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Green Energy Storage Solutions: A Research

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Abstract. One of the key elements of decarbonizing global energy networks and integrating renewable energy sources is green energy storage technology. Energy Storage Systems (ESS), which store surplus produced electricity and make it available on demand, are essential for reducing fluctuations. Electromechanical, electromagnetic, thermodynamic, chemical and hybrid approaches have all been used in the development of energy storage technologies. A comprehensive list of current papers in the literature section is compiled to illustrate the range of advancements in this field. This paper reviews green energy storage systems, focusing on their primary uses. Power utilities will benefit from this thorough analysis of energy storage systems; the researchers choose the finest and newest energy storage technology based on its practicality and affordability. These days, several nations use energy storage systems to plan for future energy needs. Variations in solar radiation cause a solar photovoltaic generator to overproduce electricity. The implementation of a hybrid energy storage system would help to increase the reliability of solar-powered power generation. The microgrid is a crucial component of the smart grid network for solar installations. This study looks at the microgrid's energy storage system for photovoltaic systems. The topologies and storage system configurations of the microgrid are analyzed together with power electronic interference, control systems, and optimization of the energy storage system and renewable sources. a general technique for sizing the HESS of PV systems using design space as well as pinch analysis. HESS scales that link generator ratings to storage capacity are developed in the proper sizes by using pinch analysis to load and resources data.

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Keyword-: Renewable Energy Sources; Power fluctuation; Energy Storage Systems; Selection Criteria.

1 Introduction

Energy may be moved between a source (a generator) and a device made specifically for its usage using electricity, which is the flow of electrons in conductive materials [1]. Light, heat, cold, and driving forces may all be produced with ease using electricity, which is unique in that it can provide a wide range of services through a variety of technological instruments [2]. Electricity is a so-called "Secondary" kind of energy, meaning that it results from the transformation of primary points and is not present in a useful form in its natural condition. The latter can come from nuclear, renewable energy sources (such as solar radiation, wind, the water cycle, biomass, etc.) or fossil fuels (oil, gas and coal) [3].

An alternative to the majority of the present energy plans is to generate power using renewable energies. Contrary to fossil fuels, electricity is a finite resource that must be transformed into another energy source in order to be utilized again. Despite the fact that there are many different ways to store energy, there are just not enough of them to supply the world's expanding need for power. This presents a major obstacle for industrial expansion, research, and innovation. Numerous, diverse, and productive investigations have been conducted in this area [4]. The majority of fundamental energies—coal, oil, and gas—are readily stored. On the other hand, storing a lot of electricity means first converting it into another type of storable energy (such thermal, chemical, kinetic, or potential energy) and then restoring it to use.

It is worth mentioning that the evolution of the world's energy situation is described by the following important discoveries: The ability of this energy vector to reduce the general use of fossil fuels, i.e. coal and oil, as well as its user-friendliness and flexibility. Will lead to a strong increase in the use of electricity in the following decades. The share of renewable energy forms in electricity production is rapidly increasing in order to achieve the goals of reducing emissions of greenhouse gases, especially water vapor (H_2O), carbon dioxide (CO_2), methane (CH_4), nitrous oxide (or N_2O) and ozone (O_3), whose increased concentration in the planet's atmosphere is the main cause of global warming.

These batteries have several advantages over other mobility solutions, which explains part of their popularity. The development of efficient electrochemical generators is therefore particularly important for portable applications (computers, mobile phones, tools, etc.) due to the growing popularity of hybrid and all-electric vehicles and the electrification of vehicle functions. Airplanes This is especially true for the transport sector. But recyclability – the ability of these energy storage devices to store and release energy reversibly over several hundred cycles – means that mobility is not the main advantage. Due to threadability and more than 97% energy efficiency, the batteries are particularly attractive for stationary applications such as storing electricity produced from renewable main sources to balance supply and demand in local electricity networks (depending on the size of the building or area).

To ensure the reliability and efficiency of power grids for large-scale electric vehicle (EV) fleets, a coordinated and efficient charging mechanism must be introduced [5]. In addition, the use of electric vehicles (EV) and renewable energy sources is a practical way to reduce the use of fossil fuels and their environmental damage. It is easy to imagine the day when all cars will be electric, as more and more car manufacturers create and sell electric car models [6]. But the range of electric cars, based largely on the size of their batteries, determines their feasibility. Compact and light, fast and often chargeable, and efficient enough to transport a person to the intended destination are all the requirements of electric car batteries [7].

Lithium-ion batteries are widely used in modern smart vehicles. Lithium cobalt oxide (LCO), the most energy-dense type of lithium chemistry, is commonly used in electric vehicles.
This work, investigated several aspects related to energy storage. The first section outlines the main issues and objectives related to energy storage. In the second section of this paper, will go over the several approaches that are currently being used to store electrical energy as well as the standards that have been used to determine which approaches are best.

2 Solar Energy

One of the sustainable sources of energy available everywhere is solar energy. Solar energy applications have been introduced in the past, including drying, humidification, housing, desalination, transportation and solar energy. Many studies have been conducted in the field addressing some of these advances and applications.CSP (Concentrating solar-thermal power) is a promising method for producing heat and electricity. Large sums of money have been invested in the development of these technologies all around the world.
Numerous commercial systems have been implemented since 2005. But we don't have the experience needed to turn CSP into a stable, affordable power source. Figure 1 demonstrates two types of solar collectors: linear focusing, which depends on the focal length of their object (parabolic bottom collector and linear Fresnel reflectors), and point concentrating to the point (solar heating towers and parabolic troughs).

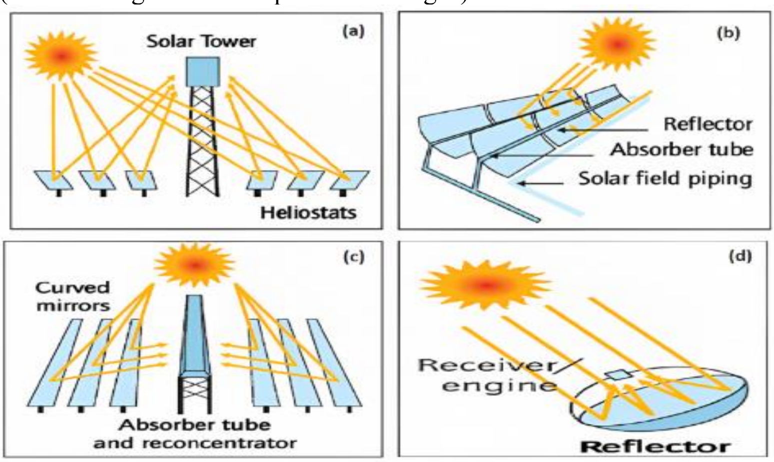

Fig. 1: CSP Technologies

Numerous investigations and analyses of extensive CSP have been carried out. Ahmadiet al.'s study [1] estimated the cost of installing CSP power systems. CSP power facilities required a larger initial investment than photovoltaic (PV) installations.Nevertheless, CSP plants' financial advantages surpassed those of PV power plants. Desideri et al.'s study [2] looked at how different technologies affected the environment. Investigations were also conducted on the environmental impacts of building, commissioning, running, and decommissioning PV and CSP plants. Compared to CSP installations, the PV system assembly had a larger environmental effect. This motivates people to study more about the CSP's historical benefits and present conditions.
Gamarra et al. [3] evaluated the implications of potential CSP project deployments on sustainability while accounting for different CSP systems and circumstances pertaining to component origin. The results showed that the central receivers had less adverse environmental effects in terms of carbon dioxide emissions and water consumption and more favorable economic effects in terms of increased added value and employment.

3 Wind Energy

Mechanical energy can be converted directly into electrical energy or indirectly into electrical energy by converting kinetic energy into electrical energy. As an integral part of all wind energy systems, wind turbines serve as a means of converting the potential energy of the wind into mechanical energy that can be used in a variety of applications by converting the wind's potential energy into mechanical energy. A wind turbine was built at the beginning of the twentieth century as a method of generating electricity by using wind power. While wind turbine technology has been slow to develop, there have been significant advancements in the design of wind turbines in the past few years. Thanks to modern technological development and the improvement of the turbine and its components, the production and efficiency of the produced electricity has improved significantly. In addition, the design of senile turbines allowed the development of certain generators and the use of power electronics. The tower, blades and hood of a wind turbine, which contain the generator, gearbox and control system, are its central components. The wind pushes the wing forward, just as an airplane wing lifts an airplane.The turbine is harnessed to power a generator located inside the hood through an opening in the drive shaft. After being converted into electrical energy by the generator, the kinetic energy is fed back to the transformer. Figure 2 illustrates the two primary wind turbine types currently employed, specifically the horizontal axis (HAWT) and vertical axes ("VAWTS").
HAWTs are the most efficient and effective wind turbines due to their greater efficiency and effectiveness. The close proximity of VAWTs to the ground reduces their exposure to wind, which decreases their power. A VAWT also needs more materials to produce the same amount of power as a HAWT and therefore, is more expensive than a HAWT since VAWTs are larger in size and require more material to produce the same amount of power.

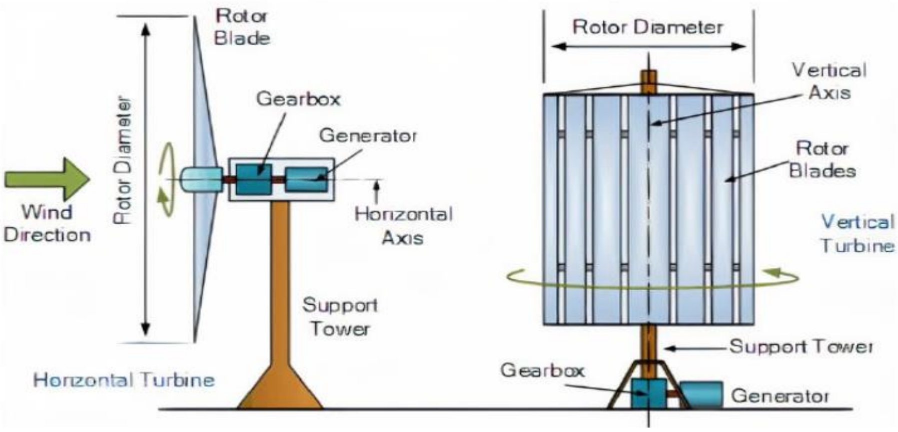

Fig. 2: Two types of wind turbine: VAWT and HAWT.

Wind turbines work on a basic rule: the wind turns the edges, which causes the shaft joined to the generator to turn. There is a gearbox that connects the turbine shaft to the generator shaft with a rotational speed of 1200-1500 revolutions per minute, which significantly increases the turbine shaft's rotational speed by 30-60 revolutions per minute. This causes the copper coil of the magnet containing the generator to rotate. Power is generated when the electrons inside the wire are energized by the relevant magnet. The regulation performance is proportional to the number of copper windings and the rotation speed of the shaft in the attractive field. Bladeless wind turbines (Vortex) are another cutting-edge specialized advancement that points to illuminate the issues of turning wind turbines such as coordinations, aesthetics, support, damping, clamor and impacts on fowls and the environment.

4 Biomass

Among the most readily available energy sources, biomass may be utilized for a variety of purposes, from direct fuel cell use to traditional burning to generating electricity. Fuel burning is a typical approach, however it is not the most effective way to extract the energy value found in different biomass resources. Biofuel production from biomass, such as biodiesel and biochar, is a promising technique with potential uses. The biomass energy resources are displayed in Figure 3. From this vantage point, Han et al.'s study [17] employed a hydrothermal treatment to examine the impact of acid pretreatment of maize straw on the production of biochar.

Fig. 3: Different sources of Biomass energy.

The high viscosity of bio-oil obtained through rapid pyrolysis makes it difficult to use. Therefore, Choi et al. [18] created a 35 kW pilot burner and equipped it with an air cleaning jet nozzle. The downward fuel injection system is designed to improve fuel injector performance and maintain a more consistent flame. There was a ratio of 9:1 for the quantity of bio-crude oil and ethanol. This improved the stability of combustion by giving an eddy current to that air. The increased swirl of combustion air reduced gas emissions and improved flame stability.

5 Renewable Energy Sources - A Hybrid Approach

It is generally accepted that renewable energy sources, like wind and solar power, only sometimes produce electricity, while being sustainable and having little to no adverse effects on the environment. Therefore, it is necessary to integrate energy storage systems with renewable sources of energy. Several renewable energy sources such as wind, solar, and biogas can sometimes be coupled with one or more additional energy storage devices, as seen in Figure 4. There is a primary goal of these integrations to provide a constant supply of energy throughout the day at a low cost to the user. In recent years, researchers have been

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studying the fusion of different types of renewable energy systems so as to be able to produce more energy at lower costs and without emitting any carbon dioxide.

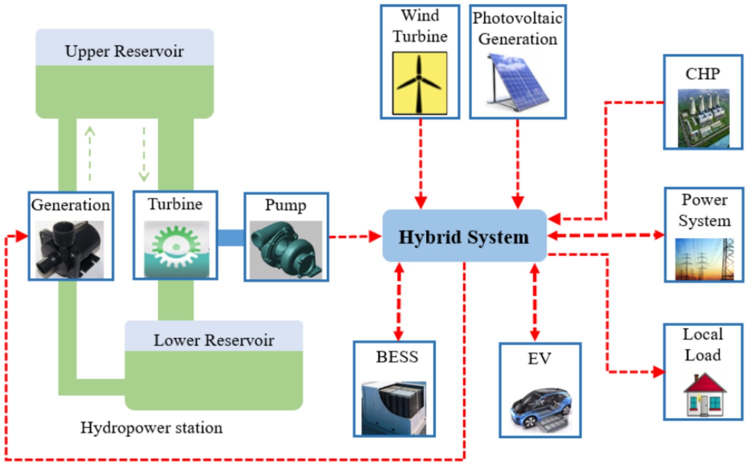

Figure 4: Power plant schematic with a combination of wind, PV, and thermal energy.

Using a computational design technique, Kim et al. [19] calculated the ratios of national electric, solar, and fuel cell systems. According to the study, the optimal energy ratio for fuel cells compared to solar cells falls between 0.46 and 0.54. Another optimization technique proposed is called DEAS, which stands for "Univariated Dynamic Search Encoding Algorithm".

5 Methods and Results

Micro-grids with renewable energy systems are connected by DC buses and Power Electronic Converters (PECs). The load and power flow are controlled by the ESS [16]. HESS is a combination of an ultracapacitor and a battery. The PV panel and microgrid are connected by the voltage controller. Figure 1 depicts the microgrid system's layout.
The PV system's output power:

$$P_{pv} = V_{pv} \times I_{pv}, \quad P_b = V_b \times I_b: \qquad (1)$$

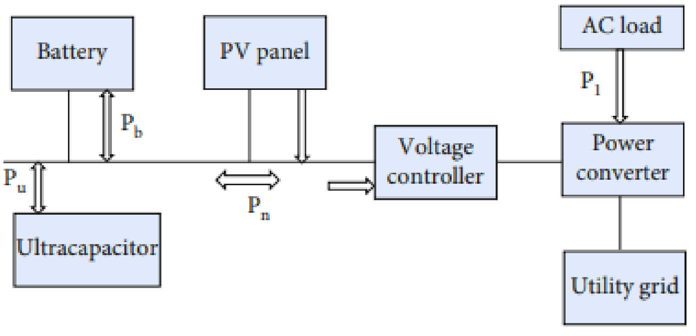

Fig. 5. Ultracapacitor's output power.

This shows the output power and current of the battery which can be seen in Equation (2):

$$P_c = V_c \times I_c\text{'}: \qquad (2)$$

This Fig. 5 shows the ultracapacitor's output power. Pl is for the power coming from the load, while Pu stands for the power that is transferred via the utility grid. In the energy storage system, the battery and ultracapacitor are used since one part is insufficient to conduct the changing power. The microgrid takes up minimal room and reduces the line's resistance.

6.1 Hybrid Energy Storage Topologies

It is possible to connect HESS and MG using several topologies. There are several topologies that may be utilized to combine HPS and HES. Power converter topologies come in three varieties: semiactive, active, and passive. A passive topology, which is an effective, straightforward, and reasonably priced design, makes it simple to join two storages with the same voltage. Since the ultimate voltage of the capacity gadgets is unregulated, the inner resistances and voltage-current characteristics primarily control the control dispersion between the HPS and HES gadgets. Hence, HPS acts as a moo pass channel for HESS and has exceptionally small vitality [18]. In a semi-active topology, the control converter of one capacity framework is found at its terminal and the other capacity framework is associated specifically to the DC transport. The plan offers way better maneuverability and transmission capability, in spite of the fact that the expansion of a transformer increments the establishment range and costs. The scope of HESS is amplified by extra transformers in this engineering. Two or more vitality capacity gadgets freely associated to the capacity framework through control converters include dynamic HESS topologies. While the system's expenses, complexity, and losses increase, there are certain advantages to this kind of topology. This configuration has the advantage of allowing for active management of all storage capacities [19].

6.2 Energy Storage System Configuration.

An ESS is necessary for the effective operation of an MG. Dispersed sources like as wind turbines and solar panels can be dispatched by the consumer. It makes up the majority of the contribution to balancing power demand, together with generation sources. It is possible to use the power that has been gathered to supply electricity when demand is high. The cost and complexity of producing and operating the energy storage system (ESS) increase with increased energy storage capacity. Thus, flexible and effective power regulation may be achieved by utilizing distributed and small-scale energy storage.

In the distributed ESS arrangement, a DER with several interfaces is connected to the ESS unit. For solar PV, the DC interface is necessary. Generally speaking, a DC chopper is less costly and simpler to operate than a DC converter. The cost of electrical interference is increased, and efficiency is increased, when the grid is connected to DER and ESS. These systems are often simple since they deal with only one type of source. Power lines are designed to receive electricity from renewable natural resources before storage, which helps balance energy flows that are concentrated on the line and delays line construction. This is advantageous. Losses occur during the recording process, although the DER and ESS connections of the power electronics can be connected independently of each other, and both the connections and line resistances are connected to both devices. The future holds the possibility of MG - a combination of decentralized and centralized ESS.

6.3 Power Electronic Interface of Energy Storage System

Figure 2 depicts the energy storage system's power interface. The ESS interface works continuously to keep the MG running for long periods of time, unlike traditional converters that only work when the main source is available. Therefore reliability and efficiency should be prioritized when choosing converter topologies. The three most common MG types are high-frequency, line-frequency, and DC MG, and each requires a different strategy for implementing ESS. Since ESSs can be converted to DC or have a DC interface, they are all considered DC sources for simplicity. DERs and ESS can be connected to the same DC bus using different DC converters. Using a combined multi-port converter ensures low cost, high efficiency and reliability compared to the original single converter system. One multi-port transformer topology that can be used in a high-voltage ESS is the buck-boost transformer; on the other hand, a boost converter can be used in a low voltage ESS. However, expanding the system is difficult because it is built on a unique combination of common components, and adding new sources would require rebuilding the system.

6.4 Hybrid Energy Storage System

In HESS applications, choosing the appropriate storage capacity is one of the biggest obstacles. Numerous methods for calculating storage capacity have been offered. While some methods are designed to evaluate a technology's HESS capacity, others may be used to size various storage systems regardless of technology. Examined are battery size techniques and how they are used in different RESs. Throughout the HESS sizing process, consideration should be given to the system's total cost and dependability. The inability of renewable energy sources to be stored for later use, in contrast to conventional energy sources, is their biggest disadvantage.

Therefore, it's imperative to use them for as much energy as possible while they're still available. Furthermore, it is not possible to ensure that they will always be consistent and focused because they rely on the local climate. They are hence unpredictable and erratic. Because solar behavior is so unpredictable, solar-powered energy is especially vulnerable to harmonic distortions and related errors, which might negatively impact system performance. At two power levels of 3500 kW and 10000 kW, a system's efficiency across two states of charge (SOC), measured in percentage. The SOC percentages vary from 26% all the way up to 96%. A three kilowatt system will have an efficiency of around 0.42 to 0.45 at 3500 kW if the SOC increases by 10%. When the load is 10000 kW, the efficiency starts at 0.27 at a SOC of 26%, and as the load rises to 96%, the efficiency increases to 0.55. As a result, the system performs more efficiently at higher states of charge and is especially effective at 10000 kW power levels when the system has been charged at a higher level.

HESS is necessary in these situations to reduce deviations and improve power quality. Other main tasks of the ESS are capacity regulation and provision of support services when necessary. Therefore, they are an important source of energy for the significant spread of renewable energy systems. Acting as a buffer or backup, the HESS can compensate for power imbalances that may occur between generator units and the load. If certain main sections fail, the island microgrid relies on the HESS to maintain a balance of real and reactive power as shown in Fig. 6.

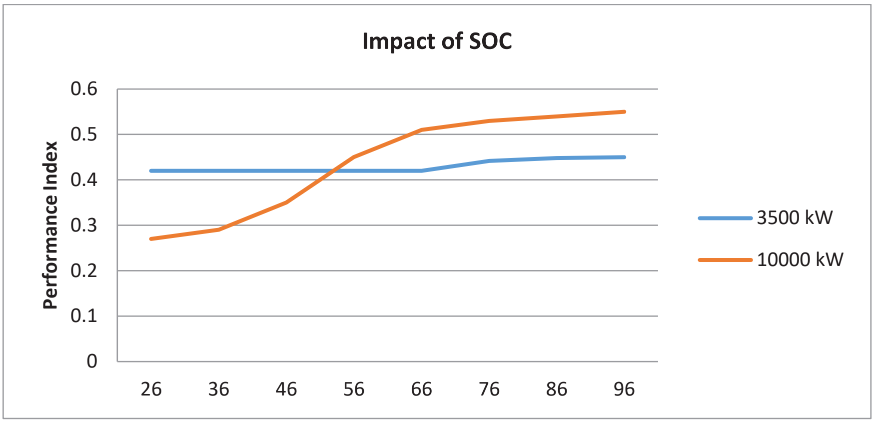

Fig. 6: Compared SOC impact on 3500kW and 10000kW.

Despite the fact that load shedding or additional generating units might be able to help solve the problem, HESS is crucial to quickly overcome the capacity shortage. The MG operates in grid-connected mode when it is connected to the grid in order to maintain the quality of the power and reactive power. Depending on the purpose of the HESS application, several HESS scaling strategies can be used. The compression analysis method is used to determine the capacity size as shown in Fig. 7.

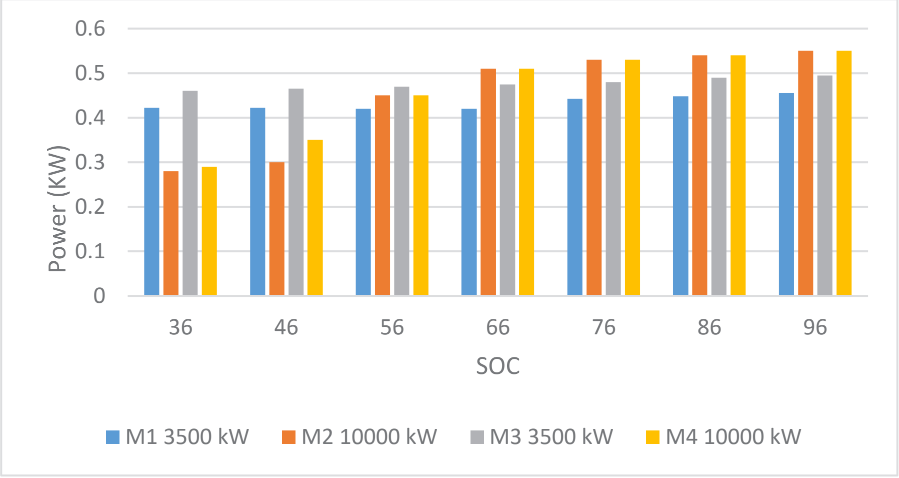

Fig. 7: Comparison of ESS with power interface.

Fig. 7 shows, Figure 7: M1 is characterized with ESS and power interface of 3500 kW, M2 with ESS of 10000 kW, M3 with ESS and power interface of 3500 kW, and M4 with ESS and power interface of 10000 kW.

6.5 Analysing pinch points.

An easy and flexible method for determining which part of a utility heat exchanger network uses the least energy is pinch analysis. This method may be used in a microgrid that is powered by renewable energy sources because it is relatively light. Pinch analysis is employed in HESS implementations. The basis of this technology is the production, loading and unloading times of the energy storage. PAM is used to generate size curves for different ranges based on resource and load data. The data storage configuration that is practical for a particular timeline is displayed on the generated graph. Pinch analysis works well to save various resources. Separate energy systems are developed using peak analysis methods. Pinch analysis emphasizes the need to set goals before creation.

As a result, it allows analyzing multiple process goals before designing a detailed process in detail. Moreover, pitch analysis gives system architects the ability to manage and visualize decision-making processes in a more organized and systematic manner through the use of schematic tools. To solve common resource conservation problems, different pinch analysis tools can be used to divide streams from different sources into different needs and meet common quality criteria combining streams from different sources.

6.6 A system for controlling the power

The hybrid ESS control strategy is considerably more complex. For self-charging and transmission, the redistribution of the power system and the characteristics of the ESS should be investigated as shown in Fig. 8. For example, where supercapacitors and batteries are used to meet charging demands, ultracapacitors respond faster and provide higher power than batteries, but have a shorter lifetime. As a result, the supercapacitor can handle very high battery currents and decide to gradually discharge or charge the battery. In this case, the battery and supercapacitor must be arranged in pairs.independent circuit.

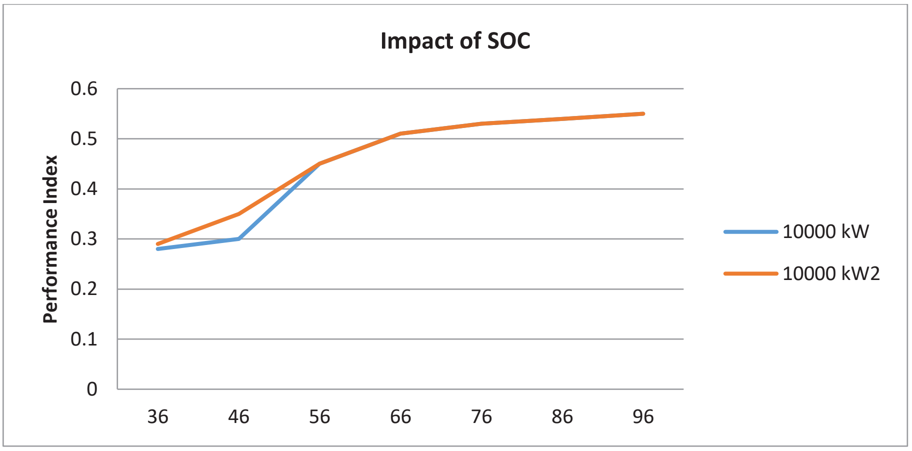

Fig. 8: performance comparison of M4

It is important to charge or discharge batteries and supercapacitors according to the instructions provided by the manufacturer if they are to have a long life, high performance and high efficiency. In order to remove sulfates from the lead plates of traditional lead-acid batteries, the batteries are charged slowly and at low intensity. There is an option to charge the ESS regularly, as well as to charge the ESS at a rate that is adjusted to the MG's power (SOC) variability.

It appears that the device is not fully charged and fully charged before charging again, which is called low SOC mode. Problems with charging and discharging are addressed by developing battery/supercapacitor management systems. There are two methods of charging an energy storage device, the current voltage method and the constant voltage method. A constant current load makes use of a steady-state feedback control strategy, whereas a direct current load makes use of a two-loop voltage control or current control strategy. It is also necessary to make use of voltage or dual circuit technology in order to control the emission of ESS. There are a variety of advanced control methods available to implement the load integration process in a cost-effective, nonlinear manner, such as neural networks, fuzzy logic, and self-adaptive logic. Changes in cell parameters, uneven charging, discharge connections, ESS aging problems and other problems should be carefully studied.

6 Conclusion and Recommendation

This study investigates the microgrid energy storage system of a photovoltaic system. Microgrid topologies and storage system configurations are explored, along with power electronics interference, control systems and renewables, and energy storage system optimization. In a HESS PV system, sizing is usually done using the design space and density analysis method. Compression analysis is used to create HESS scale sizes that combine generator estimates of storage capacity based on load and resource data. The operation of the microgrid energy storage system is introduced and the load demand analysis is performed in relation to the load condition and power management systems. In comparison with the disturbance-free energy storage system, the microgrid energy storage system with disturbance system works better. Changes in payment status affect HESS operations. HESS supports the strong performance of a microgrid with a larger battery.

References

1. Ahmadi, M.H.; Ghazvini, M.; Sadeghzadeh, M.; Nazari, M.A.; Kumar, R.; Naeimi, A.; Ming, T. "Solar power technology forelectricity generation: A critical review". Energy Sci. Eng. 6, (2018): 340–361.
2. Gamarra, A.R.; Banacloche, S.; Lechon, Y.; del Río, P. "Assessing the sustainability impacts of concentrated solar power deploymentin Europe in the context of global value chains". Renew. Sustain. Energy Rev. 2023,171, 113004.
3. Hansen, K.; Vad Mathiesen, B. "Comprehensive assessment of the role and potential for solar thermal in future energy systems". Sol. Energy 169, (2018): 144–152.
4. Lambrecht, M.; de Miguel, M.T.; Lasanta, M.I.; Pérez, F.J. "Past research and future strategies for molten chlorides application inconcentrated solar power technology". Sol. Energy Mater. Sol. Cells 237, (2022): 111557.
5. Montenon, A.C.; Meligy, R. "Control Strategies Applied to a Heat Transfer Loop of a Linear Fresnel Collector". Energies 15, (2022): 3338.
6. Leonardi, M.; Corso, R.; Milazzo, R.G.; Connelli, C.; Foti, M.; Gerardi, C.; Bizzarri, F.; Privitera, S.M.S.; Lombardo, S.A. "The Effectsof Module Temperature on the Energy Yield of Bifacial Photovoltaics: Data and Model". Energies 15, (2021): 22.
7. Vance, D.; Razban, A.; Schubert, P.; Weissbach, R. "Investigation into Sizing Photovoltaic with Energy Storage for Off-GridTransactive Scenarios". Energies 14, (2021): 1062.
8. Anani, N.; Ibrahim, H. "Performance Evaluation of Analytical Methods for Parameters Extraction of Photovoltaic Generators". Energies 13, (2020): 4825.
9. Mohamed, A.S.A.; Maghrabie, H.M. "Techno-economic feasibility analysis of Benban solar Park". Alex. Eng. J. 61, (2022): 12593–12607.
10. Hansen, L.H.; Madsen, P.H.; Blaabjerg, F.; Christensen, H.C.; Lindhard, U.; Eskildsen, K. "Generators and power electronicstechnology for wind turbines. In Proceedings of the IECON'01". 27th Annual Conference of the IEEE Industrial Electronics Society, Denver, CO, USA, 29 November–2 December 2000–2005.
11. Kumar, Y.; Ringenberg, J.; Depuru, S.S.; Devabhaktuni, V.K.; Lee, J.W.; Nikolaidis, E.; Andersen, B.; Afjeh, "Wind energy: Trendsand enabling technologies" . Renew. Sustain. Energy Rev. 53, (2016): 209–224.

12. “Wind Solar Hybrid Project—Case Study|CleanMax”.
13. International Renewable Energy Agency. About IRENA. “In Renewable Energy Statistics Statistiques D’énergie Renouvelable2022”. Estadísticas de Energía Renovable 2022; IRENA: Masdar, United Arab Emirates, 2022. (26 December 2022).
14. Akinyele, D.O.; Rayudu, R.K. “Review of energy storage technologies for sustainable power networks. Sustain”. Energy Technol.Assess. 8, (2014): 74–91.
15. Hossain, S. “Comparative Study on Horizontal Axis Wind Turbines and Vertical Axis Wind Turbines. Bachelor Thesis, World University of Bangladesh, Dhaka, Bangladesh, 2019”. (7 January 2023).
16. Han, S.; Bai, L.; Chi, M.; Xu, X.; Chen, Z.; Yu, K. “Conversion of Waste Corn Straw to Value-Added Fuel via HydrothermalCarbonization after Acid Washing”. Energies 15, (2022): 1828.
17. Choi, S.K.; Choi, Y.S.; Jeong, Y.W.; Han, S.Y.; Nguyen, Q. “Characteristics of Flame Stability and Gaseous Emission of Bio-CrudeOil from Coffee Ground in a Pilot-Scale Spray Burner”. Energies 13, (2020): 2882.
18. Kim, J.-W.; Ahn, H.; Seo, H.C.; Lee, S.C. “Optimization of Solar/Fuel Cell Hybrid Energy System Using the Combinatorial DynamicEncoding” Algorithm for Searches (cDEAS). Energies 15, (2022): 2779.