Modified Charged System Search Algorithm for Economic Optimal Scheduling of Microgrid in Grid-Connected Mode

Jamaledini, Ashkan and Soltani, Ali and Khazaei, Ehsan

Electrical and Computer Engineering Department, Sazeh Sazan Power Company, Iran, Electrical and Computer Engineering Department, Sazeh Sazan Power Company, Iran, Electrical and Computer Engineering Department, Sazeh Sazan Power Company, Iran

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Ashkan Jamaledini, Ali Soltani, Ehsan Khazaei,

Electrical and Computer Engineering Department, Sazeh Sazan Power Company, Iran

Abstract: This paper presents a new heuristic algorithm famous as charged system search algorithm for optimal operation of the microgrids (MGs) in the grid-connected mode. The algorithm is also being modified based on a mutation operator technique to speed up its convergence speed. Finally, the model is examined on IEEE 69 bus test system.

I. INTRODUCTION

Microgrids (MGs) has higher reliability and resiliency due to closeness to the consumers. Also, as the transmission lines are reduced in the MGs, the total power losses, as well as the investment and operational costs of the entire grid is decreased. However, the optimal scheduling of the MGs would be more complicated as the MG can be connected and disconnected to the main grid. To this end, develop a fast and accurate algorithm for the optimal energy management of the MG is essential. This is mainly due to any fault would be lead to system blackout. To this end, this paper developed and presents a new algorithm known as the charged system search algorithm (CSSA) to overcome the complexity of the problem. Also, this algorithm can provide a fast convergence speed for optimal energy management of the MG. It should be noted that many heuristics methods

are suggested for the optimal energy management of the MGs. However, the proposed technique is very fast along with high accuracy and lower operation cost, compared to the well-known techniques such as particle swarm optimization (PSO) and genetic algorithm (GA).

II. Grid-Connected Microgrid Mathematics

The main goal is cost minimization, given by

$$min \sum_{\forall i}[C_i P_{it} I_{it} + SU_{it} + SD_{it}] \quad (1)$$

where *I* is a binary variable (0 or 1) that controls the status of unit *i* at time *t.* Also, *SU* and *SD* are the startup and shutdown costs.

In this paper, the following nomenclature is used:

UT and DT are minimum up and down

$T_{(on)}$ and $T_{(off)}$ are the number of successive on and off hours

RU and *RD* are the ramp up and down of the generators.

Moreover, the problem has some limitation, given by (2)- (6).

$$P_{it,min} \leq P_{it} \leq P_{it,max} \quad (2)$$

$$P_{it} - P_{i(t-1)} \leq RU_i \quad (3)$$

$$P_{i(t-1)} - P_{it} \leq RD_i \quad (4)$$

$$T_{(on)it} \geq UT_i(I_{it} - I_{i(t-1)} \quad (5)$$

$$T_{(off)it} \geq DT_i(I_{i(t-1)} - I_{it} \quad (6)$$

This paper proposed and adopted a new heuristic method known as the charged system search algorithm for the MG operation. This technique is taken from [12]. Also, a

mutation operator is considered to speed up the convergence speed of the algorithm. Results shows the higher speed of the algorithm compare to the PSO and GA.

III. Simulation Results

Fig. 1 shows the IEEE 69 along with 4 DGs.

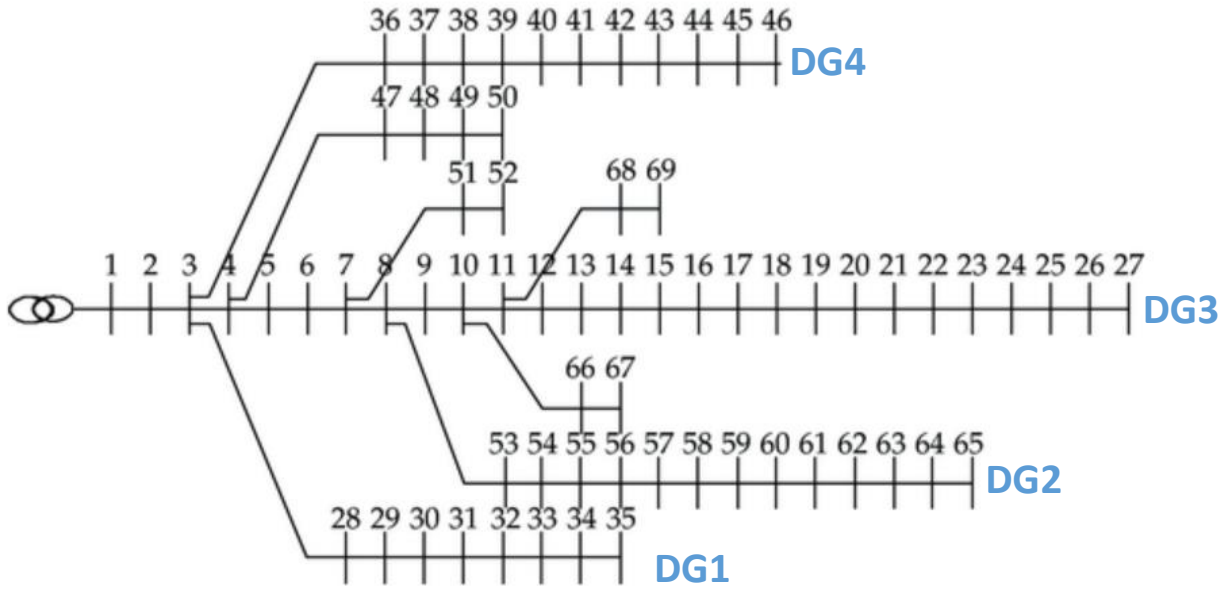

Fig. 1. IEEE 69 bus test system diagram

DGs feature are in Table I.

Table I
DGs features

	Minimum output power	Maximum output power
DG1	20	400
DG2	40	450
DG3	10	250
DG4	10	250

Load demand of the network are presented in Fig. 2.

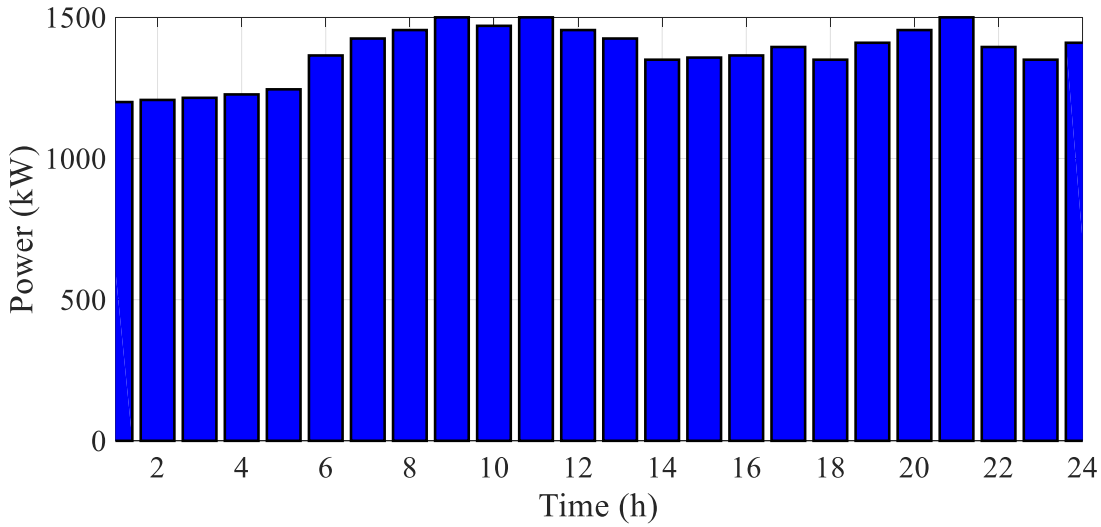

Fig. 2. Load demand of the network

DGs output power are mainly based on the economic perspective as shown in Fig. 4. The active DGs is the first DG where it has lower price.

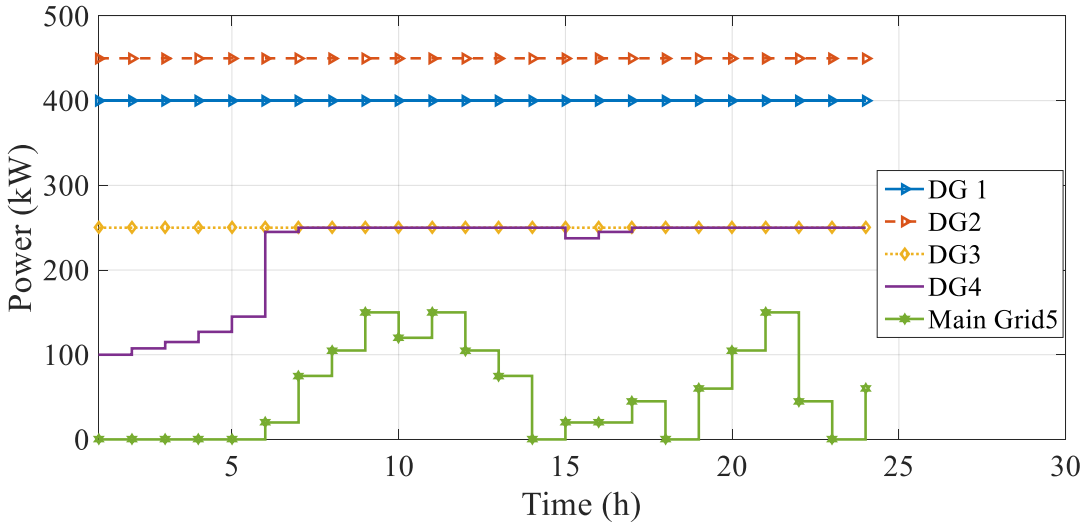

Fig. 3. Produced powers by DGs

Table II compare the operation cost and convergence speed of the algorithm. The results prove the effectiveness of the proposed model.

Table II

Cost of operation for several methods

	cost ($)	Convergence (s)
PSO	637335	11.1
GA	623437	9.9
Proposed method	534534	7.3

IV. Conclusion

Charged system search algorithm is one of the powerful heuristics techniques that has been used in this paper for optimal energy management of the grid-connected MG. Results shows that compare to the PSO and GA, this method has higher convergence speed, which is one of the key points in MG operation. In addition, it has lower operation cost for the MG operation compare to GA and PSO.

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