ISSN: 0974-5823 Vol. 6 No. 3 December, 2021

International Journal of Mechanical Engineering

DG INFLUENCES THE FUNCTIONING OF THE DISTRIBUTION NETWORK, INCLUDING POWER FLOWS AND VOLTAGES

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ABSTRACT

Reduced actual power loss, cheaper operational costs, and a better voltage profile are all benefits of distributed generation (DG). It is proposed here that the distribution network placement problem is a multi-objective optimization problem that may be solved using a biogeography-based technique for selecting optimal node locations and DG unit sizes (BBO). Biologist-inspired BBO uses migration and mutation operators to look for the best possible answer. The results of a node distribution network test show that the created approach is better to other methods. Voltages at surrounding nodes rise as a result. Techniques for coordinating voltage control resources in a system are referred to as voltage optimization. Optimal voltage settings for all transformers, capacitors, and reactive power compensation devices on the system may be found using this optimization process.

Keywords: grid, loss minimization, Distributed generation, biogeography-based optimization

INTRODUCTION

Waveforms and Harmonics A three-phase power system has distortion harmonics (3rd, 5th, 7th, 9th). If you get harmonics of even order on a three-phase system, you probably have a faulty rectifier. It's pretty uncommon to see an oscilloscope display something other than a perfect sine wave when it's connected to 120 V. Even if it's close, there's a good chance it'll be off in at least one manner.[1] As the magnitude reaches its positive and negative apexes, it may become somewhat averted or dimpled, depending on the situation. Other possibilities include a peaky look from the sine wave being constricted at extreme levels. Every cycle, random deviations from the ideal sinusoid are more likely to occur at certain points on the sine wave. Transformers for distributed photovoltaic grids the mathematical equation for the attended and dimpled sinusoid is as follows.[2]

The 180-Hz sinusoid has a frequency three times the fundamental frequency and is also in phase with the fundamental frequency component. Because of the core's structure, transformers appropriate for DPV grid applications may also have out-of-phase third harmonics. For a three-phase application, these transformers are core type and feature three limbs. [3] As an example, the peaky sinusoid may be represented mathematically as follows: It may be written a negative sign precedes the "0.25 sin (3x)" phrase, which indicates that the third harmonic component is out of phase with the fundamental frequency, as in the first waveform. Waveforms seem vastly different because of this minor mathematical change. In addition to the third harmonic, the waveform contains a number of additional harmonics. [4]

Some are in sync with the basic frequency, while others are out of sync with the frequency. Increasing the number of harmonics in the harmonic spectrum causes the waveform to become more complicated. Waveforms and Harmonics The basic frequency sinusoid may be totally obscured by distortion harmonic spectrum, rendering a sine wave unidentifiable. When the magnitudes and orders of harmonics are known, it is straightforward to rebuild the deformed waveform using frequency analysis. [5] The warped waveform is created by adding the harmonics one at a time. Two components, red and blue waves, are added together to create a green one for each value of x, which is what we get when we combine the magnitudes of the red and blue waves. A distorted waveform is more difficult to decompose into its harmonic components than a normal waveform. Calculus is involved in this procedure, which needs Fourier analysis. The Fourier spectrum analysis reveals the power inherent in each frequency component of the power signal that is being processed. Although electronic devices have been created to handle this task.[6] The basic frequency sinusoidal waveform is somewhat altered. An algorithm based on biogeography theory, known as a biogeography-based optimization (BBO), has been developed. When compared to the PSO and GA algorithms, BBO has better convergence performance. Expert academics have also used practical investigations to verify BBO's skill in optimization. It is still necessary to further strengthen the basic BBO's optimization performance since it still suffers from premature convergence and the problem of local optimization. Micro gas turbines, solar arrays, fuel cells, storage batteries and wind turbines all play a role in optimising the average daily microgrid system in summer. On the basis of fulfilling the load demand and system restrictions, an optimum scheduling model for the microgrid under grid-connected operation is constructed.[7]

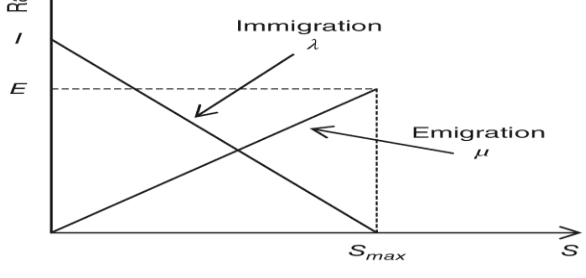

Figure 1 Optimization Pattern

According to Iftikhar (2018): [8] Using a meta-heuristic technique called Genetic Algorithm (GA) and Biogeography-based Optimization (BBO) integrated into Energy Management Controller (EMC), we examine the efficacy of home energy management in residential areas. In order to save costs and control high peak demand, EMC is deployed. Using a time-of-use pricing approach, power bills are calculated. The suggested load control and cost reduction method is shown to be effective and efficient through simulation results. EMC based on BBO outperforms EMC based on GA. Unscheduled against GA and BBO-based EMC are also compared, and the findings suggest that both outperform unscheduled. Electricity cost minimization and peak to average ratio minimization are more effectively achieved with BBO EMC than GA based EMC. We use EMC to assess HEM in this work. GA and BBO are the scheduling algorithms we employ for the appliances. On-peak hours are shifted to off-peak hours with the help of EMC. Comparing scheduled flights to unexpected ones saves money and reduces the probability of adverse reactions (PAR). When calculating electric costs, the price signal is employed. The results of the simulation suggest that BBO is effective in reducing both PAR and costs.

Mohammad Al Samman [9] If you're looking for a clean and abundant source of energy, go no further than renewable resources (RERs). If you're dealing with a non-dispatchable RER, you'll need to execute NRs on a regular basis in order to reduce power loss and optimise the voltage profile of the distribution system. Meta-heuristic approaches are widely used to handle this difficult problem because of the complicated combinational character of the problem. Traditional meta-heuristic procedures, however, typically create a lot of unfeasible answers, which impedes the search. Two-stage optimization employing biogeography-based optimization is proposed to achieve the NR and RER placement and size concurrently for the sake of minimising power loss and voltage variation. Initial solutions and network radiality are maintained by simplifying the distribution network initially, and then using the simplified version in subsequent stages. After that, the final NR and RER placements and sizes are determined in the second step. All three bus sizes are tested in the simulations; the results are then compared to previously published methodologies and some well-known optimization techniques. In addition, the RER's uncertainty and load fluctuations are also taken into account. The findings reveal that the suggested strategy outperforms the current methods in terms of accuracy. Furthermore, the results show that the hourly NR is important in decreasing power loss.

METHODOLOGY

The best settings for executing GA are as follows: a crossover chance of 0.8 and a mutation probability of 0.001. Onlooker bees are equivalent to employed bees in ABC, hence the colony size (employed bees + onlookers) is set at population size. The maximum and lowest inertia weight factors max and min are both fixed at 0.9 and 0.4, respectively, while performing PSO. Control factors such as population size and the maximum number of iterations are the same for all four approaches. It was decided that Mixite would have a 50/100 split. Third, 9th, and 15th harmonics within the secondary windings are treated with suitable phase shifting, while fifth and seventh harmonics upstream are treated with appropriate phase shifting. Even under the most intense nonlinear load circumstances, phase-shifting harmonic mitigation transformers deliver exceptionally low output voltage distortion and input current distortion (data centres, Internet service providers, telecom sites, call centres, broadcasting studios, etc.).

When zero-sequence cancellation is combined with phase shifting, it addresses 3rd, 5, 7, 9, 15, and 19 harmonics in the secondary windings. Thermal overheating, magnetic saturation, and system resonance can all be caused by harmonics and inter harmonics in the DPV-GT network. Voltage tickers and fluctuations in the system and grid voltages are the result of this. Harmonics are AC voltages and currents with frequencies that are integer multiples of the fundamental frequency of the AC circuits. When using a 60-Hz system, this might contain second, third, and fourth-order harmonics. Only odd-numbered items are allowed. As a single-objective optimization model is created by adding a weight coefficient, the environmental treatment cost model is transformed into a multi-objective optimization model and the optimization outcomes achieved with various weight coefficients are examined.

Microgrid hybrid island operation is a complex problem that requires a solution that takes into account all of the costs associated with operating a microgrid, including the investment cost of equipment, environmental protection costs, operational costs, maintenance costs, and fuel costs. A microgrid optimization operation approach based on an advanced gravitational search algorithm is used to examine multiple objectives, including economic advantages, network loss, and environmental costs. An optimization model for a microgrid based on three indicators, including the microgrid system's voltage stability, active power loss (active power consumption), and gas pollution, is constructed; the strong Pareto evolutionary algorithm presented solves this model A dynamic economic dispatch model for a microgrid with wind farms is developed using the idea of chance-constrained programming, and a hybrid intelligent optimization technique integrating sequence operation theory and a genetic algorithm is presented to solve the model. An Adaptive Modified Firefly Algorithm (AMFA) is developed to model the unpredictability of light and wind power. Many of the algorithms discussed above take economic and environmental considerations into account, however they do not take into account tactics for optimising load. This work proposes a multi-objective optimization technique that takes into account interruptible load shifting. In Distributed Photovoltaic Grid Transformers, Harmonics and Waveform Distortion (Loss, Power Rating) Grid-tied distributed photovoltaic grid transformer (DPV-GT) systems do not provide a clean sine wave voltage supply. Harmful harmonics and inter-harmonics are superimposed on supply voltage in the form of DPV-GT systems. This results in the power quality issues that might be brought on by harmonics in the voltage or current.

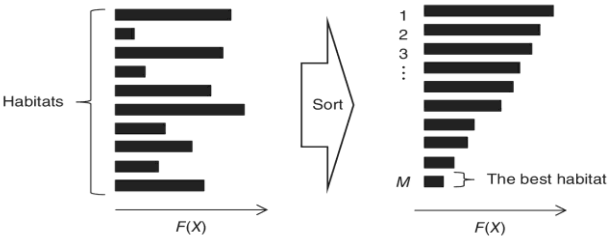

Figure 2 Distributed Grid Optimization using biogeography

As specified by IEEE P1-433-A, the harmonics are multiples of the fundamental component's frequency (e.g., 60 or 50Hz) and described by their spectral distribution and values in the frequency range. IEC 61000-2-1 defines a number of different types of inter harmonic harmonics, including voltage or current harmonics with frequencies that differ from the fundamental frequency but are not multiples of it. Due to the harmonics produced into the system by the inverter mechanism, DPV-GTs experience waveform distortions. The normal harmonic content of the solar inverter system is less than 1%, which has a negligible effect on the system. Due to the absence of wind turbine-like generators and switching and protective controls like those present in wind turbines, there is a reduced harmonic profile. As a result of cloud cover, the DPV-GTs are subjected to additional harmonics, which have an impact on the system's performance. Specifically, these harmonics are created by the intermittent generation of energy owing to cloud cover. Nonlinear loads introduce harmonics into the system. These loads pull harmonic currents, which are the source of the harmonic volt-ages. Switch-mode power supplies, gas-discharge and lamps, variable speed drives, uninterruptible power supplies, cyclo-converters, phase-angle regulated loads, arc furnaces, static-VAR compensators, and transformers are examples of harmonic current sources. Linear loads such as resistors, capacitors and inductors can also be exposed to harmonic currents as a result of distorted voltages. It is possible for single-phase loads to have total harmonic levels of up to 100 percent, however harmonic voltage distortion of more than 8.5 percent is often not expected. Modern transformer-less inverter designs also include even powered harmonics. Examples include PWM-controlled inverters. These harmonics can also be created by loads that have unbalanced I/V characteristics. In light of global warming and the depletion of energy, renewable clean energy, such as wind and solar power, has gained in popularity.

However, the unpredictability and intermittency of wind energy and light intensity have a significant impact on the grid's stability and dependability. Furthermore, it is difficult for a power infrastructure with only a few renewable sources to fulfil the demands of isolated islands. As a result of this, a microgrid, which includes a distributed power source, a load unit, a battery, and a control unit, can handle the above issues well. For many researchers, optimising a microgrid system for economic and environmental reasons has become a hot study area. First and foremost, research themes in the field of microgrid energy system optimization focus on the optimization of output power or economic model, the enhancement of evolution strategy or control system optimization. When it comes to the scheduling of distributed power generation, nonlinear and non-convex multi-objective optimization problems are the norm.

Such challenges are beyond the capabilities of typical optimization algorithms and mathematical methodologies. There are several types of intelligent optimization algorithms that have distinct impacts in different sectors. For example, the PSO, the GA, and the BFA are all examples. Recent years have seen the widespread usage of intelligent optimization algorithms in a microgrid's power distribution. Optimization algorithms have evolved throughout time via the efforts of a number of researchers. A multi-objective particle swarm algorithm based on niche technology is utilised to solve the optimization model of a microgrid, which considers the economy, environment, and system operating concerns. The running costs of a microgrid can be reduced by recycling waste heat in the system, which is done in a microgrid system.

EXPERIMENT RESULT

Biogeography optimization method are used to increase the microgrid's energy efficiency and pollution emissions. An enhanced genetic optimization technique is proposed in the classic niche technology by improving the elimination criteria for individual fitness. To decrease overall active power loss, we apply the BBO approach to discover the best position and size of PVDG units while meeting harmonic flow limits and keeping the voltage of all buses within an acceptable range. IEEE 33-bus and IEEE 69-bus power distribution networks are used in the BBO method's two study scenarios for testing purposes. The Appendix contains the data for the two systems. With the help of three different techniques, BBO's performance is evaluated for each of the two power systems using artificial bee colony (ABC), particle swarm optimization with inertia weight, and genetic algorithm (GA). It takes 30 attempts of each approach to run on a home computer with a 2.0GHz processor and 2.0GB of RAM for each case.

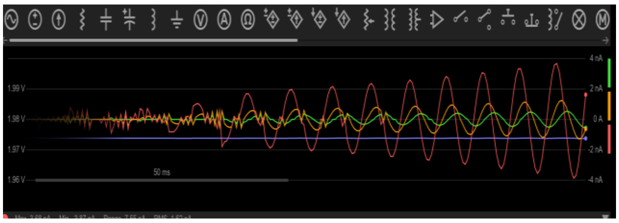

Figure 3 Output signal before optimization

This multi-objective function is handled by setting 1's weight factor 0.6 for total power loss objectives, while the weight factor 2's weight factor 0.4 for harmonic flow objectives. In addition, the selection satisfies the requirement and is also consistent with the multi-objective function. Although F2 is the sum of two harmonic objective functions, F2 THD and F2 IHD, optimization of F2 is not as significant as F1. We want to minimise F1 total power loss and maintain acceptable levels of THD and IHD. Using the new biogeography-based optimization method described in this research, which incorporates numerous power sources including wind turbines, solar cells, mini gas turbines, batteries, and grid-interaction power, the microgrid's individual characteristics and many goals may be optimised. Its storage battery can hold up to 250 kWh of charge, and it has a 50-kw maximum interaction power. The microgrid system buys energy from the big grid as positive and sells it as negative; hence, it has a 250-kWh maximum charge capacity. The peak power usage of the day is between 12:00 and 20:00, and the maximum can reach 160 kW, based on an investigation of the local climate and electricity consumption. Also included are statistics on light intensity, temperature, wind speed, and other weather conditions. Figure 1 shows that between 12:00 and 13:00 on that day, the light intensity reached 1000 W/m2, the temperature reached 31°C, and the wind speed reached 9.2 m/s at 10:00. Wind turbines and solar cells will continue to operate in MPPT mode (output curves presented) to ensure optimal use of renewable energy and maximum economic and environmental advantages. At 10:00 in the morning, the wind turbine's output power and photovoltaic power generation are at their peak, with a total output power of 46 and 36 kW, respectively, for the day.

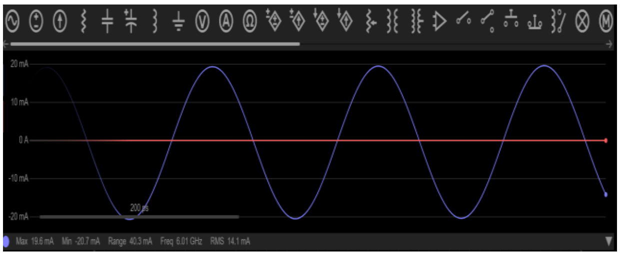

Figure 4 Optimized Noiseless DG signal

Electricity prices, environmental penalties, and other statistics are available in real time. For the BBO and IBBO algorithms, the initial population size NP is set to 100, the maximum number of species Smax is also 100, the immigration and emigration rates are both limited to 1.0, the mutation rate is also limited to 0.005, and the total number of iterations is limited to 500. These parameters are specific to the algorithms. With the population size of 100, the other algorithms have the same parameter values as the IBBO algorithm. Engineers "optimised" the electrical power system using a mix of experience, judgement, and rules of thumb devised by network operators. Second-half 20th-century engineers began to use computers for system operation, and in particular for optimising energy flows in a system by applying optimization techniques to the system. In the milestone, the optimal power flow (OPF) and techniques for solving the OPF were developed. In current power and energy systems, OPF methods have become critical. The OPF's most essential use is in the transportation of goods and services. "Dispatching" all energy sources in the system in the most cost-effective manner, or minimising overall generating costs, is the focus of this topic. Because of the physical limits of electrical networks, this optimization is generally restricted by ensuring that the power lines flow, voltage, and other technical constraints are not breached at any point in time. Complexity is the name of the game here. DG influences the functioning of the distribution network, including power flows and voltages. System losses are also affected by DG. As DG is generally positioned near to the point of consumption, the impact on losses is often beneficial. As a result, the amount of energy that must be carried is reduced, resulting in lower losses. The reliability and quality of the electrical system's power supply can also be affected by DG. Previous studies have shown that DG may lower the load on the network during key moments, or provide some of the demand in the network during breakdowns and shortages, hence improving dependability. The dependability of DG systems can be negatively impacted, particularly in circumstances when network protection systems have been unable to coordinate properly due to DG's interference. In the past, researchers have looked at the optimal placement of DG in the networks; that is, how to find the best position for DG to give system performance improvements.

CONCLUSION

It has been shown that BBO's optimization performance may be enhanced by improving the migration strategy and establishing a better migration rate determination theory. Microgrid operating technology may be enhanced by using this optimization approach based on an improved biogeographical optimization algorithm. To maximise the advantages of a microgrid, we must examine the power shifting of interruptible loads; create incentive measures for the user side; enhance demand management; and direct the load. If we can do this successfully, the maximum utilisation of renewable energy can be realised efficiently. As with the OPF problem, the DG placement issue may be expressed as an optimization. While a network operator may be able to affect the position of DG in theory, this is generally dependent on variables including site availability, construction and planning permission concerns. When connecting distributed generation (DG) to the distribution network, voltage limitations are generally the most significant stumbling block. Excess voltage fluctuations and voltage increase (overvoltage) are key concerns in "weak" networks (e.g., rural systems with long, radial electrical lines). When demand is low and DG output is high, reverse power flows and a surplus of energy from DG are common.

REFERENCE

1. Rahim, S., Javaid, N., Ahmad, A., Khan, S.A., Khan, Z.A., Alrajeh, N., Qasim, U.:Exploiting heuristic algorithms to efficiently utilize energy management controllerswith renewable energy sources. Energy Build. 129, 452–470 (2016)
2. Ma, K., Yao, T., Yang, J., Guan, X.: Residential power scheduling for demandresponse in smart grid. Int. J. Electr. Power Energy Syst. 78, 320–325 (2016)
3. Javaid, N., Javaid, S., Abdul, W., Ahmed, I., Almogren, A., Alamri, A., Niaz,I.A.: A hybrid genetic wind driven heuristic optimization algorithm for demandside management in smart grid. Energies 10(3), 319 (2017)
4. H. Iftikhar et al.4. Rajalingam, S., Malathi, V.: HEM algorithm based smart controller for home powermanagement system. Energy Build. 131, 184–192 (2016)
5. Keshtkar, A., Arzanpour, S., Keshtkar, F.: Adaptive residential demand-side man-agement using rule-based techniques in smart grid environments. Energy Build.133, 281–294 (2016)
6. Barbato, A., Capone, A., Chen, L., Martignon, F., Paris, S.: A distributed demand-side management framework for the smart grid. Comput. Commun. 57, 13–24(2015)
7. Zhao, Z., Lee, W.C., Shin, Y., Song, K.-B.: An optimal power scheduling methodfor demand response in home energy management system. IEEE Trans. Smart Grid4(3), 1391–1400 (2013).
8. Iftikhar, Hina & Asif, Salma & Maroof, Rubab & Ambreen, Khadija & Nasir Khan, Hasan & Javaid, Nadeem. (2018). Biogeography Based Optimization for Home Energy Management in Smart Grid. 177-190. 10.1007/978-3-319-65521-5_16.
9. Mohammad Al Samman1, 2020 "A two-stage method using biogeography-based optimization for simultaneous network reconfiguration and renewable energy integration" Journal of Renewable and Sustainable Energy 12, 035301 (2020); https://doi.org/10.1063/1.5144366
10. Samadi, P., Wong, V.W.S., Schober, R.: Load scheduling and power trading insystems with high penetration of renewable energy resources. IEEE Trans. SmartGrid 7(4), 1802–1812 (2016)
11. Zhu, Z., Tang, J., Lambotharan, S., Chin, W.H., Fan, Z.: An integer linear pro-gramming based optimization for home demand-side management in smart grid.In: 2012 IEEE PES, Innovative Smart Grid Technologies (ISGT), pp. 1–5. IEEE(2012)
12. Mik, S., Stuchl, J., Plato, J., Krmer, P.: A heuristic approach to active demandside management in off-grid systems operated in a smart-grid environment. EnergyBuild. 96, 272–284 (2015)
13. Jalali, M.M., Kazemi, A.: Demand side management in a smart grid with multipleelectricity suppliers. Energy 81, 766–776 (2015)
14. Shakeri, M., Shayestegan, M., Abunima, H., Reza, S.M.S., Akhtaruzzaman, M.,Alamoud, A.R.M., Sopian, K., Amin, N.: An intelligent system architecture inhome energy management systems (HEMS) for efficient demand response in smartgrid. Energy Build. 138, 154–164 (2017)
15. Mardle, S., Pascoe, S.: An overview of genetic algorithms for the solution of opti-misation problems. Comput. Higher Educ. Econ. Rev. 13(1), 16–20 (1999)14. Simon, D.: Biogeography-based optimization. IEEE Trans. Evol. Comput. 12(6),702–713 (2008)
16. Ammu, P.K., Sivakumar, K.C., Rejimoan, R.: Biogeography-based optimizationasurvey. Int. J. Electron. Comput. Sci. Eng. 2(1), 154–160 (2013)