

# Load Balancing in Distribution System Using Heuristic Search Algorithm

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**Abstract**—With the increasing use of technology and automation in various fields of modern life, the electrical outage has become a major impact to complete the requirements in the daily life of most sectors like industrial, economic and even recreational. It is, therefore, necessary to have access to a reliable electrical system to ensure continuity of consumer electric consumption. Based on the above, the heuristic searching algorithm is proposed for loads balancing in an unbalanced electrical distribution network. The imbalance ratio was calculated for the network chosen for study. The heuristic algorithm is programmed using values represent the three-phase currents of 20 houses. Each house assumes to have a smart energy meter connected with some contactors used for current balancing by phases swapping. Three cases are programmed using the heuristic algorithm to study the effect of used different numbers of contactors in each house. All the cases show high performance in loads balancing and reduced the imbalance index.

**Keywords**—load balancing; heuristic search algorithm; electrical distribution network; imbalance index.

## I. INTRODUCTION

The future of systems in the world is the transformation intelligent systems, including the electrical power system and distribution networks. Modern technology can be invested in order to eliminate many problems in the system, including an imbalance in voltage and current, as well as the unbalanced distribution of loads on the three phases of the network leading to one of its limbs exceeding the permissible load. The risks of imbalance are many, including voltage drop or malfunction of transformers and increase the probability of the breakdown. As well as the energy losses are increased due to imbalances. The unbalanced electric distribution network adversely affects the process of power production in terms of increasing loss of network. As well as increase the operation and maintenance costs of network equipment of transformers, circuit breakers and others, which called for the search for, balance mechanisms to reduce the effects of the imbalance problem. Many ways can be used to solve this problem, but some are expensive, such as redistribution and transfer of electrical transformers, using Scott transformer and Steinmetz, connect circuit breakers and capacitors, using static-VAR-compensators (SVC), feeder reconfiguration, and phase swapping [1].

Feeder reconfiguration and Phase swapping are the processes through which the network order is changed once at the system level and once at the feeder level respectively by open/close switches [2,3]. Phase swapping method is a high-efficiency way to achieve balance in terms of its three phases by re-linking loads and distributing them to the three phases of the feeder. While the method feeder reconfiguration is done by opening and closing the keys tied at the beginning and end of each feeder which is designed to balance the feeders in the electrical grid, and thus transfer several houses linked to the feeder present in each balancing process and this method is less efficient if compared to the way of phase swapping [4, 5]. The method of feeder reconfiguration has been studied by many researchers and has used various methods to find the balance cases using Heuristic Search Approach [6], GA [7], Fuzzy logic [8] and the combination of fuzzy logic and Newton–Raphson [9].

In this paper, a new method was introduced to restore balance in electric distribution network. This method is designed to operate within a region consisting of a re-distribution and balancing device (at the transformer) and intelligent devices (smart meters) in each house that switches between the three phases by using number of contactors. Where some of these houses work as three phase loads and the other as a single phase loads. The balancing is achieved by swapping the phases on one or more specific houses according to the heuristic search algorithm. This paper is organized as follows: unbalancing in the distribution network is discussed in section II; section III shows the problem description, and the proposed control strategy is discussed in section IV. Section V shows the simulation results. Finally, the conclusion will be in section VI.

## II. UNBALANCING IN DISTRIBUTION NETWORK

Each change occurs at the value of magnitude or phase shift in each phase for the ideal values of current or voltage termed as unbalance. As the operating time of the network increase, the percentage of consumption of electricity will increase and at the same time, the imbalance between the three phases will increase [10]. The increasing in unbalance load is due to [11,12]:

1. Loads increase on one of the phases without the other.
2. The manual switching of one or a number of the single phase houses to another phase.