ANT LION OPTIMIZATION OF ON-GRID SUPPORTED BY PV/WIND CONSIDERING LIBYAN ENERGY

Abdulgader Alsharif

Division of Electrical Power Engineering, School of Electrical Engineering, Faculty of Engineering
Universiti Teknologi Malaysia, UTM, 81310, Skudai, Johor
Malaysia.
Technical College of Civil Aviation and Meteorology, Esbea
Libya
habdulgader@graduate.utm.my

Tan Chee Wei*

Division of Electrical Power Engineering, School of Electrical Engineering, Faculty of Engineering
Universiti Teknologi Malaysia, UTM, 81310, Skudai, Johor
Malaysia.
cheewei@utm.my

Razman Ayop

Division of Electrical Power Engineering, School of Electrical Engineering, Faculty of Engineering
Universiti Teknologi Malaysia, UTM, 81310, Skudai, Johor
Malaysia.
razman.ayop@utm.my

***Corresponding Author email: cheewei@utm.my**

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editor@readersinsight.net

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ABSTRACT

The increasing developments in Renewable Energy Sources (RESs) which provide benefits to address the growing future electricity demand need to be studied in depth. For better power performance to solve difficulties in power production, the On-grid system integrated with RESs can be adopted. This paper is aimed to shed light on two main RESs which are Photovoltaic (PV) and Wind Turbine (WT) with battery connected to the utility grid as an on-grid system to achieve the Sustainable Development Goal 7 (SDG7). In this paper, the Energy Management Strategy (EMS) is applied to achieve the objective functions which are Levelise Cost Energy (LCE), and Loss of Load Hours (LOLH), and to calculate the Greenhouse Gas (GHG) emission. Hence, Rule-Based EMS (RB-EMS) is supported to strategies the mechanism of the system by implementing a recent nature-inspired method namely Ant Lion Optimization (ALO). This paper encourages researchers to adopt the aforementioned method for solving problems due to the available benefits. The primary contribution of this article is to provide up-to-date and state-of-the-art knowledge to achieve the proposed objective functions of this study by utilizing MATLAB environment.

Keywords: *On-Grid, ALO, RB-EMS*

RESEARCH HIGHLIGHTS

1. Implementing ALO a recent nature-inspired and provide the best performance in comparison with the benchmarking methods.
2. The Rule-based energy management strategy as high supervisory control utilized due to its advantages.
3. The study area is blessed with high solar irradiance to produce electricity in the absence cases.

Research Objectives

This research will concentrate on the below objectives:

1. To utilize the Renewable Energy Sources (RESs) in the country to achieve the Sustainable Development Goal 7 by using PV and WT (1, 2).
2. To minimize the Loss of Load Hours (LOLH) and Levelise Cost Energy (LCE) and compute the GHG as the objective functions of the study using Antlion Optimization for sizing the system components (3, 4).
3. To strategies the flown power in the system via Rule-Base-Energy Management Strategy using MATLAB (5).

Methodology

The methodology used in this study is to size the components of system that shown in Fig. 1. using recent nature-inspired method namely Ant Lion Optimization (ALO) that introduced by Mirjalili (6). In addition, the validation method utilized is Cuckoo Search Algorithm (CSA) that was initially developed by Yang And Deb in 2009 to solve structural optimization tasks (7,8). Due to the simplicity of hybridization with other algorithms, fast

convergence speed, which is suitable for many types of optimization problems ALO propoded (9,10). As hygienic sources which naturally provided are generating green power. The PV and WTs are RESs that producing a green energy and having a much lesser negative environmental impact than the traditional fossil energy (11,12). The climatology collected data illustrated in Fig. 2 sourced from the Centre for Solar Energy Research and Studies (CSERS) (13).

Fig. 1. Proposes microgrid system.

Fig. 2. Climatologically data (a) Wind speed, (b) Solar irradiance, (c) Ambient temperature.

The load profile of the four seasons in the area under study is demonstrated in Fig. 3. Where (a) is the contour plot load of the whole year, (b) is the seasonal load demand, and (c) is the daily load profile as collected from the General Electricity Company of Libya (GECOL) (14). The patterns of load are a constant during day or night time.

Fig. 3. Load profile (a) Annual Contour plot of the load demand, (b) four different seasons, (c) daily load profile

Results

In this case study, the proposed methodology is examined using the hourly data of wind speed, ambient temperature, solar irradiation, and load demand of Tripoli (Libya). The considered method in this article utilizes the mathematical equations to attain the investment costs and used the rule-based strategy to attain the objective function. The optimal result obtained from the driving methods are 0.28 %, 0.60 \$/kWh, and 2806 tone as LOLH, LCOE, and GHG, respectively.

Findings

Optimization systems are used to choose the optimum system with high energy, less cost, and less number of components to meet the load demand. In fact, the sizing of renewable energy sources is complicated compared with the conventional system due to the random nature of RESs cost (11). The widely RESs used are PV and WT due to the provision of green energy and flexibility of using the microgrid systems whether (On-grid or Off-grid). The obtained output power from the aforementioned sources are demonstrated in Fig. 4. While the optimal convergence of the two utilized algorithms is demonstrated in Fig. 5 it can be seen from the figure that the two methods have converge in almost 10 and 15 iterations, respectively. Additionally, the RB-EMS for the proposed system is illustrated in Fig. 6.

Fig. 4. Output generated power from PV and WT

Fig. 5. Convergence progression of the proposed algorithms

Fig. 6. Rule-based energy management strategy of the proposed system.

Conclusion

The aim of this study is to meet the load demand using the aforementioned RESs and examining them under Tripoli climatologically data. Additionally, to attaining the optimal number of batteries, solar panels, and wind turbines. As the two RESs (PV and WT) are analogous to each other in nature, they are capable of making a proper hybrid system to fulfil the load demand. Besides, using RESs in the area of study with the weather conditions can be considered as a great alternative to address power challenges. The number of components acquired from the proposed method for sizing show less number of elements resulting to less losses and cost over the year. From the flowchart of smooth power flow among the system components utilizing RB-EMS. From the obtained result from the ALO show that, the amount of cost and losses are less than the obtained from CSA. Matlab is utilized as a software to obtain the findings of numerical analysis simulation plots.

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Author's Biography

Abdulgader Alsharif, received the bachelor's degree in communication engineering from technical college of civil aviation and meteorology, Esbea, Libya in 2011. He received the master's degree in electric and electronic engineering from University of Turkish Aeronautical Association, Ankara-Turkey in 2016. Received the second master degree's in electric and computer engineering from Altınbaş University-Istanbul- Turkey in 2018. Currently he is a PhD candidate in Universiti Teknologi Malaysia (UTM) from the beginning of 2020. His research interests include renewable energy sources, Energy management strategies and sizing of the integrating systems with Vehicle to Grid (V2G).

Chee Wei, Tan received his B.Eng. degree in Electrical Engineering (First Class Honors) from Universiti Teknologi Malaysia (UTM), in 2003 and a Ph.D. degree in Electrical Engineering from Imperial College London, London, U.K., in 2008. He is currently an associate professor at Universiti Teknologi Malaysia and a member of the Power Electronics and Drives Research Group, School of Electrical Engineering, Faculty of Engineering. His research interests include the application of power electronics in renewable/alternative energy systems, control of power electronics and energy management system in microgrids.

Razman Ayop, received the bachelor's degree in electrical engineering with first-class honours, the master's degree in electrical engineering with specialization in power system, and the PhD degree in electrical engineering from Universiti Teknologi Malaysia (UTM), Johor, Malaysia, in 2013, 2015, and 2018, respectively. He is a Senior Lecturer with UTM and a member of Power Electronics and Drives Research Group (PEDG), UTM. His research interests include renewable energy and power electronics. This includes the photovoltaic (PV) emulator, maximum power point tracking (MPPT) converter, standalone energy management and sizing, PV modelling, vehicle to grid (V2G) system, and fuzzy logic controller.