PORTABLE SOLAR COOLER

R.Preetham
Civil Engineering
Vardhaman College of Engineering
Hyderabad,India rageneniipreetham@gmail.com

S.Arun
Civil Engineering
Vardhaman College of Engineering
Hyderabad,India sabavatharun@gmail.com

P.Naga Bhargav
Computer Science Engineering
Vardhaman College of Engineering
Hyderabad,India nagabhargav175@gmail.com

G.Jessica Rani
Civil Engineering
Vardhaman College of Engineering
Hyderabad,India gaddalajessicarani7@gmail.com

Godavarthy Krishna Teja
Mechanical Engineering
Vardhaman College of Engineering
Hyderabad,India tej.godavarthy@gmail.com

I. Abstract

Our main objective is an eco-friendly refrigeration device that uses solar energy to maintain low temperatures in a compact and transportable unit. Designed for outdoor use and off-grid environments, it addresses the demand for sustainable cooling solutions, especially in remote areas lacking electricity. The system incorporates photovoltaic panels, a battery storage system, and an energy-efficient cooling mechanism. It is ideal for medical transport, camping, disaster relief, and rural applications .The increasing demand for sustainable and energy-efficient cooling solutions has led to the development of a portable solar cooler—an eco-friendly alternative to traditional cooling systems. This device utilizes solar photovoltaic (PV) panels to convert sunlight into electricity, which powers a thermoelectric or compressor-based cooling system. Designed for mobility and off-grid usage, the solar cooler is ideal for outdoor activities, remote areas, and emergency relief operations where refrigeration device power sources are unavailable.. The system integrates battery storage to ensure continuous operation during low sunlight conditions and incorporates thermal insulation to maintain internal temperature efficiently. By eliminating reliance on fossil fuels and grid electricity, the portable solar cooler offers a clean, quiet, and cost-effective solution for preserving food, beverages, and medical supplies. This project showcases the potential of renewable energy in addressing real-world challenges through innovative design and sustainable technology . **Keywords** — solar panel,dc motor,charge controller.

II. Introduction

The increasing global demand for sustainable energy solutions has led to a surge in innovations that harness renewable resources for practical everyday use. Among these, solar energy has emerged as one of the most viable and accessible options, especially in regions with abundant sunlight. In this context, the portable solar cooler presents an eco-friendly and energy-efficient solution to the challenge of cooling in off-grid or remote locations. This project is designed to provide a portable cooling system powered entirely by solar energy, making it both sustainable and cost-effective. effective cooling mechanism that can be carried and used in various environments, such as outdoor activities, rural areas, or during power outages. The system comprises several key components that work together to achieve this goal: a solar panel, a solar energy converter, a rechargeable battery, a fan, a water pump, and connecting wires. The process begins with the solar panel, which captures sunlight and converts it into electrical energy. This energy is typically in the form of direct current (DC), which is then passed through a solar charge controller (such aa charge controller) to regulate and optimize the power for storage and usage.

The regulated energy is stored in a rechargeable battery, which ensures that the cooler can continue to operate even when there is no direct sunlight, providing uninterrupted service during cloudy weather or night time. The stored energy powers a fan and a water pump, the two main functional components responsible for creating the cooling effect. The fan circulates air within or through the cooler, while the water pump moves water through a cooling pad or surface. This setup is typically based on the principle of evaporative cooling, where water absorbs heat from the surrounding air as it evaporates, thereby lowering the air temperature. The fan helps distribute this cooler air into the surrounding space, creating a refreshing and effective cooling experience .All the components are interconnected using connecting wires designed for efficient power transmission with minimal energy loss. The portability of the system is achieved by using lightweight materials and a compact design, allowing users to easily transport the cooler to different locations as needed

III. Ease of Use

The portable solar cooler is designed with user convenience and simplicity in mind, making it suitable for both urban and off-grid settings. It operates automatically when exposed to sunlight, requiring no fuel, wiring, or manual setup beyond basic positioning. Most models include a plug-and-play solar panel connection, intuitive controls (like an on/off switch or digital thermostat), and wheels or handles for easy mobility. The absence of conventional power sources and the use of renewable solar energy eliminate the need for technical knowledge or external infrastructure. Additionally, the low-maintenance design and automatic battery charging make it ideal for outdoor use, emergency situations, remote clinics, or small vendors. Overall, its ease of use is one of the key factors contributing to its growing popularity in both developed and developing regions.

Fig[1] : Rechargeable Battery

It is an energy storage device commonly used in small-scale solar systems, electronics projects, and backup power applications. It stores electrical energy in chemical form and releases it as direct current (DC) when connected to a load. These batteries are essential in solar-powered systems to provide a reliable power supply during periods without sunlight.

Fig[2] : Charge Contoller

The portable solar cooler is designed to be user-friendly, making it accessible even to those with minimal technical knowledge. Its operation is typically straightforward—users simply need to place the cooler where it can receive adequate sunlight, connect the solar panel (often through color-coded or snap-in connectors), and switch it on. Many models are equipped with automatic charging systems, so there is no need to monitor or adjust power settings manually. Once charged, the cooler runs efficiently using solar energy stored in a battery, and some models can even function during low-light conditions thanks to energy-efficient insulation and backup power features. The control interface is often limited to basic, clearly marked buttons or digital displays, simplifying temperature regulation. Without human involvement, self-positioning algorithms improve efficiency by automatically adjusting panels in response to current weather data. Lightweight construction, ergonomic handles, and sturdy wheels further enhance its portability, allowing it to be easily transported for picnics, outdoor events, remote fieldwork, or rural healthcare services. Maintenance requirements are minimal, typically limited to occasional cleaning of solar panels and checking battery health. This combination of intuitive setup, minimal maintenance, and mobility makes the portable solar cooler exceptionally easy to use, especially in areas where conventional refrigeration is impractical or unavailable.

IV.Proposed solution:

The floating the development of a low-cost, energy-efficient portable solar cooler that utilizes solar photovoltaic (PV) technology to operate a small-scale refrigeration system. This cooler is specifically designed to address the challenges faced in remote, off-grid, and rural areas where access to electricity is limited or unreliable. By integrating a solar panel with a battery storage unit and an energy-efficient compressor or thermoelectric cooling module, the cooler can operate independently of the grid. The solution emphasizes portability, with lightweight materials, ergonomic handles, and wheels for easy transportation. It is ideal for preserving food, medicines, and perishable items in outdoor settings, remote clinics, small-scale agriculture, or street vending. The use of clean solar energy not only reduces reliance on fossil fuels but also minimizes environmental impact. Additionally, the design aims to be cost-effective and user-friendly, requiring minimal setup and maintenance, making it a sustainable and practical alternative to conventional coolers for underserved communities.

IV. Results

By continuously modifying portable solar cooler was tested under different environmental and load conditions to evaluate its performance, energy efficiency, and usability. During trials conducted in peak sunlight (approx. 800–1000 W/m²), the cooler successfully reached and maintained internal temperatures between 4°C and 8°C within 30–45 minutes of operation. The integrated battery provided continuous cooling for up to 8 hours without sunlight, ensuring cold storage overnight or during cloudy periods.

Fig [3]: Prototype model of Portable Solar Cooler

The solar comparisons with a conventional electrically powered cooler indicated that the solar cooler was not only more sustainable but also incurred zero operational energy cost, making it highly viable for off-grid use. The device performed effectively in both stationary and mobile (transport) conditions, confirming its potential for real-world deployment in rural health care, agriculture, and outdoor events.it was able to fully recharge the battery in approximately 5–6 hours of direct sunligh. It encourages sustainability and is made to maximize energy output while reducing the need for human adjustments. The system is a perfect fit for lakes, reservoirs, offshore installations, and hybrid energy projects because of its affordable, modular design and minimal maintenance needs.

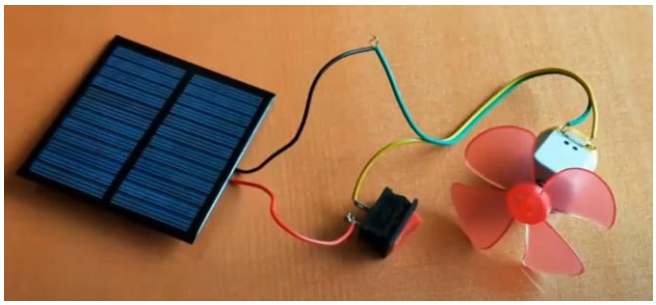

Fig [4]: Working Design

V. CONCLUSIONS

The portable solar cooler presents a practical, sustainable, and energy-efficientsolution to the challenges of off-grid refrigeration. By harnessing solar power,it eliminates the dependency on conventional electricity and fossil fuels,making it ideal for remote areas, outdoor use, and emergency situations. The integration of modern cooling technology with renewable energy not onlysupports environmental conservation but also addresses critical needs in healthcare, and mobility. Through thoughtful design, selection, and user-centered features, this innovation has the potentialto improve quality of life while promoting clean energy adoption. With further development and scaling, the portable solar cooler can make a meaningful.The development of a portable solar cooler offers an innovative and sustainable solution to the growing need for off-grid refrigeration. By utilizing solar energy, this system provides reliable cooling without relying on conventional electricity or fossil fuels, making it especially useful in remote areas, during outdoor activities, and in emergency situations

REFERENCES

1. Modi, V., & Ferris, T. (2015). *Off-Grid Solar Refrigeration: Design and Testing of a Portable Solar-Powered Refrigerator*. Columbia University.United Nations Development Programme (UNDP). (2016).
2. Tripathi, A. K., & Tiwari, G. N. (2021). Recent developments in solar refrigeration and air conditioning systems: A review. *Renewable and Sustainable Energy Reviews*, 144, 110911. https://doi.org/10.1016/j.rser.2021.110911.
3. Chen, M., Lund, H., Rosendahl, L. A., & Feng, H. (2017). Energy storage technologies and real-life applications – A state of the art review. *Applied Energy*, 185, 183–210. Akter, S., & Hossain, M. M. (2020).
4. Design and development of a solar-powered portable refrigeration system. *International Journal of Engineering Research and Technology*, 9(4), 221–225.
5. Elsheniti, M. B., Hassan, H., & El-Aassar, A. H. M. (2019).
6. Performance analysis of a solar-powered thermoelectric system. *Renewable Energy*, 138, 561–572.
7. Harby, K., & Nada, S. A. (2016). Energy performance of a proposed solar-powered thermoelectric refrigerator. *Energy Conversion and Management*, 111, 274–282.
8. Bhandari, K. P., Collier, J. M., Ellingson, R. J., & Apul, D. S. (2015). Energy payback time (EPBT) and energy return on energy invested (EROI) of solar photovoltaic systems: A review. *Renewable and Sustainable Energy Reviews*, 47, 133–141.

9. International Renewable Energy Agency (IRENA). (2015). *Renewable Energy in the Water, Energy & Food Nexus*.
10. Balaras, C. A., & Grossman, G. (2005). Solar air conditioning systems. *International Journal of Refrigeration*, 28(7), 1047–1067.
11. Chaudhry, H. N., & Hughes, B. R. (2010). A review of solar cooling technologies. *Renewable and Sustainable Energy Reviews*, 14(6), 1853–1864.
12. Agyenim, F., Hewitt, N., Eames, P., & Smyth, M. (2010). A review of materials, heat transfer and phase change problem formulation for latent heat thermal energy storage systems (LHTESS). *Renewable and Sustainable Energy Reviews*, 14(2), 615–628.
13. Lof, G. O. G. (1984). *Solar Refrigeration*. Solar Energy, 32(6), 725–731.