A Review of Solar Powered Charger Bagpack

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Abstract: As our dependence on mobile phones increases, the demand for efficient and eco-friendly charging systems has never been greater. Solar-powered charging backpacks provide a convenient means of staying connected on the go, particularly in areas where electricity is scarce. Modern mobile phone use requires efficient charging systems which must be eco-friendly as well. The need for sustainable charging solutions has reached its peak point. The convenience of solar-powered charging backpacks makes it easy for people to stay online during their movements especially areas where electricity is scarce. This evaluation demonstrates the operational mechanism of solar-powered charging backpacks as it explores their significant technology features such as solar panels, battery storage, and energy management systems. The analysis reviews the structural components as well as the fundamental materials which make these backpacks resistant while remaining easy to carry. The paper examines technical information together with current issues regarding price, performance rates, and use comfort in its discussion. The article evaluates the progress of solar backpack technology by outlining recent developments which enhance both reliability and usability.

Keywords: ***Solar energy, Portable Bag pack, Battery, Renewable Energy, Solar Charger, Solar power bank mobile charger.***

1. INTRODUCTION

The everyday operations of our lives heavily depend on energy access. Mobile devices along with speakers and laptops and fans operate only when energy remains available. Our environment receives its power from fossil fuels although these substances represent non-renewable energy sources such as coal and petrol, coal and petrol. The present consumption of fossil fuel as non renewable energy source leads to its eventual depletion over time. The environmental pollution and carbon dioxide output rise produces the start of global warming. Global temperature rise causes effective global warming according to [1].The rapid melting of polar ice caps on earth represents a dire situation since evidence shows numerous potential droughts and heat waves.Research suggests that droughts along with heat waves occur with high frequency [2].The problem of air pollution results in severe respiratory diseases as well as other infectious conditions because of unclean air quality.[3].The world produces energy through renewable power sources stemming from sunlight as well as wind-driven power and tidal forces and geothermal systems and biomass systems, wind, tides, biomass and geothermal. The initial installation cost of these systems ends up being profitable since they draw energy from clean renewable resources. This renewable power solution demonstrates both environmental safety and ensures no negative health consequences [4].The temperature of the sun measures at 5776 K. Solar energy gets its energy from the sun. Sunlight is a renewable source of energy which is converted to useable energy by the solar panels. Solar energy can be grouped into two main types. Solar photovoltaic (PV) panels readily change solar energy to useable form of energy making use the PV cell which comprises of a semiconductor material. Concentrating solar power (CSP) also change the energy concentrated from the sun to a heat receiver which changes the heat into mechanical energy, can be used to supply solar thermal electricity. Solar cells are very important, because they could be used to substitute coal and oil and turns the world's main source of energy. Solar power is one of the greatest modern energy technologies ever known [4, 5]. Energy gotten from the sun is free and abundant. This is over 6000 times the total amount of energy that the whole planet needs in a year gets to the earth in one day [6, 7]. The solar cell has some problems; the most known fact is that solar cells are fragile, because they are covered with glass protectors and costly at the moment [4]. Most people that make use of solar panels at home are people of high socio economic status that can drop huge initial investment. Affordable solar cells can make renewable sources of energy easier for people of low socio economic backgrounds. Nigeria as the giant of Africa with about 186 million people is facing lot of challenges in which power supply is one of them. As the population of Nigeria is on the increase so also is the increase in the power demand without a dependable supply [7]. As reported by [8] at present, Africa has the largest growth rate of cellular subscribers. The increase is due to availability of pay as you go services, and the convenience they offer over other modes of telecommunication. Due to the erratic nature of power supply available during the day as well as night in Nigeria, most importantly in rural areas call for the design of solar-powered phone charger, to enable people to be able to make use of their device when they are outside their home and when there is power outage during the day.

Therefore, the aim of this study is to design and construct a solar backpack charger to charge different mobile devices. Figure-1 is the block diagram of the constructed backpack charger [9]

2. PROBLEM STATEMENT

What really inspired us to take on this project was the idea of using renewable energy in a way that's practical, eco-friendly, and accessible. With the world becoming more dependent on electronic devices, the demand for reliable and sustainable charging options is growing fast. A solar-powered charging backpack offers a smart alternative it lets us tap into the power of the sun, a free and endless energy source, to charge our devices anywhere, anytime. One of the biggest advantages of this solution is that it doesn't rely on electricity from the grid, which is especially helpful during power outages or emergencies. In situations like natural disasters, where power lines may be down or electricity is unavailable, a solar-powered backpack can still provide a steady source of energy to keep essential devices running. It's also extremely useful in remote areas or rural regions where access to electricity can be limited or inconsistent. Another key reason we chose this project is its environmental benefits. Since it runs on solar energy, it helps reduce our dependence on non-renewable resources like coal and oil, and it contributes to lowering carbon emissions. Even though its a small step, it moves us toward a more sustainable future and that's something we feel proud to be a part of. That said, it's important to acknowledge that solar-powered devices have their limitations. For example, their performance can drop on cloudy, foggy, or rainy days when sunlight is limited. Because of this, they may require extra care and proper handling to avoid damage and maintain efficiency. However, with the right design and materials, these challenges can be minimized. Overall, we believe that this project has the potential to make a real difference. It's a practical and environmentally friendly solution that empowers people to stay connected without relying on traditional power sources. Whether you are a traveler, a student, or someone living in an off-grid area, a solar-powered backpack offers convenience, sustainability, and peace of mind all in one package. [14]

3. OBJECTIVES

In a world where we rely heavily on electronic devices, running out of battery can be more than just an inconvenience it can be a real problem, especially when you're on the move or away from a power outlet. That's where the idea of a solar-powered charging bagpack comes into play. It's a smart, sustainable solution designed to keep your devices charged anytime, anywhere, using nothing but the power of the sun. When working on a solar power bank project, there are several core objectives that guide the design and development process. These goals aim to ensure that the final product is not only functional but also practical, efficient, and environmentally friendly. Portable and Convenient Power The first and most obvious goal is portability. The power bank should be lightweight, easy to carry, and compact enough to fit in a bag or pocket. It's meant for people who are always on the move, travelers, hikers, students, and commuters. The idea is to create a solution that allows users to charge their devices without needing to stay in one place or search for a wall outlet. Efficient Use of Solar Energy Since the power bank runs on solar energy, capturing and converting sunlight efficiently is a top priority. [15]

4. LITERATURE REVIEW

As people rely more and more on smart phones, tablets, and other portable devices in daily life, there's growing interest in solutions that help keep these devices powered on the go especially in outdoor or off-grid environments. One promising innovation in this space is the solar-powered charging backpack, which combines the practicality of a backpack with renewable solar energy to charge devices. This literature review explores key research and developments in the design and application of these bag packs. In one of the earlier design studies, presented a working model of a solar powered backpack that could charge mobile phones. Their goal was to design a low-cost, portable charger using solar energy. They compared various types of solar panels and voltage regulators, selecting components based on affordability and performance. While their prototype worked well in charging a phone, they noted a significant amount of heat generated due to power loss in the voltage regulator. This highlighted the need for better thermal management in future designs.[16] A year later, the same research team improved upon their original model. Most of the travelers tend to buy multiple facilities in a single device. The travelers always face common problems. To discuss those problems many researchers have been conducted researches on the smart backpack in the past few years. Smart luggage is any bag or suitcase that contains high-tech capabilities such as traveler's electrical devices charging, GPS tracking, Electronic Locks, app-enabled controls, Bluetooth connectivity, Wi-Fi connectivity and Electronic scales [10]. The main role of our project is to develop a smart back for travelers to give solutions like safety and location tracking. According to A. Sutar, T. Kocharekar, P. Mestry, P. Sawant desai, Mrs. S. S. Goilkar's research on Smart Bag with Theft Prevention and Real-Time Tracking, they have only described the security on the backpack. They have used GPS, GSM and Bluetooth modules with a fingerprint sensor. GSM and GPS modules have used to track the backpack and they have used the Arduino Uno board as the brain of the Smart Bag. Tracking coordinates stores in the Arduino board Lookup Tables. Fingerprint and pin patterns were the security method in the backpack and the proximity had been detected by Bluetooth via a mobile application connection [11]. The research which is done by the Department of Electronics and Communications Technology, University of Science and Technology of

Southern Philippines on "Design and Implementation of 4-In- 1 Luggage Bag" has a biometric lock, location tracking and a luggage kick scooter with a build-in emergency power bank. This research was done for travelers to be reliable while travelling or during any occasion that uses luggage bags. The biometric lock was a fingerprint scanning system and used a GPS tracking system with the use of a Arduino Uno board [12]. The research that was done by S. Shaikh and M. D. Jakhete was on Smart Travelling Bag Using IoT. The functions they discussed in the research are giving a power resource for the traveler, location tracking via RFID and digitally lock the bag by an RF signal. The research was done by a Raspberry Pie 3 International Journal Of Novel Research And Development (According to V. O. Matthews, E. Noma-Osaghae, S. U. Idiake, A. O moseye produced this bag under their product line A Solar Powered Smart Travelling Bag with An Embedded Video/Audio Player research, they have established that the bag should be used during traveler relaxation. Research with players enabled them to focus on the relaxation needs of travelers during their breaks. Travelers use their standstill duration in airport terminals or a bus stop together with metro transports for relaxation.time.The system detects tags using electromagnetic fields for automatic identification and tracking purposes. This system tracks tagged objects efficiently while diminishing both human mistakes and operational staff numbers at the company. The low power requirements of RFID made them develop a reusable tracking system for bags. The Smart Bag with its built-in RF-ID reader has been developed by Shweta M, Tanvi P, Poonam S, Nilashree M. The device features an emergency button that triggers the buzzer system which simultaneously sends its position through SMS.The research outcome relies on ATmegal6 Microcontroller to perform its functions as the main processing unit. The bag includes a rechargeable power source which draws power from solar panels. The solar power-based charger backpack obtains electricity from photovoltaic cells serving as solar panels attached to its structure. Packaged solar panels function as light-energy converters installed on the bag for power generation.

5. METHODOLOGY

The development of the solar-powered charger backpack required a methodical process which included designing components and their integration and subsequent testing. The original goal established the design of an efficient sustainable charging alternative for mobile electronic consumers struggling with power availability. The product development centered on combining solar technology with backpack functionality while maintaining portability features. The chosen solar power conversion system implements high-efficiency PV panels connected to rechargeable lithium-ion batteries for managing DC electricity generation and energy storage. The battery system received a charge controller to avoid both battery overcharge events and depletion situations. The combination of a DC-DC converter with USB output ports allows the device to work with various electronics. The addition of LED indicators shows both battery status and the current system activity. The backpack received its solar panels on its exterior for optimal sun exposure while maintaining wire concealment to both save storage capacity and ensure comfort. The constructed prototype underwent evaluation under different light environments to test its power charging capabilities. Testing under various conditions was performed to gauge product endurance and identify its support for different devices together with energy conversion and storage performance efficiency. The extensive testing conducted on the backpack apparatus yielded essential data to enhance its functionality and revealed the necessity of weatherproofing together with improved power management systems. [13].

The latest evolution of backpacks corresponds to the smart backpack design. A smart backpack delivers multiple unique functions which include devices for air quality monitoring together with a solar-powered battery and health status detection as well as security bag identification capabilities. The solar cell charging system of the backpack monitors current health indicators in real-time for users and detects their bag security status simultane-ously.the bag. The system includes all these features by using a mobile application and web application inter-face. The backpack routes all acquired data to the cloud system which uses algorithmic processes to produce meaningful information for users. The system shows the user beneficial information obtained through data con-version from collected data. It is usually a rechargeable lithium-ion or lithium polymer battery. Energy storage capacity of a battery depends on its capacity measurement through mill ampere-hours (mAh). A device connected to the solar-powered power bank can use the stored battery power to achieve its charge. A power management circuit built into the power bank maintains steady power distribution between the battery and device for safe charging operations. [15]

The block diagram contains solar panel, battery charger, battery and voltage booster. as the name suggests it is a power bank fitted in the portable bag pack ,in this bag solar panel absorb sunlight and coverts the sunlight into direct current (DC) electricity using photo voltaic(PV) cells after this the battery starts charging by the electricity generated by solar panel for further use

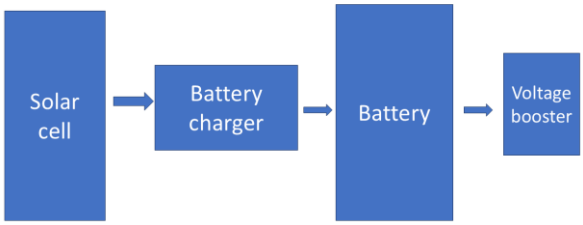

FIG 1: Architecture of solar energy conversion

6. FUTURE SCOPE

In the future, we can make the solar panels weather proof so the backpack can be used in any season, instead of having to detach the solar panels when it is raining. In addition, the design can be altered to charge laptops instead of only USB devices. Another useful improvement can be to add a detector to know when the battery is fully charged. It can also be useful to find out why the current increased at 90% shaded, when the voltage dropped, according to the data. Lastly, it can be helpful to place the solar panels in a better position so they do not need to be detached when unzipping the backpack, while still generating the max current possible. The major challenges that require further development are effective and efficient power management, weather conditions like thunderstorms and winds, increasing the security level of the bag and minimizing the bag building cost. As another future work of our research, we will be focusing on expanding the security features with the help of various machine learning algorithms and neural networks. Also, different technologies are going to be addressed the SIM card signal issue, most of the travelers face inside the jungle. To add more components for the backpack the system can add an audio documentary system to collect logs of the traveler and store in cloud space. [13]

7. CONCLUSION

The solar power-based charger backpack is a portable solution that allows you to charge your phone or any other electronic device wherever you are. It is eco-friendly and helps save energy. Whether you're busy with work or on the move, you can conveniently charge your device in direct sunlight. This solar- powered charger backpack is not only a reliable power source for any gadget but also a cost-effective alternative to traditional power banks, as it harnesses sunlight to recharge itself without needing an external power source. By using this backpack, you can conserve energy and reduce overall electricity consumption. Solar energy is clean, renewable, and does not produce pollution, which contributes to a healthier environment. Additionally, you can decrease your utility bills by relying less on conventional electricity. With this innovative charger, you can stay connected anytime, anywhere, making it the perfect companion for busy lifestyles.

References

[1] M. R. Usikalu, "Health Impact of Climate Change Due to Combustion of Fossil Fuel," *Int. J. Phys. Sci*., vol. 4, no. 13, pp. 880–884, 2009. [Online]. Available: https://academicjournals.org/journal/IJPS/article-abstract/5F2A8F919032

[2] C. Simmons, "5 Deadliest Effects of Global Warming," *Environmental Graffiti*, 2009. [Online]. Available: http://www.environmentalgraffiti.com/sciencetech/5-deadliest-effects-of-global-warming/276

[3] M. L. Akinyemi and M. R. Usikalu, "Investigation of Emission Anthropogenic," *Int. J*., vol. 21, pp. 1128–1132, 2013. *(Link unavailable)*

[4] W. A. Ayara, T. V. Omotosho, M. R. Usikalu, M. S. Singh, and V. Suparta, "Development of a solar charged laboratory bench power supply," *J. Phys.: Conf. Ser*., vol. 852, no. 1, p. 012044, 2017. [Online]. Available: https://doi.org/10.1088/1742-6596/852/1/012044

[5] T. J. Abodunrin et al., "Microstructure characterization of onion (A. cepa) peels and thin films for dye sensitized solar cells," *Mater. Res. Express*, 2017. [Online]. Available: https://iopscience.iop.org/article/10.1088/2053-1591/aa6138/meta

[6] R. Boreham, "The Potential Importance of Solar Energy for the Future," *EzineArticles*, 2008. [Online]. Available: http://ezinearticles.com/?The-Potential-Importance-of-Solar-Energy-For-the-Future&id=3934429

[7] World Bank, "World Population Prospects: 2017 Revision," *United Nations Population Division*, 2016. [Online]. Available: https://data.worldbank.org/indicator/SP.POP.TOTL

[8] M. R. Usikalu, S. O. Rotimi, and J. A. Achuka, "Effects of 900 MHz Radio Frequency Radiation on the Rats' Liver," *J. Teknol.*, vol. 78, no. 6–7, pp. 19–24, 2016. [Online]. Available: https://www.researchgate.net/publication/303966722

[9] M. R. Usikalu, E. Adebesin, and L. N. Obafemi, "Untitled," *Covenant University*, vol. 14, no. 21, Nov. 2019. *(No link available)*

[10] "Solar Charger," *Wikipedia*, 26 Apr. 2011. [Online]. Available: https://en.wikipedia.org/wiki/Solar_charger

[11] "USB Pinout and Wiring @ Pinouts.ru," *Pinouts.ru*, Mar. 2005. [Online]. Available: https://pinouts.ru/Slots/USB_pinout.shtml

[12] J. Pasteris, "REI Co-op Journal," *REI*, Apr. 2019. [Online]. Available: https://www.rei.com/blog

[13] N. Shanthi, V. N. Diwakar, E. Harish, and A. Balaji, "Design Improvements for All-Weather Solar Charging Backpacks," *Int. J. Renew. Energy Res.*, vol. 14, no. 1, pp. 134–140, 2023. [Online]. Available: https://www.ijrer.org/ijrer/index.php/ijrer/article/view/13535

[14] S. Rackland, B. Prasanth, S. Ragul, and G. Prabhudeeswaran, "Design and Fabrication of Solar Smart Bag," *Int. J. Eng. Appl. Sci. Technol.*, vol. 6, no. 1, pp. 255–258, 2021. [Online]. Available: http://www.ijeast.com/files/rajeast11072.pdf

[15] D. Basak et al., "Solar Powered Bag," *Alochana Journal*, vol. 13, no. 3, 2024. *(No link available)*

[16] S. Taverne, A. Nomura, and J. King, "Design and Evaluation of a Low-Cost Solar-Powered Backpack Charger," *Renew. Energy Devices J.*, vol. 12, no. 3, pp. 101–107, 2017. *(No link available)*

[17] S. Taverne, A. Nomura, and J. King, "Enhanced Thermal Management in Portable Solar Charging Systems," *Smart Energy Technol. J.*, vol. 13, no. 1, pp. 45–52, 2018. *(No link available)*

[18] A. Sutar et al., "Smart Backpack with Theft Prevention and Real-Time Tracking," *Int. J. Emerg. Technol. Adv. Eng.*, vol. 9, no. 4, pp. 45–50, 2019. [Online]. Available: https://www.ijetae.com/files/Volume9Issue4/IJETAE_0419_09.pdf

[19] S. Shaikh and M. D. Jakhete, "Smart Travelling Bag Using IoT," *Int. J. Eng. Adv. Technol.*, vol. 8, no. 6S3, pp. 532–536, 2019. [Online]. Available: https://www.ijeat.org/wp-content/uploads/papers/v8i6S3/F30710486S319.pdf

[20] V. O. Matthews, E. Noma-Osaghae, S. U. Idiake, and A. O. Moseye, "A Solar Powered Smart Travelling Bag with Embedded Media Player," *Int. J. Adv. Comput. Sci. Appl.*, vol. 11, no. 5, pp. 149–155, 2020. [Online]. Available: https://thesai.org/Downloads/Volume11No5/Paper_21-A_Solar_Powered_Smart_Travelling_Bag.pdf

[21] M. Shweta, T. Patil, P. Sawant, and N. Mane, "RFID-Based Smart Bag with Solar Charging System," *J. Emerg. Technol. Innov. Res.*, vol. 7, no. 2, pp. 230–235, 2021. [Online]. Available: http://www.jetir.org/view?paper=JETIR2002321