Economic Dispatch on Microgrid by using Cuckoo Search Algorithm  
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Abstract— In this modern science world, the usage of power is very high. As the usage is increased, the power demand is also gets increased. In order to compromise/compensate the power demand, different forms of power sources are preferred. Dispatchable energy resources (non-renewable energy sources) are the sources can be turned on and off in short amount of time and it is generated from different techniques. Non-dispatchable energy resources (renewable energy resources) include the nuclear power plants, hydroelectric plants, and wind and wave energy resources. The Distributed Energy Resources (DER) typically use these renewable energy sources, including small hydro, biomas, solar power, wind power and geothermal power for an electric power distribution system and DER is coordinated within a microgrid. A Microgrid is a localized group of electricity generation, energy storage and loads that operates connected to a centralized grid (macrogrid). This work focuses on to minimize the total operation cost in microgrid. Here, the operating cost is optimized by using a new cuckoo search algorithm. Cuckoo search is a meta-heuristic algorithm. The algorithm is implemented using MATLAB package.  

Key words: Economic Dispatch, Microgrid, Cuckoo Search Algorithm  

I. INTRODUCTION  
Microgrid is an integrated energy system intelligently managing interconnected loads and distributed energy resources and capable of operating in parallel with, or independently, from the existing utility’s grid. A microgrid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. Microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode.  

The economic dispatch of generation in power systems is one of the most important optimization problems for both the generating companies competing in a free electricity market and the systems operator (SO) in charge with fair handling of transactions between electricity suppliers and their customers. The fuel cost component is still the major part of the variable cost of electricity generation, directly reflected in the electricity bills. Economic dispatch aims at allocating the electricity load demand to the committed generating units in the most economic or profitable way, while continuously respecting the physical constraints of the power system.  

The concept of MicroGrid (MG) has been proposed as a way to solve several problems associated with the integration of small generators in distribution feeders. The ability of MG operates either connected to the main grid or as an island, without the need of a fast and sophisticated central control, allows exploring in large scale, the use of the renewable and nonrenewable electricity generating technologies in the local consumption. The main advantage of the MG can be regarded as a manageable entity within the power system, operated as a single aggregated load with the potential to participate in the provision of ancillary services to the utility.  

II. EXISTING SYSTEM  
The main objective of the economic dispatch of generation in power systems is to determine the output of each generating unit based on the committed generation mix for the next dispatch interval such that the total generation cost is minimized, while continuously respecting system constraints. To reduce the operation cost, previously Simulated Annealing, Genetic Algorithm(GA)[2], Dynamic Programming (DP), Evolutionary Programming(EP) Neural Network(NN) Particle Swarm Optimization(PSO)[4], Artificial Bee Colony (ABC) algorithms were used. Here, ABC is discussed.  

A. Artificial Bee Colony (ABC)  
1) Introduction  
Swarm Intelligence employs the collective behaviors in the animal societies to design algorithms. In 2005, Karaboga proposed an Artificial Bee Colony (ABC), which is based on a particular intelligent behavior of honeybee swarms.[5]  

- ABC is developed based on inspecting the behaviors of real bees on finding nectar and sharing the information of food sources to the bees in the hive.  
- Agents in ABC:  
  - The Employed Bee  
  - The Onlooker Bee  
  - The Scout  
- The Employed Bee: It stays on a food source and provides the neighborhood of the source in its memory.  
- The Onlooker Bee: It gets the information of food sources from the employed bees in the hive and select one of the food source to gather the nectar.  
- The Scout: It is responsible for finding new food, the new nectar, sources.  

2) Procedures of ABC  
- Initialize the population.  
- Modify positions.  
- Apply selection criterion.  
- Repeat (cycle.)  
- Allow the employed bees to share the food information with onlooker bees.  
- Allow the onlooker bees to choose the best food source based on the probability calculation.  
- Apply selection criterion.
- Check for an abundant solution, and (if exists) initiate a new food-source position. Otherwise, follow the next step.
- Retain best solution so far.
- Until stopping rule.

Algorithms like Cuckoo Search Algorithm can handle the above complexities & lead to good quality of solutions. The number of parameters to be tuned is less than GA and PSO [12], and thus it is potentially more generic to adapt to a wider class of optimization problems. CS is more generic and robust for many optimization problems, comparing with other meta-heuristic algorithms.

A. Cuckoo Search Algorithm (CSA):
CSA (Cuckoo search algorithm) is a new meta-heuristic optimization algorithm developed by Yang and Deb in 2009. This algorithm is based on the obligate brood parasitic behavior of some cuckoo species in combination with the Levy flight behavior of some birds and fruit flies[1]. CSA has been successfully applied in multi-objective scheduling problem, reliability optimization problems and DG allocation in distribution network. Two main characteristics of meta-heuristic algorithms are: Intensification and Diversification. Intensification means to focus the search in a local region knowing that a current good solution is found in this region. Diversification means to generate diverse solutions so as to explore the search space on a global scale. A good balance between intensification & diversification is to be found during the selection of the best solutions to improve the rate of algorithm convergence. A good combination of these two major components will usually ensure that global optimality is achievable.

Cuckoo Search is a nature-based searching technique which is inspired from the obligate brood parasitism of some cuckoo species by laying their eggs in the nests of other host birds of other species[11]. Cuckoo Search Algorithm is a meta-heuristic algorithm developed in recent times. It can act as a very efficient tool for selecting the proper combination of generators for practical non convex economic load dispatch subjected to several constraints, especially for large scale systems. In addition, this algorithm is enhanced by the so-called Lévy flights. Cuckoo search is based on three idealized rules:
1) Each cuckoo lays one egg (a design solution) at a time, and dumps its egg in a randomly chosen nest among the fixed number of available host nests.
2) The best nests with high quality of egg (better solution) will be carried over to the next generation.
3) The number of available hosts nests is fixed, and the egg laid by a cuckoo is discovered by the host bird with a probability of pa [0,1]. In this case, it can simply either throw the egg away or abandon the nest and find a new location to build a completely new one.

B. Flowchart of CSA:
Now, based on the algorithm for CSA, the flowchart can be easily drawn. The flowchart of CSA will definitely help in better understanding of the cuckoo search technique & give a clear view of it. The flowchart describing CSA via Lévy flights is shown Fig. 2.
IV. RESULT ANALYSIS

A. Power Output for 40 Gen:

<table>
<thead>
<tr>
<th>Output (MW)</th>
<th>CSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>112.0518</td>
</tr>
<tr>
<td>P2</td>
<td>111.4948</td>
</tr>
<tr>
<td>P3</td>
<td>97.5626</td>
</tr>
<tr>
<td>P4</td>
<td>179.8000</td>
</tr>
<tr>
<td>P5</td>
<td>88.9934</td>
</tr>
<tr>
<td>P6</td>
<td>140.0000</td>
</tr>
<tr>
<td>P7</td>
<td>299.9903</td>
</tr>
<tr>
<td>P8</td>
<td>284.9506</td>
</tr>
<tr>
<td>P9</td>
<td>284.9583</td>
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<tr>
<td>P10</td>
<td>130.0006</td>
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<tr>
<td>P11</td>
<td>94.0000</td>
</tr>
<tr>
<td>P12</td>
<td>94.0000</td>
</tr>
<tr>
<td>P13</td>
<td>214.7621</td>
</tr>
<tr>
<td>P14</td>
<td>304.5194</td>
</tr>
<tr>
<td>P15</td>
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<td>P18</td>
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<tr>
<td>P19</td>
<td>511.2797</td>
</tr>
<tr>
<td>P20</td>
<td>511.2799</td>
</tr>
</tbody>
</table>

Fig. 2: Flowchart of CSA Algorithm

Fig. 3: Cost convergence characteristic of microgrid power dispatch

V. CONCLUSION

The economic dispatch problem was formulated in accordance with various constraints related to the operation of a microgrid. The microgrid on ELD is solved using the proposed new Cuckoo Search Algorithm. As compared with the existing algorithms, the new meta-heuristic algorithm provides a better operation cost. The results are compared for three and six generating units system. The program is written in MATLAB software package.

REFERENCES


