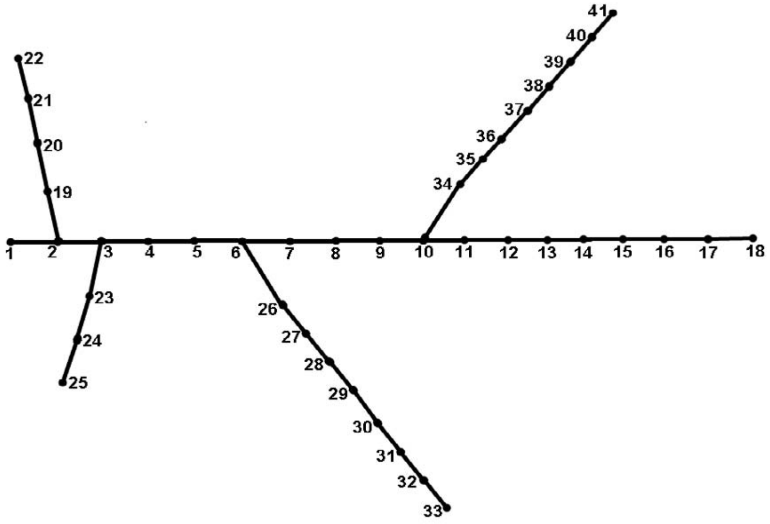

Fig. 1.single-line diagram of the IEEE 41 bus radial distribution system.

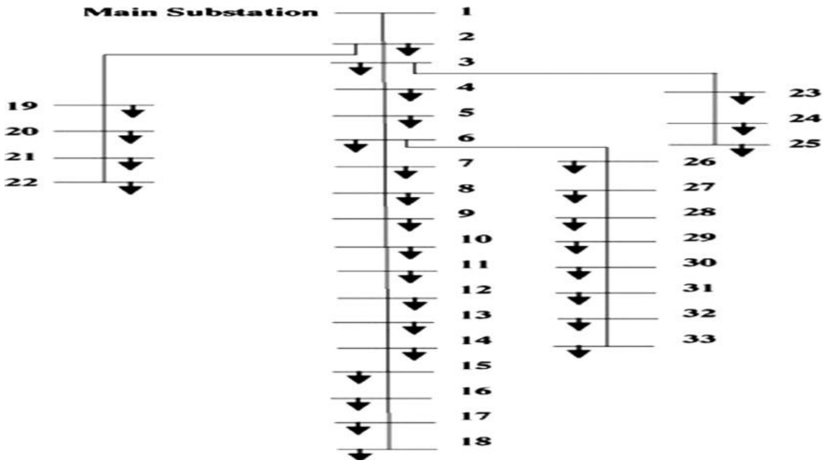

Fig. 1.single-line diagram of the IEEE 33 bus radial distribution system

In this paper we compared the diffferent types of distribution systems with the help of power losses.the folowing table explains the result

system	Minlp		bfo	
	Before dg	After dg	Before dg	After dg
33	362.3403	82.4681	362.3403	80.3852
41	801.0032	284.4572	801.0032	279.2770
69	405.4470	209.6643	405.4470	195.0641

Table .1 comparison of power loss using MINLP and BFOA

In the 33-bus system the power loss is minimized to 82.4681 kw using MINLP , whereas with BFO it is came to a value of 80.3852 kw.

In the 41-bus system the power loss is minimized to 284.4572kw using MINLP , whereas with BFO it is came to a value of 279.2770 kw.

In the 69-bus system the power loss is minimized to 209.6643kw using MINLP , whereas with BFO it is came to a value of 209.6643 kw. By observing the above table we can make a statement that using these algorithms the increase in number of buses causes the power loss to reduce .

Comparison of voltages by applying MINLP and BFOA to 33 bus system:

In 33 bus system, the table is shows the placing of DG by using MINPL and BEOA.

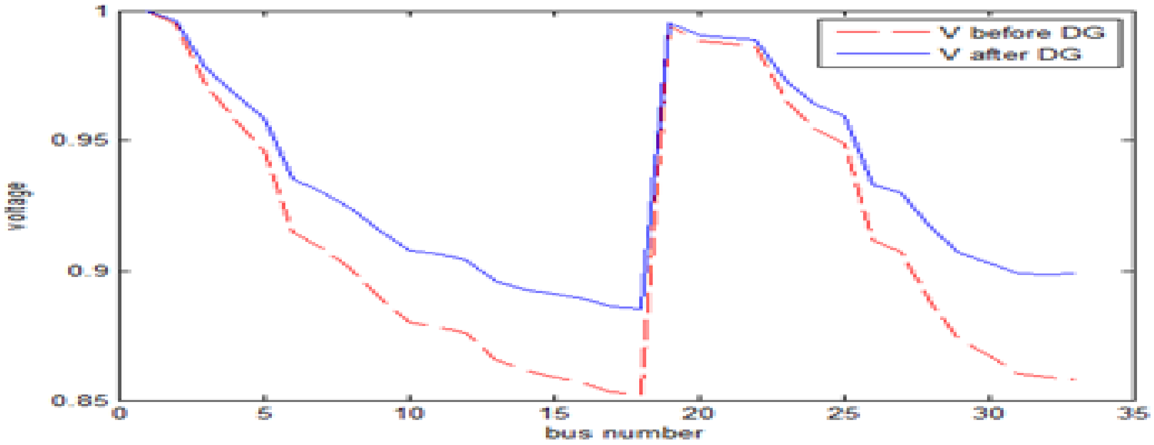

Fig.4. Comparison of voltages before and after the insertion of the DG.

The fig.4 shows us the voltage improvement of the 33 bus system after the DG is applied.

Sensitive buses	Before dg	MINLP	BFO
7	0.9088	0.9297	0.9305
11	0.8785	0.9055	0.9063
18	0.8523	0.8846	0.8854
26	0.9114	0.9321	0.9331
33	0.8583	0.8963	0.8989

Table .2 comparison of voltages by applying MINLP and BFOA to 33 bus system

Comparison of voltages by applying MINLP and BFOA to 41 bus system:

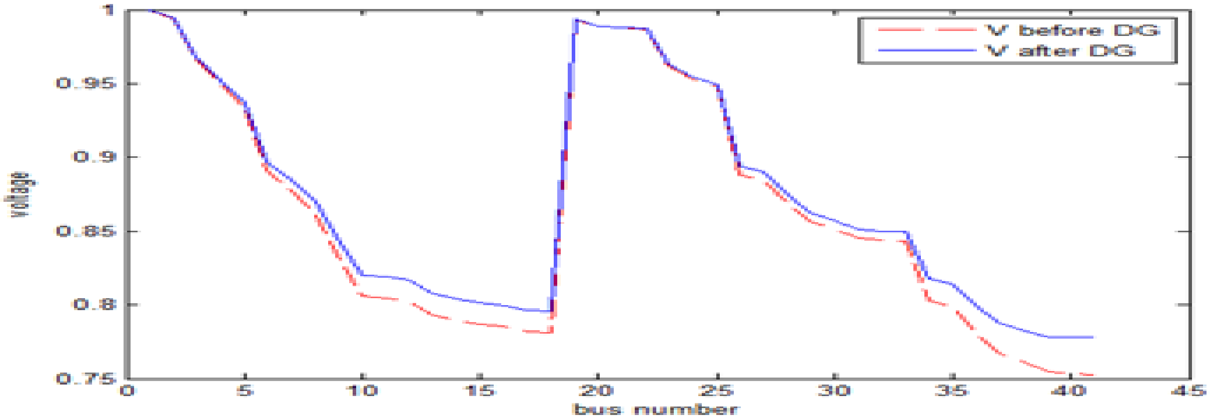

Fig.5. Comparison of voltages before and after the insertion of the DG in 41 bus system.

In 41 bus system, the table is shows the placing of DG by using MINPL and BEOA.

Sensitive buses	Before dg	MINLP	BFO
7	0.8775	0.8836	0.8846
11	0.8047	0.8169	0.8188

18	0.7811	0.7937	0.7956
26	0.8881	0.8932	0.8940
34	0.8029	0.8155	0.8174
41	0.7529	0.7750	0.7784

Table .3 comparison of voltages by applying MINLP and BFOA to 41 bus system

Comparison of voltages by applying MINLP and BFOA to 69 bus system:

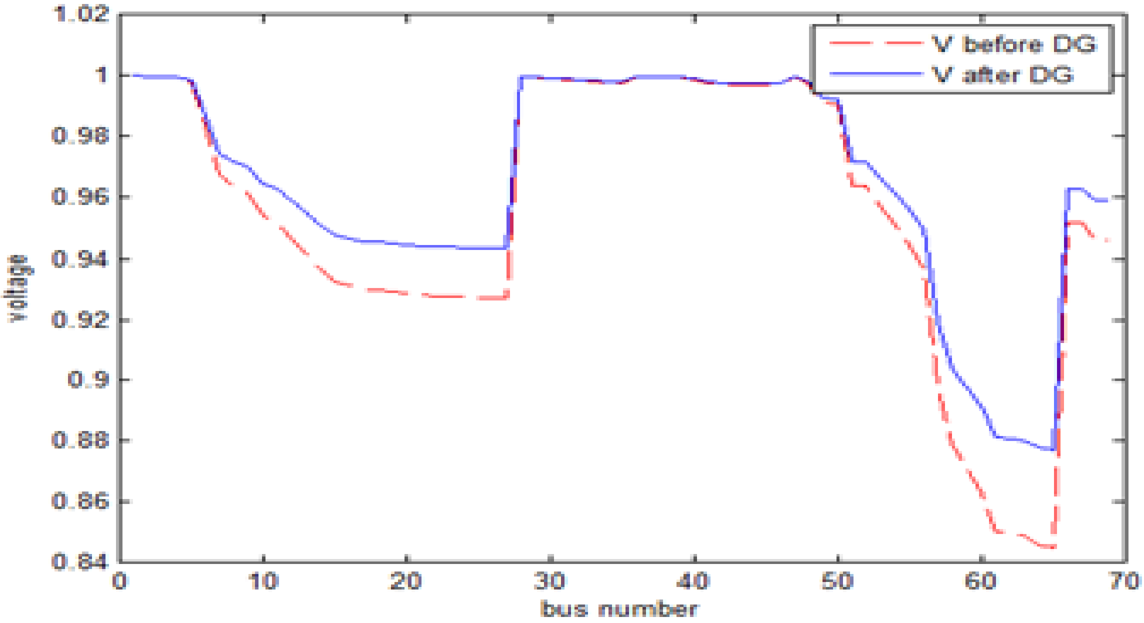

Fig.6. Comparison of voltages before and after the insertion of the DG in 69 bus system.

The above fig.5 indicates the improvement in the voltage of the 41 bus system. The fig.6 indicates us the comparison of the voltage after the insertion of the DG in 41 bus system.

In 69 bus system, the table is shows the placing of DG by using MINPL and BEOA.

Sensitive buses	Before dg	MINLP	BFO
11	0.9519	0.9620	0.9623
18	0.9300	0.9442	0.9444
26	0.9271	0.9419	0.9421
33	0.9982	0.9989	0.9989
40	0.9988	0.9990	0.9990
51	0.96938	0.9717	0.9719
65	0.8452	0.8825	0.8840
69	0.461	0.9574	0.9576

Table .4 comparison of voltages by applying MINLP and BFOA to 69 bus system

CONCLUSIONS

In this paper, methods for optimal DG unit placement in distribution systems are studied. The effectiveness of the proposed method is tested using the 33, 41 and 66- bus systems. It can be concluded that from the above case studies the placement of the DG have the strong influence on the power loss and on the voltage profile of the system. The candidate buses for the DG units installation are selected based on the sensitivity of the voltage. DG size and location can have positive impacts on the voltage stability margin. Therefore, an optimization method can be used to determine the locations and sizes of the DG units, to achieve the target of improving the voltage stability margin. In the present paper we have compared the results using mixed integer non- linear programming and bacterial foraging algorithms. It is clear that using the bacterial algorithm the result is more appropriate.

REFERENCES

[1]L. L. Grigsby, The Electric Power Engineering Handbook. New York: CRC/IEEE, 2001.

[2] R. B. Prada and L. J. Souza, ―Voltage stability and thermal limit: Constraints on the maximum loading of electrical energy distribution feeders, Proc. Inst. Electr. Eng.—Gen.,Transm. Distrib., vol. 145, pp. 573–577, 1998.

[3]C. Haiyan and C. Jinfu, ―Power flow study and voltage stability analysis for distribution systems with distributed generation, in Proc. IEEE PES General Meeting, 2006, 8 pp.

[4]N. G. A. Hemdan and M. Kurrat, ―Distributed generation location and capacity effect on voltage stability of distribution networks, in Proc. Annu. IEEE Conf., 2008, pp. 1–5, Student Paper.

[5]H. Hedayati, S. A. Nabaviniaki, and A. Akbarimajd, ―A method for placement of DG units in distribution networks, IEEE Trans. Power Del., vol. 23, pp. 1620–1628, 2008.

[6]M. Alonso and H. Amaris, ―Voltage stability in distribution networks with DG, in Proc. IEEE PowerTech, Bucharest, Romania, 2009, pp. 1–6.

[7]R. S. Al Abri,Ehab F. El-Saadany, and Yasser M. Atwa. ―Optimal Placement and Sizing Method to Improve the Voltage Stability Margin in a Distribution System Using Distributed Generation,IEEE transactions on power systems, vol. 28, no. 1, feb 2013.

[8]DebirupaHore,DuttaChowdhury ―Review: An Analysis of Different Population based Optimization Techniques used for Optimum Allocation and Sizing of Distributed Generations in Distributed Network,IJAREEIE Vol. 2, Issue 5, May 2013.

[9]V. Kumar, I. Gupta, H.O. Gupta and C.P. Agarwal‘ ―Voltage and current sensitivities of radial distribution network: a new approach,EE Proc.-Gener. Transm.Distrib., Vol. 152, No. 6, November 2005.

[10]C. Hsiao-Dong and R. Jean-Jumeau, ―Toward a practical performance index for predicting voltage collapse in electric power systems, IEEE Trans. Power Syst., vol. 10, no. 2, pp. 584–592, May 1995.

[11]Seyed Abbas Taher, Seyed AhmadrezaAfsari, ―Optimal location and sizing of DSTATCOM in distribution systems by immune algorithm, 2014.

[12] Minnan Wang and Jin Zhong, ―Islanding of Systems of Distributed Generation using Optimization Methodology, IEEE 2012.