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Analysis of Economic Dispatch of Integration of PV- wind Generation Connected to Microgrid with Load-storage

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ABSTRACT

The most effective and economical power dispatching for microgrids is incorporated into the new power system optimisation, it is essential for reducing energy use and pollution. The microgrid should make money and deliver power that meets the absolute minimal requirements. In this study, we propose a combined optimisation approach for a distributed energy system with wind-photovoltaic load storage. The cost of production, the cost of discharge, the cost of acquisition, and the revenue from the sale of energy are all taken into consideration in this model. The relevant particle swarm optimization-based model solution algorithm is also supplied. The efficiency of the suggested model and algorithm is further demonstrated. In this research, Using a project case study, the joint optimal method for a distributed energy system with wind-photovoltaic load storage is examined and addressed.. It also presents the most practical and affordable power dispatching strategies under various scenarios.

Keywords: *Battery; Wind turbine; Photovoltaic system; Load; Microgrid; EPD.*

1.0 Introduction

In order to fulfil the strategic objectives of “carbon peaking” and “carbon neutralisation,” the new energy, represented by wind and solar power, has been steadily replacing the traditional power production unit and has started to access a substantial number of microgrids [1-3]. Multiple power sources and loads may operate effectively and dependably inside a network thanks to microgrids. They have the capacity to run both alone and in tandem with the traditional main power network. The cost-effectiveness and dependability of microgrids are now the subject of research [4,5].

A model of a wind-photovoltaic storage integrated power generating system was created by Zhu et al. [6]. The objective of the study was to ascertain the best overall microgrid economics for everyday use. The system loss and the flexible load coordination cost of skipping wind and solar energy were the study’s optimisation factors. To lower the cost of environmental protection, Wang et al. [7] developed a microgrid model for optimal dispatching. Fauzan et al. [8] suggested an ideal BES dispatching control strategy in order to optimise the size of power generating module for hybrid electricity production systems made up of an engine powered by diesel, solar power generation, and rechargeable energy storage. They did this by taking into account the Indonesian island’s particular power consumption characteristics.

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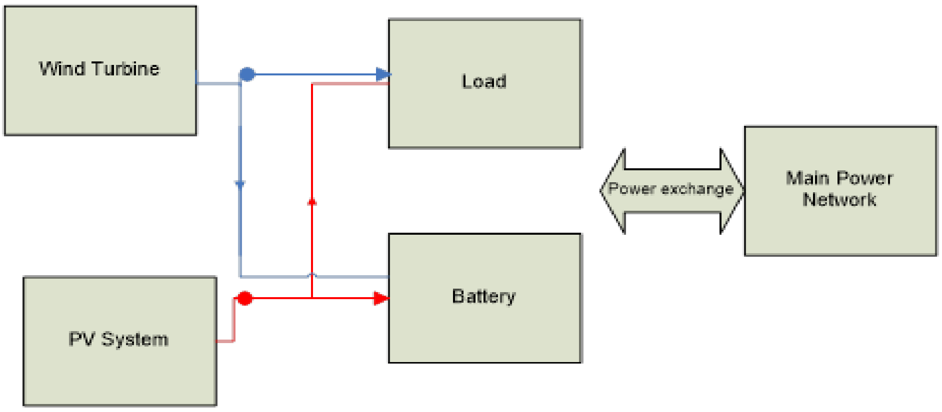
Yang et al. [9] created an affordable optimum dispatching CCHP microgrid model with IDR using the distributed modelling approach. Alireza et al.'s [10] economic optimisation technique for independent multi-carrier microgrids advocated taking into account the total yearly cost to deal with battery deterioration and reliability issues. Javid et al. [11] created an economic optimisation model using HOMER software after analysing.

A distribution network reliability evaluation approach was provided by Zhao et al. [20] that transforms the cost of a dependable power supply into system power deficit. The reliability evaluation approach for a microgrid was created . [21] based on consumer perception. [24] lowered the topological structure and assessed the dependability of the microgrid in light of the complicated structural issues as well as the least path and minimal cut set. [26] used the Monte Carlo simulation approach and model order reduction to assess the dependability of energy-distributed flexible power networks. [27] developed a reliability assessment approach for electricity distribution networks based on machine learning.

2.0 The Coordination Operation Model of Microgrid in Multi-scenario

As shown in Figure 1, a microgrid commonly connects to a WT, PV, and batteries, in contrast to the standard distribution network. Photovoltaic power plants convert solar energy into DC electrical energy, in contrast to wind turbines, which transform wind energy into AC electrical energy. The environment can have an impact on how much power wind and solar turbines produce. Peak shaving and valley filling tasks are carried out by a battery in the microgrid. Following categories can be used to separate microgrids' running costs and income:

Figure 1: Block Diagram of Microgrid



2.1 Examine the cost situation

2.1.1 Power generation cost

The cost of generating power for the microgrid is split into two parts: the cost of employing solar panels and wind turbines to generate electricity.

$$C_1 = \sum_{i=1}^{N_T} (\lambda_\omega P_{\omega t}\Delta t + \lambda_g P_{g,t}\Delta t)$$

The cost of renewable energy power production produced by the microgrid operation during a specific time period is denoted by C1 in Formula (1). The windmill is now producing Pw,t of electricity. The photovoltaic system's output of power is represented by the symbol Pg,t. The letters w and g stand for the average cost per kilowatt hour of energy production for photovoltaics and wind turbines.

2.1.2 Power cost

If there is not enough electricity available for operation, the microgrid must take power from the primary electrical grid to fulfil load demand.

$$C_2 = \sum_{i=1}^{N_T} (av_{1,t}(P_{1,t} - P_{\omega,t} - P_{g,t}).\Delta t)$$

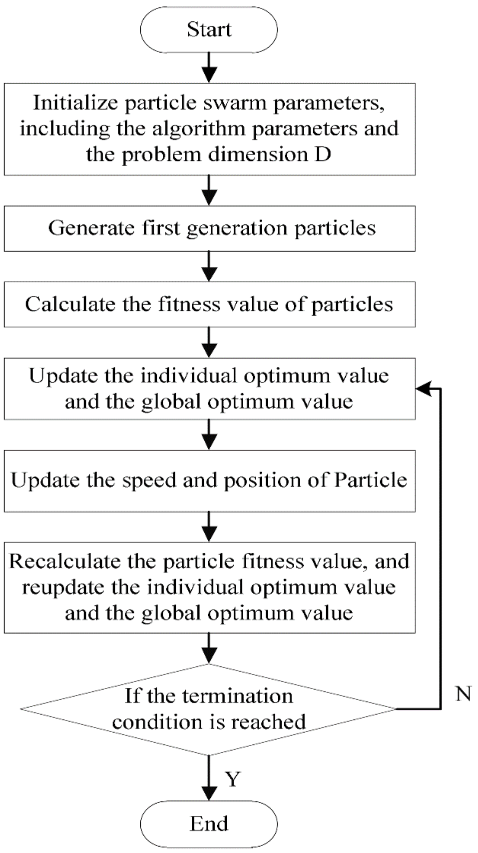
$$C_3 = \sum_{i=1}^{N_T} (\lambda_{bat,t} P_{bat,t})\Delta t$$

The cost of the electrical energy produced by the microgrid during a certain time period is denoted by C2 in Formula (2). The load power at time t is represented by Pl,t. 1,t denotes the price of electricity at time t. The numbers 0 and 1 are represented by the power buy sign, represented by the symbol A. When the microgrid's internal supply is insufficient to meet the load requirement, a = 0. It is possible for the microgrid to run independently. Therefore, when a = 1, the microgrid assures the load's power supply by obtaining electricity from the main power network.

2.2 Used algorithm for microgrid

The cooperative optimisation of the wind-photovoltaic load storage is used to explain the coordinated operation of a multi-scenario microgrid using a nonlinear programming optimisation model.

Figure 2: Flowchart of the Solution Algorithm based on PSO



Two examples of clever optimisation methods that may be utilised to solve the model include the artificial bee colony algorithm and military strategy optimisation. Particle swarm optimisation (PSO) was selected for our investigation due to its quick convergence, high portability, and potent global search capabilities; contrasting other intelligent optimisation methods was outside the purview of our study.

Set the particle swarm technique's population size NP, iteration count G, learning factors c1 and c2, and problem dimension D parameters to their default settings. For our experiment, we picked G to be 300, c1 and c2 to be 1.49445, and NP to be 1000. The results of the investigation demonstrate that the dimension D offered a one-time answer to the problem of the battery's charging and discharging states as well as its power consumption. D is set precisely at 24.

3.0 Case Study

If the electrical energy produced by the solar and wind turbines is greater than what is needed to power the load, the excess energy is uploaded to the main power grid. If not, the load need must be satisfied by using the main power network to buy electricity from it. As shown in Figure 3, the microgrid model for Scenario 1 changes. Figure 4 demonstrates that between 0:00 and 9:00, the wind turbine generates a significant amount of energy while the solar power production is low and the load fluctuates considerably, because more electricity is generated from renewable sources than is required to fulfil load demand. The microgrid will buy electricity from the national grid between 9:00 and 10:00 when demand for electricity exceeds renewable energy production. Between the hours of 10:00 and 12:00. The solar power progressively declines to zero from 13:00 to 24:00, while the wind turbine's output fluctuates downward. Since the load is greater than the quantity of energy supplied by renewable sources.

Figure 3: Waveform Shows the Behaviour of Connected Component of Load

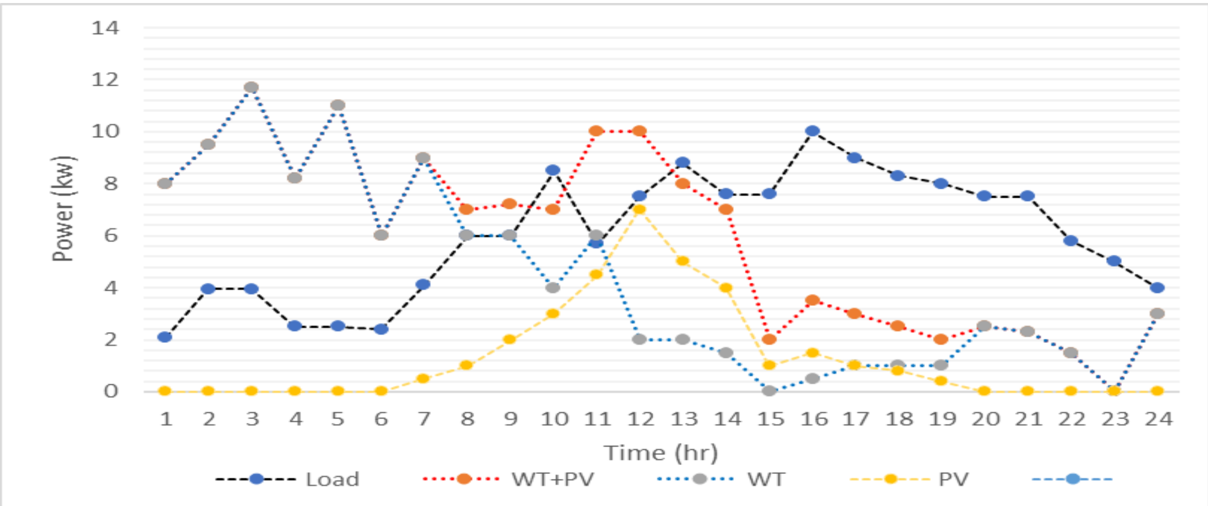


Figure 3 demonstrates that between 0:00 and 9:00, the wind turbine generates a significant amount of energy while the solar power production is low and the load fluctuates considerably.. When the generation of renewable energy exceeds the demand between the hours of 10:00 and 12:00. The microgrid must buy power from the main power grid since the quantity of energy generated by renewable sources cannot meet demand.

Scenario 2: The microgrid is permitted to forgo the use of the wind turbine, photovoltaics, and batteries in favour of participating in dispatching. In Scenario 2, giving up the solar panel and wind turbine is acceptable..

The wind turbine and the photovoltaics are turned off between the hours of 0:00 and 7:00 due to the fact that it is more expensive to create energy from renewable sources than to purchase it, as shown in Figures 9 and 10. Due to the lower cost of producing electricity from these sources, solar energy and wind turbines are completely connected to the microgrid between the hours of 7:00 and 10:00.

Figure 4: The Power Curves Shows the Behaviour of Connected Component of Load

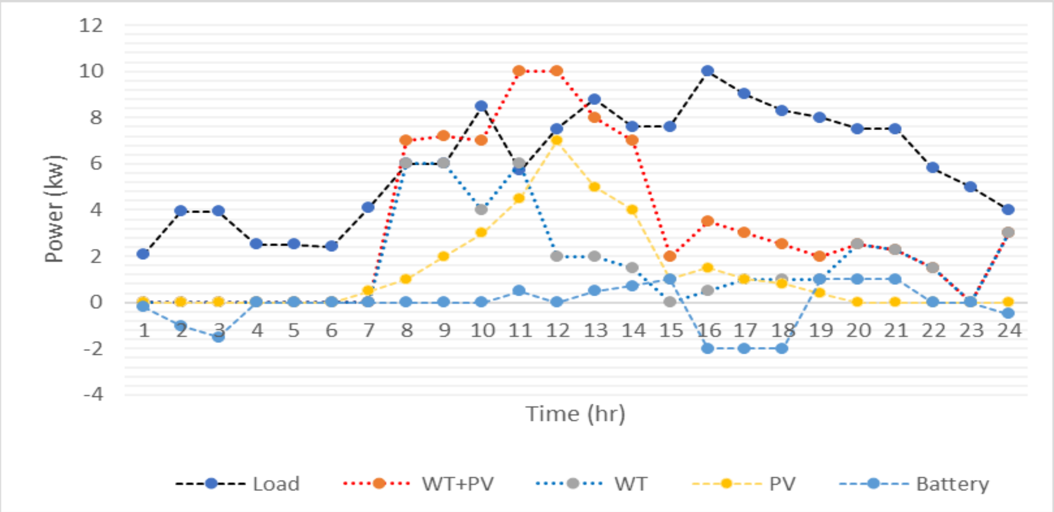
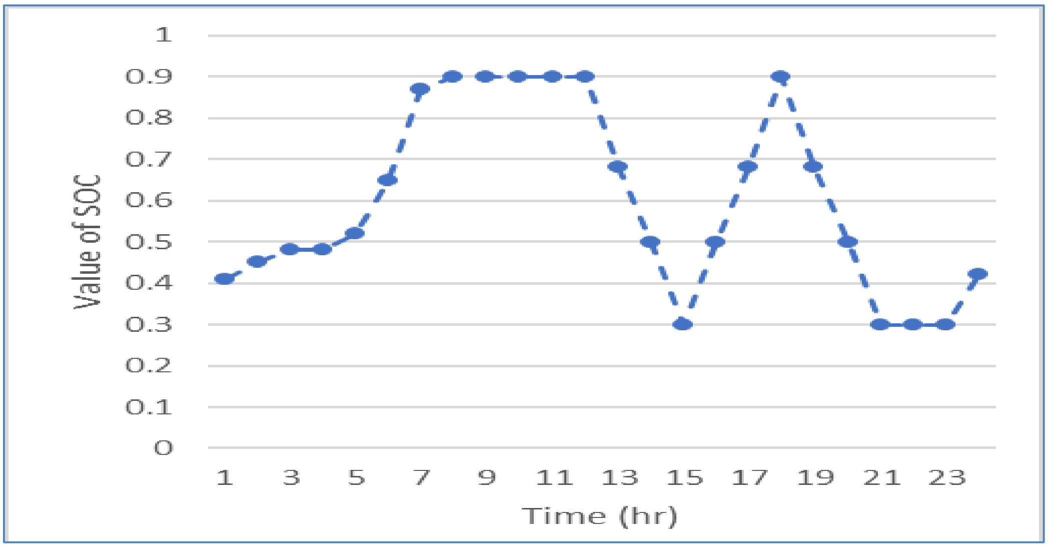


Figure 5: Check the Value of SOC of the Battery



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4.0 Conclusions

In this study, which proposes an integrated functioning idea about a multi-scenario hybrid employing wind-photovoltaic storage combination optimisation, the lowest running cost for one period is employed as the optimisation aim. The model takes into account charge/discharge limits as well as charge/discharge frequency constraints in addition to power generating costs, discharge costs, power purchase costs, and sales income. The relevant PSO-based model solution algorithm is now also displayed. In order to demonstrate the effectiveness of the recommended model and algorithm, the project in the region is used as the application scenario. A coordinated operational paradigm for a multi-study of DG is tested and fully discussed using the project as a basis, and the most effective methods for distributing electricity economically in various situations are also given. If the secondary power network and the microgrid cannot exchange electricity, the microgrid's economics will suffer.

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