International Research Journal of Applied and Basic Sciences

ISSN 2251-838X / Vol, 4 (10): 2884-2896
Science Explorer Publications

Simultaneous placement sub-transmission substation and distributed generation considering load uncertainty

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ABSTRACT: Generally, the main goal of distribution networks design and expansion is to respond to electricity consumption growth with the most efficiency, while not contravene the constraints governing the system. High amount of investment and along with the ever-increasing demand for energy and equipment price growth make the designers concentrate on more precise and suitable ways to design these networks. Appearance of distributed generation in distribution systems in addition to change in operation stages of these systems has provided the ability for these companies to design systems with lower cost. To gain this goal, the design of distribution systems should be revised. This paper presents a new method to obtain the number, location, capacity and servicing area of each sub-transmission substation through candidate and available substation locations, considering the possibility of DG installation on any of load centers, where The uncertainty of forecasted load of each load center is considered as a fuzzy model. In this method the optimization is performed using genetic algorithm with constraints including voltage drop, substations and DGs loading capacity and unidirectional connection between substations and loads.

Keywords: Sub-transmission substation,Distributed generation resources, Uncertainty load, Genetic algorithm, simultaneous placement.

INTRODUCTION

Substations and feeders are the main parts of a distribution system. Usually, there are various options to meet system's load growth so that an objective function of constant and current costs is created to select the best of them and is used to evaluate the efficiency of those options. So, by selecting the suitable location of substations with presence of distributed generation resources, the response to load consumption growth is observed completely which can lead to economical and technical efficiency. In (Temraz and satama,2002), A new model of planning for obtaining location and capacity of distribution substations and their servicing area was extended. In this paper, planning planning procedure has been divided in two sets: the first subset defines the location and capacity of sub-transmission substation and the second includes optimal routing of distribution eeders. In (Haghifam and Shahabi,2002), a method has been implemented for optimal sizing and loading of substations which can lead to load uncertainty, which uses LR fuzzy numbers in load points. In this reference design is performed in single stage interval. In (Carrano and Taka,2009) optimal sitting and design problems of substation placement have been considered simultaneously, using a new hybrid intelligent quasi-newton algorithm and genetic algorithm. Here also the problem has been solved as single stage. In (EL-foully and Zwinelding,2008), a universal objective function has been researched for in order to determine the location of sub-transmission substations, considering technical and economical constraints. Genetic algorithm has been used to optimize the objective function. Here, the problem has been solved as multi-stage. In (Farrokhifar and Banasharifian,2009), substation sitting and design problem is universally designed and tabu search has been used to solve the problem. The problem has been designed in single stage and the reliability is designed as multi-objective. All above researches have been performed without DG consideration. Studies have been performed with regards to the regarding of distributed generation resources as a new option to provide the required demand, without considering economical and technical realities.

In this paper, a method has been presented to obtain the optimal number, location, capacity and servicing area of sub-transmission substations. With taking the uncertainty of to forecasted loads into account, the presented method has been implemented based on genetic algorithm and fuzzy model based on the amount of load of electrical areas. Also, in this paper obtaining the location, capacity and servicing area of sub-transmission substations is modeled and solved, statically for a period of time, in presence of DG resources as a new option to match the demanded system capacity. This problem is considered from distribution utilities point of view and we have tried to consider the constant and variable costs related to substation construction and DG resources with regards to technical and economical issues. Restrictions such as voltage drop, the loading capacity of substations and DG resources and radiality obligations, have been also considered.

Proposed objective function and related constraints form a nonlinear mathematical model and genetic algorithm is used as optimization tool.

Mathematical Modeling

The goal of simultaneous sitting of sub-transmission substations and DG resources is to provide demanded capacity of demanded capacity of network using these equipments, minimizing the costs of system's installation and operation, when observing the governing constraints. The design problem, in this paper, has been modeled statically in a single time stage. Decision variables of the problem are the location, number, capacity and separated servicing area for substations and DG resources.

Objective Function

The plan costs are divided in two main parts: the first part is constant investments which can be expended just at the time of installing substations and DG resources and is independent of loading and operating period. The one includes variable costs which depends on operation and loading of substations and DG resources. Mathematical model of proposed objective function for statically sitting of sub-transmission substations and DG resources is presented in (1), which consists of three parts. The first part includes costs of access to sub-transmission substations, cost of substation installation and cost of access to load centers. The second part includes costs of DG installation and its connection to load points and the third part includes the installation costs of loss and the operation cost of sub-transmission substations and DG resources.

$$Min\tilde{F} = F_1 + F_2 + \tilde{F}_3 \quad (1)$$

$$F_1 = \sum_{i=1}^{ns}[AC(i)(1-\exp(H.P_{s\max}(i)) + CS(P_{s\max}(i)) + CF\sum_{j=1}^{nl} D_{ij}.(1-\exp(-H.\alpha_{ij}))] \quad (2)$$

$$F_2 = \sum_{i=1}^{ndg}[CDG(P_{DG}(i)) + CF\sum_{j=1}^{nl} D_{gij}.(1-\exp(-H.(1-\sum_{k=1}^{ns}\alpha_{kj})))] \quad (3)$$

$$\tilde{F}_3 = \sum_{t=1}^{nt}[(F_{pw})^t[[\sum_{i=1}^{ns}\sum_{j=1}^{nl}\alpha_{ij}.(\tilde{P}_l(j).pf_j + R.D_{ij}.(\frac{\tilde{P}_l(j)}{\tilde{V}(j)})^2)*8760*\tilde{K}_s(i)] +$$
$$[\sum_{i=1}^{ndg}\sum_{j=1}^{nl} PR(i).pf_j + R.D_{gij}(\frac{PR(i)}{\tilde{V}(j)})^2 * 8760 * K_{DG}(i)]]]$$

(4)

(5)
$$PR(i)=\begin{cases}P_{DG}(i) & i=j\\ 0 & i\neq j\end{cases}$$

$$f_{pw}=\frac{1+\inf r}{1+\operatorname{int} r}$$
(6)

Where

ndg number of candidate DGs

nl number of system load points

ns number of candidate and existing substations

AC(i) Cost of accessibility to sub-transmission substation i ($)

$P_{s\max}(i)$ Peak load of sub-transmission substation i (MVA)

H a large positive number

α_{ij} Binary decision variable denoting whether load point j is connected to substation i or not.

CF construction cost of medium voltage network ($/km)

D_{ij} distance of load point j from sub-transmission substation i. (km)

CDG(P_{DG}(i)) Usually, DG resources are installed as modules of a particular capacity (e.g. 1 MVA). This is shown in function $(P_{DG,i})$ C_{DG} in above equation.

D_{gij} distance of load point j from DG i (km)

pf_j Power factor of load j

R resistance of medium voltage network (Ω/Km)

$\tilde{V}(j)$ voltage of jth load point (a fuzzy number) (KV)

infr Annual inflation rate

intr Annual interest rate

$\tilde{K}_s(i)$ Cost of energy in sub-transmission substation(i) purchased from transmission network(a fuzzy number), ($/MWh)

Nt Effective functioning period of equipments. (per year)

$\tilde{P}_l(j)$ Load of jth load point (a fuzzy number)

$K_{DG}(i)$ Cost of power generation in DG units including Fuel, maintenance, and repair.)$/MWh(

$P_{DG}(i)$ power generation in ith DG unit

CS shows the installation cost of a sub-transmission substation, containing transformers and equipments, as a function of loading. Capacity of substations has a discrete nature and can get special values. In the above equation the stepped nature of installation cost of each substation is only obtained according to the function CS(P_{smax}(i)) with regards to its loading, which has been shown in Figure (1).

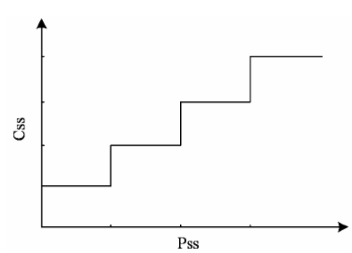


Figure 1 . The stepped nature of installation cost of each substation

With regards to the capacity of DG resources, which are usually less than 10 MVA, they occupy less surface in comparison to sub-transmission substations. So, unlike substations, where the required area is one of important parameters of installation cost, this parameter is not so effective for DG resources installation, and the only considerable cost is the cost of purchase and installation of the equipments of DG resources. Generation of DG resources requires expenditure to provide input energy resource and maintenance of the unit. In this paper a defined capacities of DG (0, 1, 2 MW) may be installed on each load point, and utilized capacity is also divided to PF of that DG.

Constraints
Loading limit of sub-transmission subsations

$$0 \le P_{SS.j} \le K_i . S_{SS.j} \qquad i = 1,2,\ldots,nss \quad ,S_{SS.i} \in \Omega_i \tag{7}$$

K_i Maximum loadability of sub-transmission substation i
$S_{ss,j}$ ith sub-transmission substation capacity
Ω_i total installable capacity in substation i

Operating constraint of dg resources

Loading of each unit should be less than its capacity.

$$0 \le P_{DG.i} \le S_{DG.j} \qquad i = 1,2,\ldots,ndg \tag{8}$$

Where $S_{DG.j}$ shows the capacity of ith unit in MVA.

Voltage drop limit

The voltage drop at each load point should be maintained at an acceptable range. As in proposed model, in the presence of DG units, each load point is fed through a sub-transmission substation and one or more DG unit(s), load flow has been used to calculate the voltage drop of each load point. In load flow equations, sub-transmission substation has been considered as slack and DG resources as PV buses. Load points are modeled as PQ buses. Load flow calculation is conducted for each load level, so if $\Delta V_{j.d}$ is the voltage drop of load point j, for load level d:

$$0 \le \Delta V_{j.d} \le \Delta V_{MAX} \qquad j = 1,2,\ldots,nlp, \qquad d = 1,2,\ldots,nld \tag{9}$$

Where ΔV_{MAX} maximum possible voltage drop

It should be noted that for the proposed model, the parameter ΔV_{max} may be considered as a criterion to control the maximum distance of load point from substations and DG resources, so that by selecting lower values for ΔV_{max} the maximum distance is reduced.

The limitation of load point feeding by generation units

When designing distribution networks in presence of DG resources, it is tried to provide the most of network's load's demand, by sub-transmission substations, and DG resources will not be the main providers of energy. So, maximum limitation of the power can be generated by DG for each load point is considered as follows:

$$\sum_{i=1}^{ndg} \beta_{ij.d} \le 0.35 \qquad j = 1,2,\ldots,nlp \qquad d = 1,2,\ldots,nld \tag{10}$$

The limitation of radial topology of medium voltage network

According to the above descriptions, the constraint of radial feeding of load points from sub-transmission substations can be defined as follows:

$$\sum_{i=1}^{nss} \alpha_{ij} = 1 \qquad j = 1,2,\ldots,nlp \tag{11}$$

$$\sum_{i=1}^{nss}\left(1-e^{-M\sum_{d=1}^{nld}\beta_{ij,d}}\right)\leq 1 \qquad , \; j=1,2,\ldots,nlp \tag{12}$$

The limitation of substation installation and dg installation in candidate locations

Usually, installing substations in a candidate location or expansion of available substations face with technical and geographical constraints, such that they cannot be installed or expanded more than a particular capacity. This constraint has been modeled as:

$$0\leq S_{SS,I}\leq S_{SS,i}^{MAX} \qquad , \; i=1,2,\ldots,nss \tag{13}$$

Where $S_{ss,j}^{max}$ is the maximum installable capacity in substation location i in MVA. Though, installing DG resources encounter less limitation in comparison to substations, from location point of view, but each candidate location includes a maximum capacity limit for DG installation, which can be defined as follows:

$$0\leq S_{DG,j}\leq S_{DG,j}^{MAX} \qquad i=1,2,\ldots,ndg \tag{14}$$

Where $S_{DG,j}^{MAX}$ is maximum installable capacity of DG in location i in MVA.

Fuzzy model of load point's power

Forecasted power amount of each load point for each time period is presented as LR triangular and normal fuzzy number.

m average load
R , L right and left
M(x) membership function

$$M(x)=\begin{cases}\dfrac{x-(m-L)}{L} & x\leq m\\[2ex] \dfrac{(R+m)}{R}-\dfrac{x}{R} & x\geq m\end{cases} \tag{15}$$

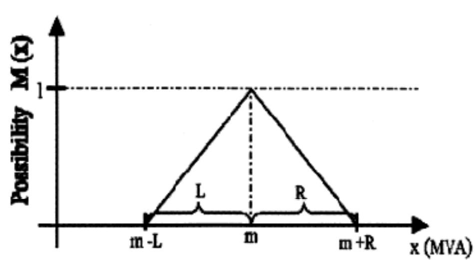


figure 2.fuzzy model of load point's power

It should be noted that load points have hypothetical nature and this model is propounded as a virtual feeder which is representative of a real feeder. With this description, the distance from substation (or DG) i with the coordinate (X_i ,Y_i) from load point j with the coordinate (X_j , Y_j) is calculated as follows:

$$L_{ij} = \left|X_i - X_j\right| + \left|Y_i - Y_j\right| \qquad (16)$$

Solution based on genetic algorithm

This paper uses genetic algorithm to solve the optimization problem. The problem is coded as binary strings. The algorithm starts with a random generated primary population and then the feasibility of each member is checked with regards to limitations and constraints of the problem, and crossover and mutation operators are applied to the members with higher fitness according to objective function.

The main steps of the algorithm

Each chromosome, that is a member of population, represents the connection of load points to substations and DG resources, in various load levels. The proposed chromosome structure consists of some substrings as shown in fig. 3. The first irst part of chromosome (SS), includes nl genes and represents the connection of load points to substation. The second substring of chromosome contains ndg genes, which represents the connection of DG resources to load points. Each gene j of this substring represents a particular capacity of DG which may be (0, 1, 2 MW) and the utilization capacity is divided to the PF of that DG.

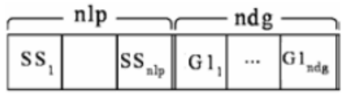


Figure 3. The proposed chromosome structure

Here, each DG has a predefined distance from substation and also nl=ndg. To implement the algorithm on the network, a primary population is generated randomly and then two double point crossover and single point mutation operators are applied.

Principally, the implementation of selection operator is such that the presence index for chromosomes with higher fitness be more in new population. In this research, selection elitism has been employed to expedite the procedure of convergence. In this method, firstly, the best chromosomes are selected for new generation with the probability of 100%. Then, BTS method is used to select chromosomes in identical number of primary population, based on fitness. But, as the objective function is presented as a fuzzy number ($\tilde{a} = (a_L + 2a_M + a_R)$), the selection is performed using the following equation:

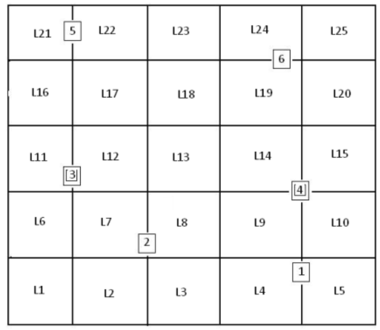
$$R(\tilde{a}) = (a_l + 2a_m + a_R)/4 \qquad (17)$$

Numerical studies

In this paper, an example is designed to evaluate the proposed algorithm, and then studies have been performed on, and then the studies are applied on Tabriz network which is a real network.

Base standard network

The area under study, for this example, is presented in fig. 4 , which contains 25 load points, which their load forecast data as fuzzy load format are presented in table 1. The required technical and economical data of for this study is presented in table 2. The area contains two available substations with capacity of 45 MVA and 4 candidate locations for installing new sub-transmission substations, where maximum allowable loading is 70% of installed capacity. Other specifications of these substations are presented in table 2. 25 candidate locations are considered in which DG resources to be installed, with maximum installable capacity of 2 MVA.



Candidate substations available substations

Figure 4. base standard network

In this study, it is assumed that DG capacity is a coefficient of 1 MVA. So, the minimum installable capacity of a candidate location will be 1 MVA.

In this paper, two studies are performed to describe the proposed method, which for state 1, the sitting is performed using proposed algorithm just for sub-transmission substations, with eliminating DG candidate locations (where here are load points' locations), and for state 2, DG installation possibility is considered in candidate locations in each load point location, to consider the simultaneous sitting of substations and DG resources. Other, input data are as state 1, which are presented as bellow.

Table 1. load forecast data

Power (MVA)							
Load point	Maximum possible value	Highest possible value	Lowest possible value	Load point	Maximum possible value	Highest possible value	Lowest possible value
1	8	5.6	3.2	14	9	6.3	3.6
2	6	4.2	2.4	15	10	7	4
3	6	4.2	2.4	16	10	7	4
4	10	7	4	17	10	8	6
5	7	4.9	2.8	18	9	7	5
6	6	4.2	2.4	19	8	5	3
7	8	5.6	3.2	20	7	4	2
8	10	7	4	21	6	4	2
9	9	6.3	3.6	22	8	5	1
10	8	5.6	3.2	23	9	7	4
11	9	6.3	3.6	24	10	6	2
12	8	5.6	3.2	25	6	4	2
13	7	4.9	2.8				

Table 2. the required technical and economical data for base standard network

Parameter	Value	Parameter	Value
The Maximum Cost possible of energy in sub-transmission substations	50	Authorized capacity of building substations in the candidate location 1,2,5,6	30,45,60,75
The highest Cost possible of energy in sub-transmission substations	30	Authorized capacity of building substations in the candidate location 3,4	45,60,75
The lowest Cost possible of energy in sub-transmission substations	20	Cost of accessibility to sub-transmission substation 1,2,5,6	150000
Construction cost of DG ($/MWH)	280000	Cost of accessibility to sub-transmission substation 3,4	0
Opration cost of DG ($/MWH)	44	Annual interest rate	25
Resistance of medium voltage network (Ω/Km)	.125	Annual inflation rate	.07
Reactance of medium voltage network (Ω/Km)	.127	Annual interest rate	.12
Nominal Voltage(KV)	20	maximum possible voltage drop (%)	5
construction cost of medium voltage network ($/KM)	3000		

Table 3. selected substations results for case studies

Case study 1			Case study 2		
Substations number	capacity (MW)	Load points service area	Substations number	capacity (MW)	Load points service area
1	60	3,4,5,9,10	1	60	2,4,5,14,15,20
2	45	2,7,8,13	2	60	3,6,7,8,9,12
3	60	1,6,11,12,16	3	45	1,11,16,17
4	60	14,15,19,20,25	4	60	10,13,19,23,24,25
5	75	17,18,21,22,23,24	5	30	18,21,22
6	0	-	6	0	-

Table 4. selected DGs results for case study 2

DG number	DG capacity (MW)	DG number	DG capacity (MW)	DG number	DG capacity (MW)
1	1	10	1	19	1
2	1	11	2	20	1
3	1	12	1	21	1
4	2	13	1	22	0
5	1	14	2	23	2
6	1	15	2	24	1
7	1	16	2	25	1
8	2	17	2		
9	2	18	2		

Table 4.The cost components of the tests

Parameters	Case study 1	Case study 2
Cost of accessibility to sub-transmission substations ($) {AC_{ss}}	450000	450000
The installation cost of sub-transmission substations ($) {$IC_{ss}$}	6700000	5300000
The installation cost of DGs ($) {$IC_{DG}$}	0	9520000
The opration cost of substations ($)	10^8*(19.48671,8.175402,3.019866)	10^8*(16.2482,6.156965,1.7252)
The opration cost of DGs ($)	0	10^7*10.56543
construction cost of medium voltage network	210000	320400
Objective function value ($)	10^8*(19.56031,8.175402,3.019866)	10^8*(17.46065,7.368768,2.93636)

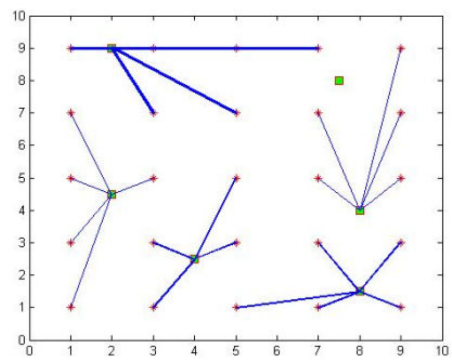


Figure 5. Substations and loads connection in state 1

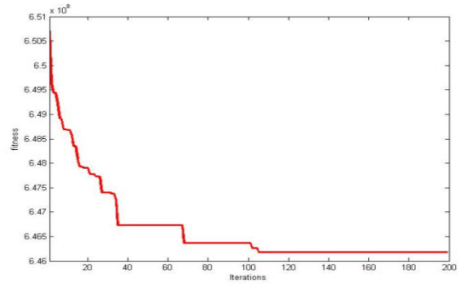


Figure 6. convergence system in state 1

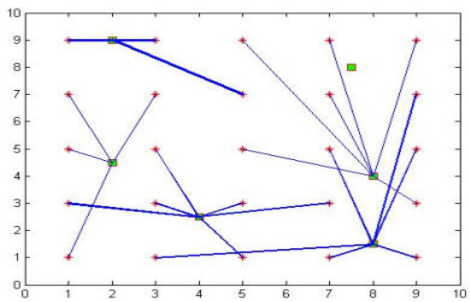


Figure 7. Substations and loads connection in state 2

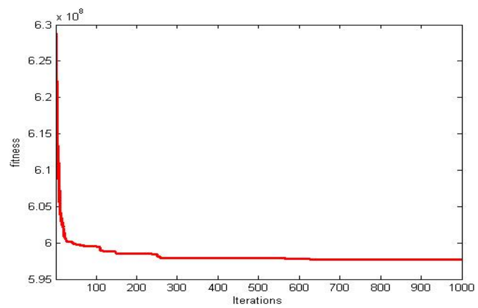


Figure 8. convergence system in state 2

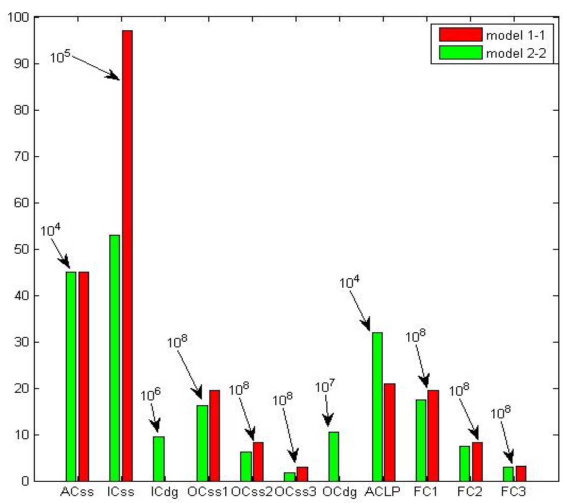


Figure 9. results comparison for two states

Real network

This network belongs to Tabriz sub-transmission network, which the data is presented in table (6) and the network is shown in fig 10-6. The area under study contains 40 load points where the data is presented in table 6-7, in fuzzy load format. The required technical and economical data are presented in table 6-11. This area contains 9 available substations with the capacity of 30 MW for substations 1, 2, 4, 7 and 45 MW for substations, 3, 5, 6, 8, 9, and 11 candidate locations for installing new substations with maximum loading of 70% of installed capacity. Other specifications of these substations are presented in table 6-8. 40 candidate locations are assumed for installing DG resources with maximum installable capacity of 4 MVA for all locations. In this section, DGs are identical to previous state and study results are presented in table (7).

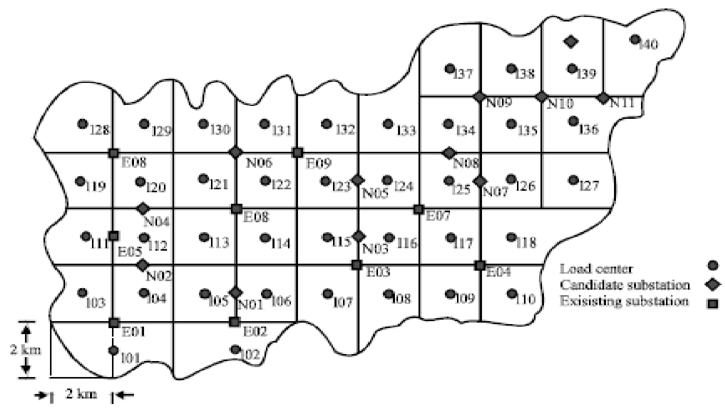


Figure 10. Real Network

In this study, it is assumed that DG capacity is a coefficient of 1 MVA. So, the minimum installable capacity of a candidate location will be 1 MVA (maximum is 4MVA).

In this paper, two studies are performed to describe the proposed method, which for state 1, the sitting is performed using proposed algorithm just for sub-transmission substations, with eliminating DG candidate locations (where here are load points' locations), and for state 2, DG installation possibility is considered in candidate locations in each load point location, to consider the simultaneous sitting of substations and DG resources. Other, input data are as state 1, which are presented as bellow.

Table 6. load forecast data

Power (MVA)							
Load point	Maximum possible value	Highest possible value	Lowest possible value	Load point	Maximum possible value	Highest possible value	Lowest possible value
1	13	8	4	21	13	8	4
2	13	8	4	22	9	6	3
3	13	8	4	23	4	2	1
4	13	8	4	24	10	7	4
5	9	6	3	25	14	9	5
6	9	6	3	26	13	8	4
7	9	6	3	27	10	7	4
8	10	7	4	28	13	8	4
9	9	6	3	29	13	8	4
10	13	8	4	30	7	4	2
11	9	6	3	31	10	7	4
12	10	7	4	32	13	8	4
13	6	3	1	33	10	7	4
14	9	6	3	34	14	9	5
15	13	8	4	35	14	9	5
16	5	3	1	36	14	9	5
17	5	2	1	37	13	8	4
18	4	2	1	38	10	7	4
19	9	6	3	39	11	8	4
20	8	5	3	40	13	8	4

Table 7. The required technical and economical data for real network

Parameter	Value	Parameter	Value
The Maximum Cost possible of energy in sub-transmission substations	50	Authorized capacity of building substations in the candidate location 10 to 20	30,45,60,75
The highest Cost possible of energy in sub-transmission substations	30	Authorized capacity of building substations in the candidate location 1,2,4,7	30,45,60,75
The lowest Cost possible of energy in sub-transmission substations	20	Authorized capacity of building substations in the candidate location 3,5,6,8,9	45,60,75
Construction cost of DG ($/MWH)	280000	Cost of accessibility to candidate sub-transmission substation	150000
Opration cost of DG ($/MWH)	27	Cost of accessibility to existing sub-transmission substation	0
Resistance of medium voltage network (Ω/Km)	.125	Effective functioning period of equipments. (per year)	15
Reactance of medium voltage network (Ω/Km)	.125	Annual inflation rate	.07
Nominal Voltage(KV)	20	Annual interest rate	.12
construction cost of medium voltage network($/KM)	5000	maximum possible voltage drop (%)	5

Table 8. selected substations results for case study 1

Substations number	capacity	Load points service area	Substations number	capacity	Load points service area
1	45	3,4	11	30	5,12
2	30	6	12	30	24,33
3	45	15,17	13	30	20,30
4	60	8,10,18,26	14	0	_
5	45	2,11,13	15	0	_
6	45	14,21,22	16	30	25
7	30	7,27	17	30	9,38
8	60	19,28,29	18	45	34,35
9	45	16,31,32	19	60	36,39,40
10	30	1,23	20	0	_

Table 9. selected substations results for case study 2

Substations number	capacity	Load points service area	Substations number	capacity	Load points service area
1	45	1,3,12	11	0	_
2	30	2,6,13	12	0	_
3	45	7,8,16,23,25	13	0	_
4	30	10,26	14	0	_
5	45	4,11,19,30	15	0	_
6	45	5,14,15,24	16	30	33,40
7	60	18,22,34,35,37	17	0	_
8	45	20,28,29,31	18	30	38,39
9	45	9,17,21,32	19	30	27,36
10	0	_	20	0	_

Table 10. selected DGs results for case study 2

DG number	DG capacity (MW)	DG number	DG capacity (MW)	DG number	DG capacity (MW)
1	4	15	4	29	4
2	4	16	2	30	2
3	4	17	1	31	3
4	4	18	1	32	4
5	3	19	2	33	3
6	3	20	2	34	4
7	3	21	4	35	4
8	3	22	2	36	4
9	3	23	1	37	4
10	4	24	3	38	3
11	3	25	4	39	3
12	3	26	4	40	4
13	2	27	3		
14	3	28	4		

Table 11. The cost components of the tests

Parameters	Case study 1	Case study 2
Cost of accessibility to sub-transmission substations ($) {AC_{ss}}	1200000	450000
The installation cost of sub-transmission substations ($) {$IC_{ss}$}	5250000	1850000
The installation cost of DGs ($) {$IC_{DG}$}	0	35000000
The opration cost of substations ($)	)17.65427,6.717709,2.3167(10^{8}*	)12.31125,3.55337,0.2178549(10^{8}*
The opration cost of DGs ($)	0	10^{8} *2.8289
construction cost of medium voltage network	513418	590509
Objective function value ($)	)17.7239,6.787343,2.386334(10^{8}*	)15.52182,6.761175,3.423288(10^{8}*

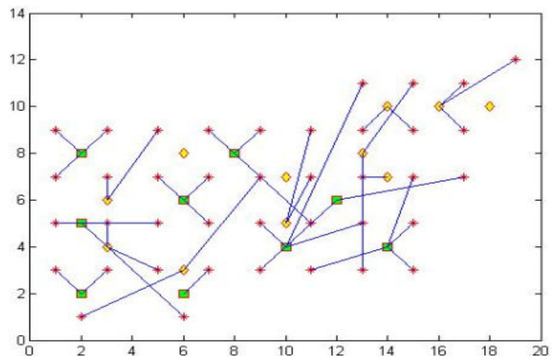


Figure 5. Substations and loads connection in state 1

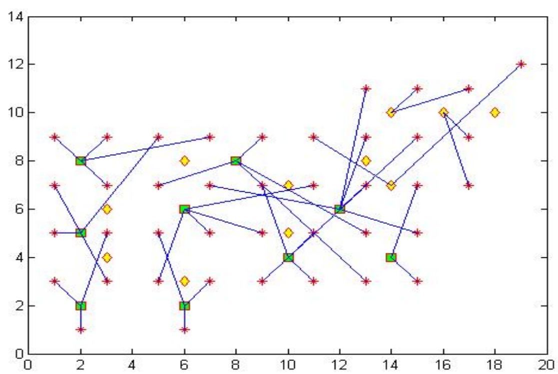


Figure 7. Substations and loads connection in state 2

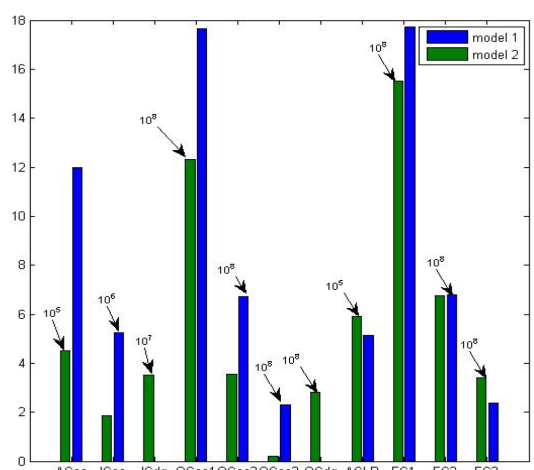


Figure 9. results comparison for two states

CONCLUSION

The presence of DG resources has provided new options in distribution system design. This can provide considerable economical advantages to distribution companies. With regards to the effect of various factors in obtaining the optimal composition of sub-transmission substations and DG resources, to provide the capacity of distribution networks and also, considering uncertainty of networks' loads, the solving of the problem is associated with particular complexities. In this paper, the problem of simultaneous sitting of sub-transmission substations and DG resources in distribution networks, from Distribution Company's point of view, is modeled in a mathematical model as an objective function and its related constraints. In presented model, it is tried to consider the costs due to DG installation as well as sub-transmission substations, as system demand provider resource, as much as possible. To solve the proposed model, the genetic algorithm has been used, employment steps were described and finally, the proposed model applied to a standard and real network and the produced results were presented.

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