Integrating Renewable Energy Capacity Optimally

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Received: 4 October, 2022, Manuscript No.BBOA-22-80048; **Editor Assigned:** 6 October, 2022, PreQC No. BBOA-22-80048 (PQ); **Reviewed**: 21 October, 2022, QC No. BBOA-22-80048 (Q); **Revised**: 26 October, 2022, Manuscript No. BBOA-22-80048 (R); **Published**: 31 October, 2022, doi:10.37532/bboa.22.3.5.5.

Abstract

The creation and use of new energy is an unavoidable trend as fossil fuel resources are depleted and energy consumption rises. Because it is abundant and clean, renewable energy has gained attention. However, due to the unpredictable and intermittent nature of renewable energy, it is challenging for the traditional power system to meet user demands after renewable energy is connected, and it is challenging to address the issue of renewable energy consumption by relying solely on the traditional power system. As fossil fuel reserves run out and energy demand grows, the development and usage of new energy is an inevitable trend. Renewable energy has attracted interest because it is cheap and plentiful. It is difficult for the traditional power system to meet user demands after renewable energy is connected, and it is difficult to address the problem of renewable energy consumption by relying solely on the traditional power system, due to the unpredictable and intermittent nature of renewable energy.

Keywords: Degradation • Integrated Energy System • District Heating Network • Fossil fuel • Renewable

Introduction

Due to the growing shortage of old primary energy sources and their environmental degradation, renewable energy with low carbon emissions has gained popularity. Energy systems are interdependent, which makes energy sources rigid and ineffectively used. In addition, following grid connection, the steady functioning of the power system is difficult due to the erratic, fluctuating, and intermittent nature of renewable energy generation. The Integrated Energy System (IES) is a new kind of energy network that is presented as a solution to the aforementioned issues. Its coordinated dispatch and planning of electricity, heat, and gas make it possible to utilise energy in an integrated manner. The cost input can be reduced while still fulfilling the IES dependability with an appropriate capacity allocation. Due to the unpredictability of wind and PV, it is crucial to prepare appropriately for each device's capacity in the IES.

The planning of IES is frequently seen in two aspects in contemporary research processes:

1. The configuration of the system capacity size and the choice of system facility kinds.
2. Data optimization for yearly or daily load-side demand.

It is possible to allocate generating and storage capacity economically. In order to reduce costs, new scheduling and planning optimization techniques for CHP systems were developed. The running expenses can be reduced by using a cooperative operating model for an IES with transmission losses. In IESs, the unpredictability of wind and PV is a critical issue. The technique of optimum scheduling uses three basic strategies: scenario optimization, resilient optimization, and fuzzy optimization. Different research approaches were suggested to cope with this uncertainty for improved system scheduling in this study, which uses the uncertainty of wind output as the study object. The uncertainty of PV may be somewhat managed by the aggregator-mediated demand response, and it can also be managed by creating plausible scenarios using Latin hypercube sampling and K-means algorithms. A technique to coordinate the operation of the power system and the DHN with cogeneration scheduling was presented, using the temperature dynamics of a District Heating Network (DHN) with energy storage to control the change in wind energy. Given that it is unknown how renewable energy uncertainty will affect the power system, a novel uncertainty assessment technique has been presented to determine how it will affect the dynamic performance of the power system.

There is a shortage of study on the operational characteristics of certain pieces of equipment in the IES research, which mostly focuses on demand side response and uncertainty analysis. The classic economic analysis approach is not entirely relevant to the IES in the examination of different forms of energy flows. In light of the unpredictability of renewable energy, this study focuses on the ideal configuration of the capacity specifications and operating approaches of various devices in the IES. First, the mathematical model and constraints of the energy equipment in the IES are built; next, the IES's optimization technique is highlighted; next, the algorithm for solving the objective is introduced; and finally, the two-layer model is solved to produce the best possible design plan and operation outcomes.

In order to demonstrate the viability and superiority of the IES in the future energy development process, the traditional energy system is contrasted with the IES in order to confirm that the proposed method can achieve the lowest cost investment while meeting the reliability and safety constraints. This paper's contribution entails:

1. A specific model of the IES equipment is created, and its features are researched.
2. The economics of the IES is examined using the double-layer optimization approach while taking into account the model restrictions, renewable energy uncertainty, and equipment operation characteristics.

Conclusion

This study builds an IES that combines cooling, heating, and power supply while fully accounting for the use of renewable energy. The design of a capacity allocation-operation plan optimization model has two layers. This demonstrates that IES may lessen the impact of the unpredictable and volatility of renewable energy generation on the electrical system, enhance the system's capacity to regulate peak loads, decrease the dependency on fossil fuels, and encourage the reduction of carbon emissions. In addition, it may lower system construction and maintenance costs and improve the operating characteristics of different types of equipment by configuring core equipment capacity optimally. The ability of the IES to handle the situation in which numerous load needs, such as power supply, heating, and cooling, are integrated with one another is crucial to the success of the dual carbon policy and the energy reform.

Cite this article: Singh, S. Integrating Renewable Energy Capacity Optimally. Bioenergy Bioresour: Open Access. 2022, 03 (05), 05