Physical Security and Sustainability of Data Centers

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Abstract: Data centers, which are centralized locations to manage and store data and applications, house network infrastructure and computers, also known as information technology (IT) equipment. The network infrastructure consists of gateways, routers, switches, servers, firewalls, storage systems, and application delivery controllers. At data centers, a substantial volume of data is distributed, processed, and evaluated. Businesses can connect with service providers by using a data center. Hardware and software within commercial buildings with on-site data centers must be protected. Physical security and software security are the two categories of security. Protecting people, property, and networks from threats such as terrorism, burglary, theft, natural disasters, and other events that could cause injury or financial loss to a company or organization is known as physical security. Techniques for preventing unauthorized access to the data kept on the servers are part of software security. Security measures must be updated frequently because new dangerous software (malware) is created each year to bypass numerous firewalls guarding the data. This conceptual study explores socio-techno-economic elements of more sustainably utilizing data centers. The macro- and micro-analyses of technological and economic change are compared in this essay. There is a chance to lessen the impact on the environment and the cost of power in data centers with the advent of microgrids. This study suggests a grid-tied hybrid solar-wind-hydrogen system that uses a fuzzy logic control (FLC) algorithm and a Maximum Power Point Tracking (MPPT) system to lower the load demand of buildings. Global warming is a serious environmental issue that the planet is now facing. The best solution to this issue is to use renewable energy. Using a campus-installed experimental setup, the model results of the proposed Hybrid Renewable Energy System (HRES) were confirmed. The dynamic simulation of the HRES was carried out in MATLAB-Simulink. In order to determine the best configuration for the proposed HRES while still meeting the annual load requirements for the university campus, a techno-economic analysis (TEA) of the proposed system was conducted. The analysis revealed that by using the FLC-based MPPT system, there is a potential for 2% extra power output from the anticipated HRES. This can guarantee a lower Levelized Cost of Electricity (LCOE) for the anticipated HRES and significant savings of $2.17 million.

1 INTRODUCTION

Data centers, which are centralized locations to manage and store data and applications, are where network infrastructure, computers, and other IT hardware are kept. Networks require infrastructures such as gateways, routers, switches, servers, firewalls, storage systems, and application delivery controllers. A substantial amount of data is distributed, processed, and analyzed at data centers.

Businesses can connect with service providers by using a data center. Hardware and software within commercial buildings with on-site data centers must be protected. The two types of core data center security are physical security and software security. Physical security is the defense of people, assets, and networks against dangers like terrorism, burglary, theft, natural disasters, and other occurrences that could result in harm or financial loss to a business or organization. Techniques for preventing unauthorized access to the data kept on the servers are part of software security. Security measures must be updated frequently because new dangerous software (malware) is created each year to bypass numerous firewalls guarding the data.

An analysis of the socio-techno-economic benefits of more sustainably using data centers is provided in this conceptual study. In this essay, the macro- and micro-analyses of technological and economic change are contrasted. The potential to lessen the cost of

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power and the environmental impact of data centers emerges with the advent of microgrids.

A hybrid grid-tied solar, wind, and hydrogen system with an MPPT system and a fuzzy logic control (FLC) algorithm is recommended in this paper as a way to reduce the load demand of buildings.

Global warming is a serious environmental issue that the planet is now facing. One of the best solutions to this issue is to use renewable energy.

The suggested hybrid renewable energy systems (HRES) model results were validated using an experimental setup deployed on campus. In MATLAB-Simulink, the HRES' dynamic simulation was completed. A techno-economic analysis (TEA) of the proposed system was carried out in order to identify the best configuration for the planned HRES while still satisfying the annual load needs of the university campus. The analysis revealed that by using the FLC-based MPPT system, there is a potential for 2% extra power generation from the anticipated HRES. This can guarantee a reduced Levelized cost of electricity (LCOE) for the anticipated HRES and significant savings of $2.17 million

2 SUNSTAINABLE DATA CENTER

Our daily lives are significantly impacted by information systems. Although we rely on technology, it consumes a lot of resources to calculate our needs. Data centers serve as the foundation of Information and Communication Technology (ICT) networks. ICT boosts GDP growth, but the environmental costs cannot be disregarded. Since data centers use a significant quantity of energy, technology pioneers improved power efficiency in the previous ten years. The phrase "sustainability" is broad. Human, social, economic, environmental, and technical sustainability will be assessed along five different axes. This ought to give people a more comprehensive understanding of the term "sustainable" and help them comprehend the data center's operating principles and environmental effects. Following a quick definition of the term "data center," the broad term "sustainability" will be divided into dimensions in the section "Overview of Data Centers." In this essay, we'll talk about five aspects of sustainability. The section Topics of Data Centers lists issues relating to sustainability in the context of data centers. These are divided into seven categories: facility, productivity, expanding data production, heat management, energy utilization, and zero waste. A data center architecture based on fuzzy logic control should be able to address those problems. By using values between 0 and 1, fuzzy logic, a sort of multi-valued logic, can represent linguistic variables in a manner similar to how people think. Figure 1 depicts the three components of the fuzzy logic controller: fuzzification, rule interface, and defuzzification. Fuzzification is the process through which linguistic variables are created from numerical input variables. It is common practice to use the error (E) and variation of error as the controller's input variables (CE). The fluctuation in the error illustrates how the MPP operating point of the PV system, which should be zero, varies throughout the power-voltage curve. It has a value between 0 and 1, and the transformation is finished by using the membership functions offered for different input variable ranges. The interface must carry out the rule-based operations that define the controller's behavior. The controller will create a language variable that establishes the duty ratio of the converter and incrementally reduces the error to zero. During the defuzzification phase, the membership functions are employed to obtain the numerical output values.

The HOMER program was used to conduct a techno-economic study of the proposed system in order to identify the best configuration for the planned HRES while still fulfilling the required annual load for the Chikushi campus. According to the results, the estimated COE value for the HRES equipped with the FLC-based MPPT was lower. A sensitivity study that considered the market prices of renewable energy technologies in 2030 was used to further assess the viability of the projected HRES. The results demonstrated that lowering the market cost of the solar system—the primary source of energy in the HRES—is essential for increasing the COE. Larger systems can be created, as shown by this analysis, if installation and maintenance costs for renewable energy systems decline as projected. Using two inputs, the FLC evaluates the operating point (OP) location.

These are the operating point's displacement direction and the slope of the tangential line of the power-voltage (P-V) curve. Table 1 shows the fuzzy rule that was applied in this study. These 25 rules define the fuzzy outputs. The three segments of the power-voltage curve are shown in Figure 2. In region 1, E(k) is positive. This indicates that the operational point is on the left side of the MPP. To reach the MPP, reduce the duty ratio. For example, OP will approach MPP from the side where CE(k) is NS and E(k) is PS.

For the time being, the fuzzy controller outputs ZE to avoid oscillations. In region 2, OP is rather close to MPP and E(k) is zero. When CE(k) is NB, the OP moves to the right.

The controller increases the duty cycle currently to bring the OP closer to MPP. The duty cycle D(k) is then calculated from the fuzzy controller's outputs (D), which are converted into numerical form. In this case, the cost analysis of the HRES parts is discussed using projected pricing. The starting capital costs for solar panels, wind turbines, fuel cells, and electrolyzes in 2020 are listed in the below table, along with the projected costs for 2030. The number of renewable energy plants built during the past several years has increased significantly as a result of the laws, funding, and research and development of each major nation. Solar power is one of these technologies that is regarded as being the most competitive. The overall installed cost was reduced by 74% between 2010 and 2018.

To reduce its reliance on energy imports and transition the economy away from fossil fuels in order to meet climate goals, India is proposing a significant increase in the generation of green hydrogen. By 2047, New Delhi wants to have a 25-million-ton yearly manufacturing capacity, according to sources familiar with the plans who asked to remain anonymous because the information has not yet been made available. However, they warned that the figure can vary in the future depending on technology and the prospects for demand in the nation. Email inquiries for comment from electricity and renewable energy ministry media representatives went unanswered right away.

3 CONCLUSIONS

This study suggested putting in a grid-tied hybrid solar-wind system at Chennai's university. An FLC-based MPPT, which offers quick power regulation with reduced oscillations in a variety of weather circumstances, is a feature of the planned HRES. In MATLAB-Simulink, the suggested HRES system's dynamic simulation was carried out. The study's findings suggested that the FLC-based MPPT performed better when it came to HRES power regulation. The results demonstrate that by utilizing the FLC-based MPPT, each KW installed capacity of solar panels on the university campus may provide an additional 26.2 kWh/y of power.

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