Design Simulation of Improvement of Voltage Profile and Loss Minimization by Efficient Placement of Distributed Generation in Grid Connected System

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Abstract— Electricity consumption is rapidly increasing, and the gap between generation and load is widening. The mismatch between demand and load causes a range of problems, including failure, low power, and, in certain cases, blackout. These issues will be solved by including Distributed Generation (DG) into the system. For maximum dependability, technological and economic benefits, and optimal size and capabilities of distributed generators, the proper distribution of power systems, kind of generating equipment, number of units, and so on are critical. Among these concerns, the difficulty of placing DG units in the best location and size is critical. Inadequate DG resource distribution to the power system will result in increased power losses. This problem is solved using genetic algorithms. For the conventional 15 bus radial distribution system, the load flow is generated using the backward forward sweep method. Load flow is used to assess the impact of DG size and location on system losses. Machine losses rise as a result of inappropriate DG allocation. As a result, the genetic algorithm (GA), an evolutionary process, is being researched, and an algorithm is being created to discover the appropriate size and position of the distributed generation unit in a radial distribution system. The overall active power losses are reduced, and the voltage profile is improved due to proper DG allocation. Introduces a multi-objective feature that accounts for active power losses, voltage changes, and DG costs, with each variable given a weight. Voltage limits, active power loss constraints, and DG size limitations all affect objective feature minimization. This method is utilized on the conventional 15 bus radial distribution system.

Keywords-Distributed Generation, Micro grid, PSO, ELD, OPF, IEEE-33 Bus, Power System optimization.

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I. INTRODUCTION

In the short term, governments, academia, and non- governmental organizations (NGOs) reflect on the concept of a "microgrid" and its demand because it is a subject of worry that around 1.2 billion people in developing countries do not have access to electricity. Furthermore, microgrids have grown in favor in rural areas with limited access to the main grid, with

power rats fueled by prohibitively high transportation costs (Martinson 2015). Microgrids have also become increasingly important. Meanwhile, capital expenditures for inexhaustible and advanced capacity are rapidly declining, the development of these transported age assets necessitates alternatives in places where transmission agreements are not reached, and oil product transportation costs are increasing power levels (Longe et al . 2014) The spread of ages is a sweaty alternative to increasing the strength of frames for surprising and simple opportunities in Alaska, where one in elevent people live in remote regions (Goldsmith 2008) and the average power cost is
17.46 pennies / kWh, the nation's most impressive (U.S. Vitality Knowledge Administration 2016). (Densmore and Prasad 2015). The microgrid in distant locations has attracted a lot of interest as a result of all of these factors and opportunities.

A basic power appropriation microgrid is defined as a collection of loads and dispersed vitality assets that may be controlled in a planned manner with or without a macrogrid connection. When executives push ahead and need a response to improve their vitality, innovations, such as sustainable generator age or capacity expansion, are integrated in circulated vitality assets (Stadler et al . 2013). (Stadler and colleagues,
2013). Microgrid research is often classified into two categories: macrogrid-related island microgrid analysis and microgrid analysis. Because capital use of sufficient vitality assets of theory leads to arrangements in which the microgrid is connected to the basic lattice, imposing a smaller limit than on- site demand even when power prices are unusually expensive, the results from one methodology and then the next methodology will be completely different. Again, the island microgrids should be included in speculative programs for the total demand for framework vitality. Unless a provincial community has little capital assets, it's interesting that the overall estimated speculation limit in light of the expense of unserved vitality is seladly assessed rather than venture options
in a transmission agency (Schnitzer et al . 2014). Microgrid research may also be isolated in the analysis of the operation and venture options. First and foremost, the project research oversees the best method for enhancing the benefits for microgrid owners after appropriate energy resources are in place. Microgrid interest study, on the other hand, coordinates the precise acquisition, estimation, and location of the spread of vitality attributes in order to maximize the microgrid owner's advantage (Fathima and Palanisamy 2015). Lately, there has been a surge in interest in sustainable products such as rotation, tiny hydro turbines, sunshine, photovoltaic

cells, biomass, geothermal, and CHP, or hybrid. The power companies are currently employing a snapshot reconstruction technique and are requesting that the electrical grid be expanded to accommodate the growing demand. Along these lines, the notion of Distributed Generation (DG) is created to meet this need. The advancement of distributed generation has resulted in new enhancements to the traditional power system. Dissemination Generation is critical to the transportation system because it improves frame reliability, reduces power outages, and raises the voltage profile.

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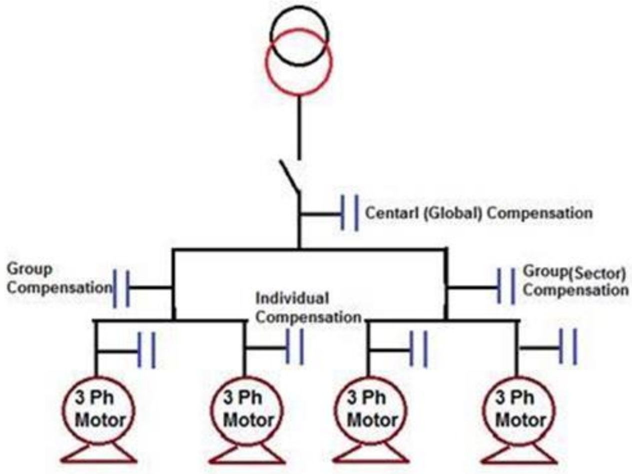

Figure 1.1: Overview of Distribution System

In the current paradigm of centralized generation, electricity is generated mainly shipments via the transmission and distribution grids generation facilities Consumers. Consumers. Latest energy efficiency and reliability measures have however been investigated Opportunities to change and increase the new generation paradigm efficiency. One of the best candidates in this context to supplement the current one paradigm is distributed to generate electricity near its point of use. IEEE describes distributed generation as electricity generation by installations small enough to allow interconnection at almost central generating plants at any power system point. Any point. Generation distributed (or DG) is usually a small (typically 1 kW – 50 MW) generation. Generating electricity at a spot close to customers or close to customers tied to the delivery grid of electricity. There are, but are not limited, distributed generators synchronous generators, generators of induction, reciprocal motors, micro turbines (fuel turbines operating on fossil fuel such as gasoline, propane and natural fuels with high energy sources) gas turbines, fuel cells, photovoltaic and wind

turbines for combustion [19] . When distributed generation is applied to the power system, the power system faces several problems. Current system already; this is because the power system is not built for distributed distribution In mind the age. Adding generation may affect issues with power quality, device reliability loss, performance reduction, over-voltage and protection Issues. The distribution of the power system on the other side is well planned, which could handle the generation addition if proper grounding, transformers and transformers are available. There is security given. There are, however, limitations to adding distributed generations if it goes beyond its limit, so it is necessary to alter and alter the already built equipment and security of the distributed system, which could thus promote the new generation Convergence. Renewable and distributed generation ties to delivery networks have increased complexity within the current operation and control of the network. Such a challenge is the transformation of the network from passive to becoming more active is mainly due to where this new generation is connected.

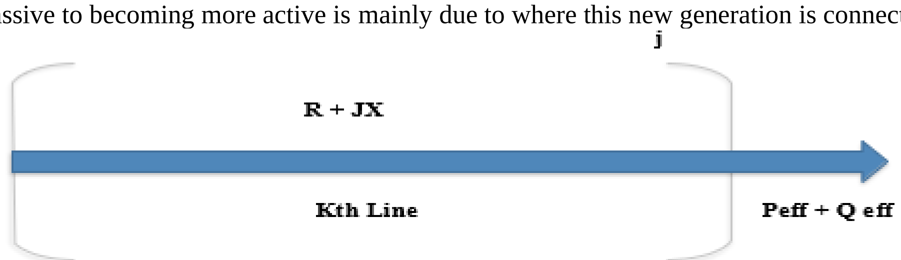

Figure 1.2: Structure of Bus System

Small electric power plants are now viable because to new technological advancements. Furthermore, in order to reduce the impact of power generation on the environment, more renewable energy sources are being used, which has aided in the development and deployment of innovative power supply solutions. In this modern view, this generation does not simply belong to level 1. As a result, centralised generating meets part of the energy demand, while dispersed generation meets the rest. Any small-scale power generation technology that supplies electricity at or near the load site is referred to as distributed generation. It can be connected to the distribution grid, directly to the customer's plant, or both. According to studies, distributed power has the potential to absorb

up to 20% more energy, or 35 gigawatts (GW), in the next 20 years. The scientific art of DG includes small gas turbine generators (including a microturbine), reciprocating internal combustion engines and generators, fuel cells, and solar panels. Solar thermal conversion, DG (also known as the Stirling motor), and biomass conversion are examples of other technologies. In this article, the word DG refers to power output units of less than
10 MW. Backup power production, peak storage, peak allocation, base load generation, or combined heat and power to meet thermal and electrical loads for a specific site are all services that DG can provide utilities and customers. VAR support for ancillary services, voltage support, network dependability, spin reserve, and other more cost-effective advantages all add up to simpler energy than scheduled loads. The environmental benefits of DG technology art can be taken from genuine green electricity (i.e. pictures) in Voltaic) to significantly reduce one or more pollutants linked with coal- fired electricity production. DG vapour sulphur dioxide (turbine generator SO2) emissions of natural gas, for example, of less than a tenth, nitrogen oxides (NOX 1 percent) or less (carbon dioxide CO. 2) low emissions of 40% over several modern coal-fired boiler power plants; these units are safe enough to be located in residential and industrial environments (DPCA, 1998). Some of the current DG technology art includes solar systems, wind turbines, fuel cells, micro turbines, generators, and synchronous induction generators.

II. TYPES OF DISTRIBUTED GENERATION

Distributed generation is defined as an electrical source connected to the power grid that is small enough relative to centralised power plants at a position very close to / or at the customer's site[6, 30]. The greatest evident effect of increased DG unit generation is reduced network loading[11-12]. Modular, small/medium-sized energy conversion units that transform primary energy resources into electricity, as well as combined heat and power (CHP) heating and cooling technologies, are examples of DG technologies. There are three major forms of distributed generation based on device type and grid connection[13-14]. There are two types of traditional DGs that can be directly connected to the electric grid. Induction generators are used in the first, whereas synchronous generators are used in the second. The third type is inverter-based distributed generation (IBDG). Synchronous generators are utilized in most reciprocating motors and high-power turbines (gas, steam, and hydro). They may be both interested in and reacting to the utility system. The electricity system would be plagued by faults caused by these generators. Induction generators are only regularly employed in wind turbines and some low-head hydro applications[15]. Based on electronics, they may have capacitors or reactive compensators[16]. On the utility side, these generators will only produce fault currents for a few cycles during three-phase faults. Interconnection protection for induction generators usually just entails relaying over / under voltage and frequency. Due to continual advancements in power electronics (PE) technologies, they are widely employed to convert most sources of electrical energy into useful sources. One of the most important advantages of PE converters is their quick responsiveness, which is manifested in improved power quality. PE-based inverters are often employed in non-traditional, tiny distributed generators, such as micro turbine generators (MTG), fuel cells (FC), photovoltaic (PV), and fuel cells paired with battery-like energy storage devices. These systems use solid-state microprocessor-controlled technologies to connect asynchronously to the power grid. When the utility device is absent, digital control can reduce the output power and shut down the machine. These technologies can also be employed in high-reliability applications, such as micro grids, to reduce fault currents in distributed generation[15-17]. According to IEEE standard 1547 connectivity criteria, the PE interface can give enough flexibility for parallel and disconnection[11]. However, depending on the situation and interconnection needs, it may be more sensitive.
In terms of security, DG link systems can be classified into two groups: rotating machine-based and inverter-based connections. Depending on the type of generating unit, the voltage produced by inverter-based DG might be DC or AC. DG systems employ inverters to convert their voltage to the nominal value at system frequency in this case[18]. Between renewable energy sources and power networks, the use of a power electronic interface has become required. Recently, there have been two reasons for the rapid evolution of mobile devices. The first is the improvement of electronic power capabilities in terms of the speed and capability of these switches. Second, real-time computer controllers must incorporate sophisticated and complex control algorithms. As a result, these two additions considerably improve the converters' cost-effectiveness and grid compatibility. [29] A general overview of DG units will be presented in the next section, with a focus on their potential influence on distribution networks. Additionally, various aspects of PV, wind turbines, fuel cells, and micro-turbine units as inverter-based DG sources are described. The purpose is to clarify some key points about these technologies. Solar energy is obtained indirectly through the wind. Wind energy accounts for about 1% of total solar radiation that reaches Earth[30]. Wind has been used to pump water, crush grain, propel ships, and create energy for ages. Wind turbines (WTs) convert kinetic energy from the wind into mechanical energy that drives electric generators. The blades that drive a shaft to create power are turned by the wind. The electricity generated by the WT can be directly stored in batteries[20]. Wind energy is one of the most promising DG technologies among renewable resources because of its environmentally favorable characteristics[21]. Wind energy has a number of practical, environmental, and economic advantages. As a renewable energy source, wind energy provides low operating and maintenance expenses. It also doesn't pollute the air or water, and it doesn't include a lot of waste. Unlike traditional thermal power plants, they do not use natural resources such as coal, oil, or gas, and they do not require water during operation. A wind farm is a collection of wind turbines that can be regarded a single source of energy. Modern wind turbines can be built on or off the coast. The capacity and position of wind turbines are determined by load demand and wind speed. The lack of active and reactive control is the root of the major power system issues connected with bringing wind energy into the electrical grid. The goal of active and reactive power management is to keep frequency and voltage within safe limits. Because wind speed is unpredictable, the voltage generated must be converted to DC and then back to AC using inverters. Wind turbines with a fixed speed, on the other hand, are directly connected to the grid[22]. A photovoltaic system collects sunlight and converts it into electrical energy. When exposed to sunlight, semiconductor components in this device's solar cell structure convert photon gathered energy into electricity. The cells are arranged in a fixed or mobile array to keep an eye on the sun for maximum power[22]. These systems are pollution-free and environmentally friendly. They are user-friendly, with basic designs that

do not require any additional fuel. They do, however, necessitate large locations and come at a considerable initial cost. PV systems generate DC voltage, which is converted to AC via inverters. Photovoltaic systems that include and do not include storage systems. The fuel cell was conceived by Sir William Grove in 1839[12]. It was used to control spacecraft in the 1960s, which was the first practical application. Fuel cells have recently been used in a variety of applications because to its excellent power quality, high performance, adaptability, and environmental advantages.

They are new technologies for producing electricity from this electrochemical process that rely on the conversion of hydrogen (from a fuel source) and oxygen (from the air) into water. Essentially, hydrogen fuel enters the cell through the anode, whereas oxygen or air enters through the cathode. The flow of charged hydrogen and oxygen particles is controlled to generate electrical energy. DC voltage is generated by the fuel cells. The DC voltage is converted to AC voltage using inverters, which can then be fed into the grid or used to power local loads. The material used in the electrolyte must have a high electron resistance and a low proton resistance. A fuel reformer is used in modern fuel cell technology to separate hydrogen from hydrocarbon fuels such as petrol, ethane, methane, and even gasoline. An exterior fuel reformer is added to low-temperature fuel cells, whilst high-temperature units use inside ones for compact structure and high-efficiency operation. A fuel cell uses energy to generate heat and water, but it has a high operating cost, which is its principal disadvantage. On the other hand, the effects of pollutant emissions and the aging of electrolyte properties, as well as their impact on cell performance and longevity, must be thoroughly investigated[18].

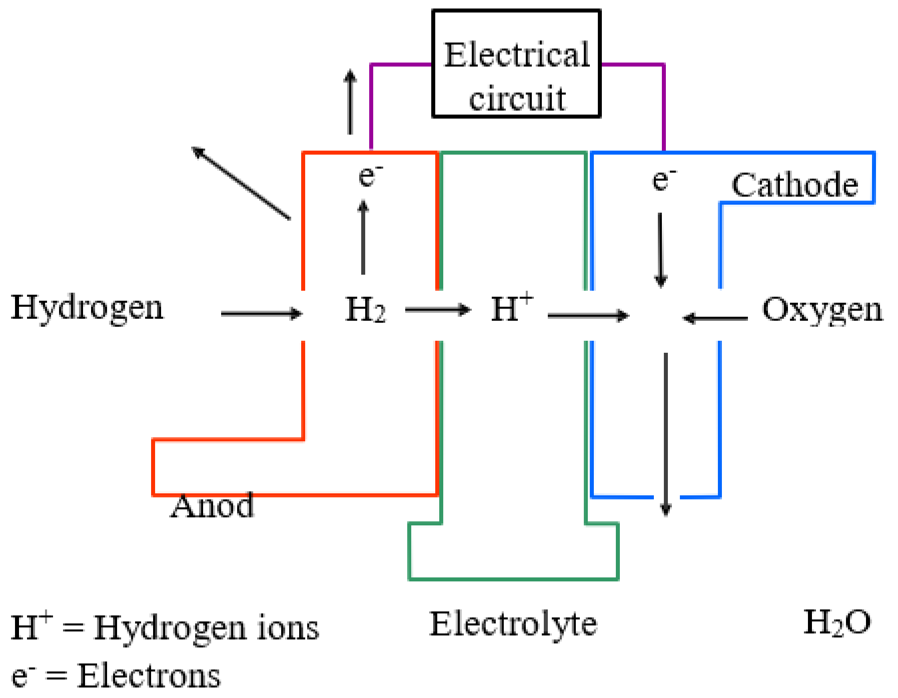

Fig 1.3 Operation principles of fuel cells [18]

IV. SIMULATION AND RESULTS

For radial distribution systems, unidirectional power flow from the substations to the customers can be assumed. The highest voltage can be expected at the substations whereas the lowest voltage occurs at the customer points of connection. Hence, the voltage is decreasing from the substation along the feeders to the customers.

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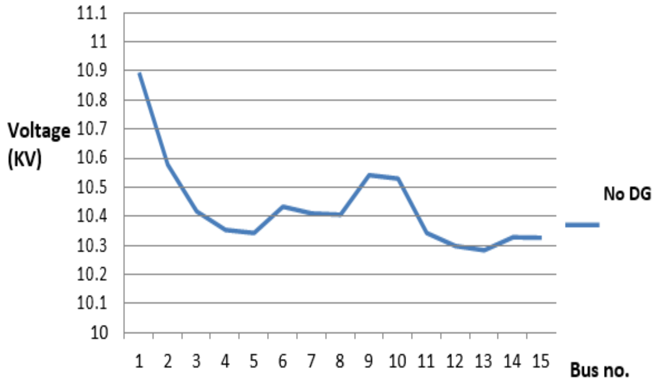

Fig. 1.4 Voltage profile of 15-bus distribution system without DG

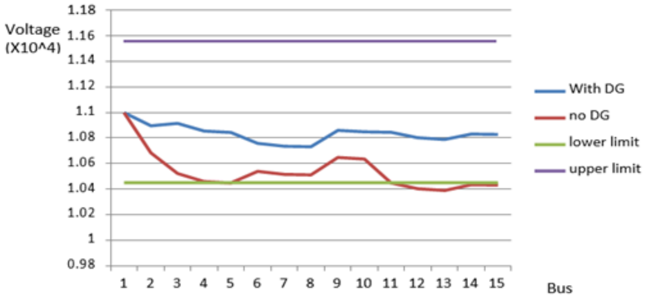

Figure 1.5 mprovement in Voltage Profile with respect to bus

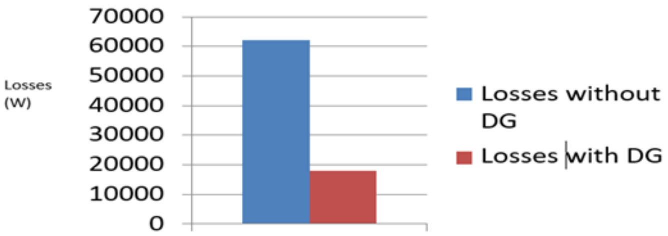

Figure 1.6 Comparison of Losses With and Without DG

Power injections from DGs change network power flows thereby modifying energy losses. Electrical line loss occurs when current flows through transmission and distribution systems. The magnitude of the loss depends upon amount of current flow and line resistance. Therefore, line loss can be decreased by reducing either line current or resistance or both. If DG is used to provide energy locally to the load, the line loss can be reduced because of decrease in current flow in some part of the network. Voltage violations due to presence of
distributed generators can considerably limit the amount of power supplied by these generators in distribution networks. Before installing or allowing the installation of a distributed generator, utility engineers must analyse the worst operating scenarios to guarantee that the network voltages will not be adversely affected by the generators.

V. CONCLUSION

Using the standard 15 bus radial distribution system, power flow is produced using method for Backward Forward Sweep (BFS).The effect of DG size and position on device losses is investigated using this power flow process.The DG allocation and sizing question is of great importance. Installation in non- optimal locations, DG units can lead to an increase in device losses, resulting in a rise in costs and, thus, an effect contrary to what is desired.For that reason, the use of a method of optimization capable of suggesting the best solution for It is very useful for a given delivery network.For optimal sizing and position, the Genetic Algorithm is an evolutionary process. Optimum DG size and position for single (losses) and multi- objective is obtained for two objectives: losses and deviation of accumulated voltage) works.Taking account of costs along with losses and CVD, the best size and position.The outcome is distinct from that of the previous case.

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