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Power Management Strategy and Sizing Optimization Techniques for Hybrid Energy Systems Considering Feature Selection: Mini Review

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Abstract:
This paper proposes a supervision system control called Power Management Strategy (PMS) that optimizes the performance of a system while minimizing its energy consumption. The strategy involves selecting the appropriate features that have the most impact on system performance and using them to control the power usage of the system. A Feature Selection (FS) algorithm is developed that weighs the importance of each feature and identifies those that are most relevant for the desired system behaviour. To validate the strategy, experiments were conducted using a real-world system with varying workloads. The discussion shows that the proposed power management strategy can significantly reduce energy consumption without losing performance.

Keywords: Power Management, Hybrid Energy, Feature Selection.

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إستراتيجية إدارة الطاقة وتقنيات التحسين الحجمي لأنظمة الطاقة الهجينة مع مراعاة اختيار الميزات: مراجعة مصغرة

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الملخص
تقترح هذه الورقة التحكم في نظام الإشراف يسمى إستراتيجية إدارة الطاقة (PMS) التي تعمل على تحسين أداء النظام مع تقليل استهلاكه للطاقة. تتضمن الإستراتيجية اختيار الميزات المناسبة التي لها أكبر تأثير على أداء النظام واستخدامها

للتحكم في استخدام الطاقة للنظام. تم تطوير خوارزمية اختيار الميزات (FS) التي تزن أهمية كل ميزة وتحدد تلك الأكثر صلة بسلوك النظام المطلوب. للتحقق من صحة الاستراتيجية، أجريت التجارب باستخدام نظام العالم الحقيقي بأعباء عمل متفاوتة. توضح المناقشة أن استراتيجية إدارة الطاقة المقترحة يمكن أن تقلل بشكل كبير من استهلاك الطاقة دون فقدان الأداء.

الكلمات المفتاحية: إدارة الطاقة، الطاقة الهجينة، اختيار الميزات.

1. Introduction

A power management strategy based on feature selection sizing for hybrid energy systems involves selecting the most appropriate combination of energy sources (solar, wind, gas, diesel) and storage options (batteries, flywheels, pumped hydro, compressed air) based on the power demand and availability profile of the system [1], [2]. Feature selection involves evaluating various system parameters such as load demand, source availability, and energy storage capacity and selecting the optimal combination of these features to optimize system performance [3]. The sizing of the system's energy sources and storage capacity should be optimized to ensure that power demand is met efficiently while minimizing system costs and carbon emissions [4], [5]. This involves balancing the cost of equipment, installation, and maintenance with the energy savings and environmental benefits of the system [6], [7].

The power management strategy should also include real-time monitoring and control of energy sources and storage options to ensure that the energy is being used efficiently and effectively [8]–[10]. By employing a feature selection sizing approach and applying an optimized power management strategy, hybrid energy systems can help reduce the cost and environmental impact of energy production while providing reliability [11], [12]. Two types of feature selection have been reported in the literature filter-based and wrapper-based [13]–[15]. The former is computationally expensive while the latter is providing results better than the first mentioned [16].

The contribution of the article is briefly discussing the combination of the sizing optimization techniques along with the power energy management from the perspective of combination. While the rest of the article is organized as follows. Section 2 presents the classification of power energy management. The optimization techniques with their explanations are positioned in Section 3. The discussion regarding the PMS and the optimization techniques are taken place in Section 4. Eventually, the summary conclusion is followed by the list of references.

2. Power Management Strategy Objectives

The main objectives of the PMS are utilized to optimize the usage of power resources in an efficient and effective manner while minimizing energy consumption and associated costs. The main objectives of PMS are tabulated in Table 1.

Table 2 Power management strategy objectives [17]–[20].

Lis of PMS objective	Classification	Features
Satisfy constraints	Operation mode selections Required driving power	• Ensure a constant power • Guarantee a reliable power
Reduce emission	Pollutant emission power CO_2 emission minimization	• Improving sustainability • Obtained green environment
Use ESS efficiency	A prolonged lifetime of ESS Battery SoC regulation considering battery limitation	• Reducing wastage • Minimizing energy consumption
Improve fuel economy	Fuel consumption minimization Energy-optimal travel Reduce operational costs	• Helps to reduce energy costs. implementing energy-efficient devices and technologies • Adopting smart PMS
Improve sustainability	Reduction of GHG RESs adoption	• To promote sustainable energy • Minimize the environmental impact of energy production and consumption

3. Sizing Optimization Techniques

Sizing optimization technologies for renewable energy sources integration systems can vary depending on the specific renewable energy sources being integrated and the goals of the integration [21], [22]. In

the context of energy management for renewable energy sources integration, nature-inspired algorithms can be used to optimize the energy production and consumption of renewable energy sources, such as solar and wind power [23], [24]. These algorithms can be used to determine the optimal power production schedule for each renewable energy source, taking into account the variability and intermittency of the sources [25], [26]. Some common sizing optimization techniques are shown in Table 2.

Table 2 Sizing optimization techniques [27]–[31].

Modelling Sizing Techniques	Explanation
Load Analysis	Understanding the energy load requirements of a building or area is important in determining the amount of renewable energy that can be integrated into the system.
Weather Modeling	Analyzing weather patterns and seasonal changes can help determine the optimal sizing for renewable energy systems such as solar panels or wind turbines.
Technology Performance Modeling	Predicting the performance of renewable energy technologies such as solar panels or wind turbines can help determine the optima

Furthermore, these algorithms can be used to optimize the use of energy storage systems, such as batteries or pumped hydro, to store excess energy when it is available and release it when it is needed. Moreover, there are a number of sizing optimization techniques utilized by different scholars to size the microgrid system components as figured out in Figure 1. By optimizing the energy production and consumption of renewable energy sources, nature-inspired algorithms with an energy management strategy can make renewable energy more cost-effective and reliable, helping to accelerate the transition to a sustainable energy future [32]–[35].

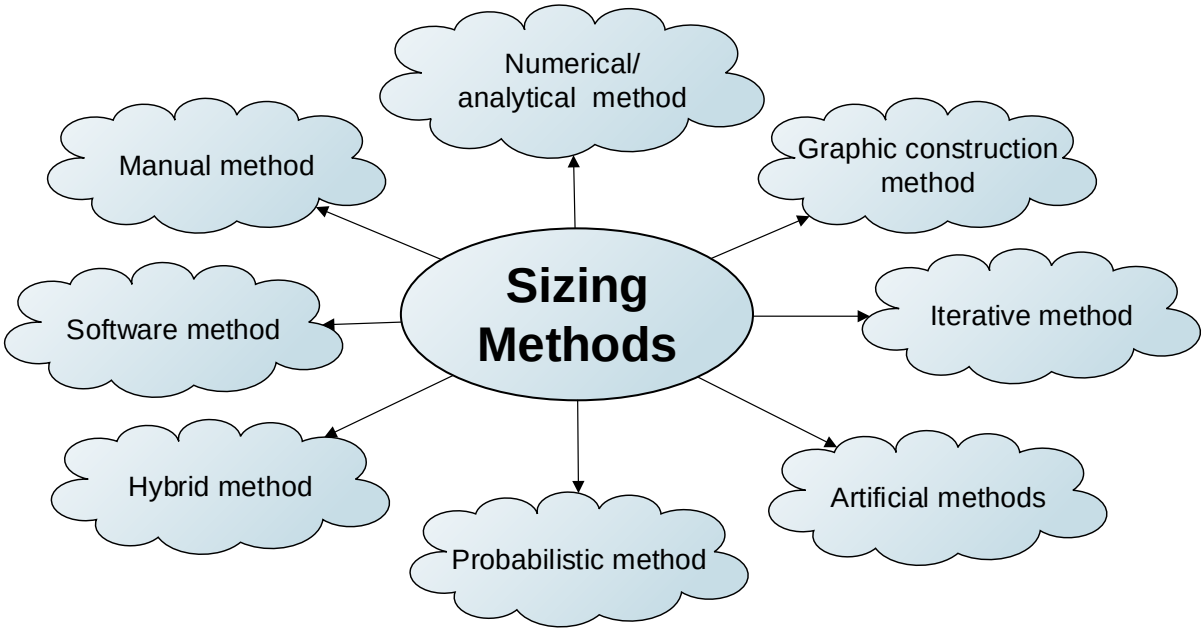

Figure 1 Sizing Optimization algorithms tree.

4. Discussions

The power management strategy objective is to efficiently manage the use and distribution of power in a system or device in a way that optimizes power usage and minimizes wastage. The primary goal of the strategy is to ensure that the power is distributed to all the subsystems or components in the system as per requirement without any interruption or downtime. Sizing optimization techniques, on the other hand, refer to the optimization of the size and design of various components in a system to ensure that they consume less power while maintaining their performance efficiency. In this regard, the power efficiency of the system is optimized by reducing the size of several components, which ultimately reduces the heat generated and power consumed by the components.

Conclusion

In conclusion, power management is a critical aspect of modern electronic devices that require efficient use of energy and battery life. A robust power management strategy is necessary to optimize energy consumption and improve device performance. Additionally, feature selection is vital in ensuring that the most suitable components and applications are used to save on power usage. With the increasing demand for sustainable and eco-friendly technologies, proper power management and feature selection are essential for the success of electronic devices.

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