International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

"DESIGN AND IMPLEMENTATION OF MICRO SOLAR DOME"

Laxmi I Naikar[1], Alfaz K Sharif [2],Ayan M Mannurkar[3], Prof B S Hugar[4]*

[1]Dept of Electrical and Electronic Engineering, S.G.Balekundri Institute of Technology, Belagavi, Karnataka, India, 590010.
laxminaikar20@gmail.com
[2]Dept of Electrical and Electronic Engineering, S.G.Balekundri Institute of Technology, Belagavi, Karnataka, India, 590010.
alfazsharif90254@gmail.com
[3]Dept of Electrical and Electronic Engineering, S.G.Balekundri Institute of Technology, Belagavi, Karnataka, India, 590010.
ayaanmannurkar@gmail.com
[5]Dept of Electrical and Electronic Engineering, S.G.Balekundri Institute of Technology, Belagavi, Karnataka, India, 590010
hugar.basavaraj@gmail.com

ABSTRACT :

Micro solar dome is an expanding field in the green technology .This technology uses materials like micro solar dome to create the clean energy. The design process emphasizes cost effectiveness scalability and environmental sustainability using readily available materials and simple fabrication techniques. This project focus on the design,development and implementation of the low cost,energy,efficient lighting device powerd by solar energy

Keywords: Micro solar dome,clean energy,renewable energy,marginalized communities,dimmer,diffuser,solar panel

Introduction :

A sun tunnel is also called a solar tube, light tunnel, or tubular skylight. It is an innovative daylighting solution that brings natural light into spaces that lack access to direct sunlight. It consists of a highly reflective tube that channels sunlight from a roof-mounted dome or flat collector to a diffuser inside the building, effectively illuminating areas such as hallways, bathrooms, closets, and other dark or windowless spaces.

Sun tunnels are energy-efficient, cost-effective, and easy to install. Thus, they are an ideal alternative for traditional skylights. The interior aesthetics are enhanced through natural light provision, thus reducing dependence on artificial lighting, thus possibly lowering energy bills and making it a more sustainable environment in which to live or work. In their design, they minimize heat gain or loss for maintaining comfort indoors all the year round.

Structure :

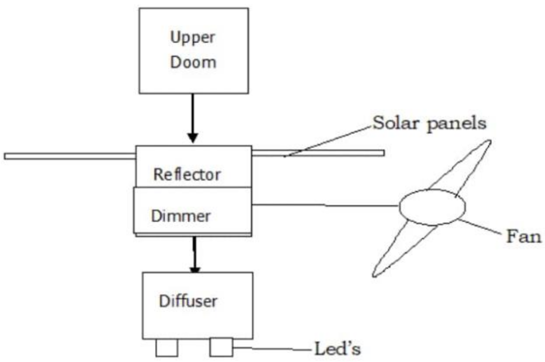
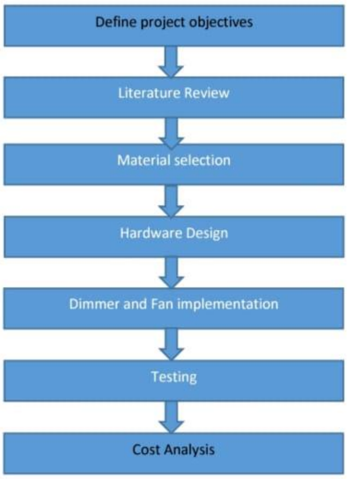


Fig 1: Circuit diagram

In the prototyping and selection of proper materials, which can be polycarbonate or fiberglass for the dome shell and solar panels with other components, a working prototype is constructed in integrating the solar panels, the battery storage, and the wiring system. Testing the prototype becomes comprehensive in that it involves checking on energy generation, storage efficiency, and environmental stress tests, thus proving whether it can withstand real-world applications. From the results, the system is optimized to improve energy efficiency, durability, and cost-effectiveness. The final phase involves deployment and real-world implementation, where the micro solar dome is installed in target locations. A monitoring and maintenance system is put in place to ensure long-term reliability. This methodology ensures that the micro solar dome is an efficient, scalable, and sustainable solution for off-grid energy needs, offering clean and reliable solar power for diverse applications.

Methodology:



The project follows a structured workflow starting with defining project objectives to establish clear goals. A literature review is conducted to gather relevant research and insights. Next, suitable materials are selected to ensure the feasibility of the project. The hardware design phase follows, where the system framework is developed. After that, the dimmer and fan implementation is carried out to integrate key components. The project then undergoes testing to evaluate its performance and functionality. Finally, a cost analysis is conducted to assess the financial feasibility and overall budget requirements.

Components used:

a) CRYSTALLINE DOME: The dome's curved surface allows for optimal solar exposure, as the shape can be oriented to maximize sunlight collection at different times of the day and throughout the year.

A dome-shaped solar structure is an innovative solution for the maximum generation of solar energy while minimizing the environmental impact of traditional building designs. Its geometric properties make it suitable for a wide range of applications, including solar-powered homes, greenhouses, power stations, and off-grid systems. While the construction and maintenance might be more complex compared to traditional structures, the long-term energy efficiency and durability make it a promising option for sustainable development and renewable energy use.

Fig.1

- **a)** Aluminum sheet: Flat, thin piece of aluminum metal, widely used in many applications because of its versatility, light weight, and resistance to corrosion. It comes in different thicknesses and sizes, making it suitable for most industrial, commercial, and consumer needs.
- **b)** Aluminum sheets are available in thicknesses ranging from 0.016 inches to 0.25 inches or more. Thicker sheets are commonly referred to as plates.
- **c)** The sheets come in standard sizes, like 4x8 feet and 5x10 feet, though they can also be cut based on particular demands.

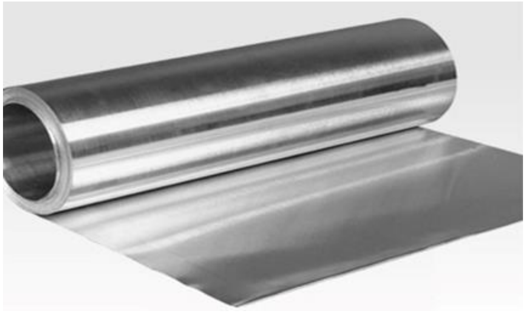


Fig.2

d) Acrylic dome: An acrylic dome is a transparent, dome-shaped structure composed of acrylic plastic, also referred to as PMMA (Polymethyl Methacrylate). Acrylic is a favorite material because it has high optical clarity, strength, and weather resistance, and it is the best for different applications that demand a clear, lightweight, and strong dome structure. Acrylic has a very high transparency, so in this application, it will excel compared to glass, which makes acrylic domes excellent for applications where visibility and light transmission are required. Acrylic is durable in rain, wind, and snow, thus suitable for indoor or outdoor applications.

Fig.3

D) Solar panel :- A solar panel is a device that converts sunlight into electricity through a process called photovoltaic (PV) effect. It is one of the most common renewable energy technologies used for harnessing solar energy. Solar panels are made up of many individual solar cells that work together to generate electricity. The front layer is usually tempered glass, which protects the cells from environmental factors like dust, moisture, and physical damage. The actual cells responsible for generating electricity, usually arranged in a grid-like pattern on the panel. A durable, weather-resistant layer at the back that provides support and helps with heat dissipation. This usually is made of aluminum and comprises holding the solar cells and glass in place while providing structural integrity to the panel.

Fig.4

E) Battery 5.5AH: It means, a battery of capacity of 5.5 ampere-hour, AH. Such a measure informs about the charge that would be stored and delivered over time by that battery. The AH rating is important in determining how long a battery will last when it is providing a certain amount of current. The higher the ampere-hour (AH) rating, the more current the battery can provide for a longer period. With its 5.5AH rating, this finds a balance to provide sufficient power while still offering a compact, manageable size The majority of the batteries that possess a 5.5AH rating are always rechargeable so that they will be used for a long period without constant replacements. They use these batteries for various applications; from electronics up to vehicles, and even some energy storage systems.

Fig.5

F) DC LED STRIP : - The strip consists of thousands of LEDs (Light Emitting Diodes) placed in a flexible printed circuit board. These LEDs use less power; they give a lot of light with little or no heat dissipation. The LED strip uses a DC power. This could be as simple as 5V DC to as high as 12V, 24V, etc depending on the spec of the strip. The most common voltages for LED strips are 12V and 24V. The strips are usually flexible, making them easy to install along curved or irregular surfaces. Many DC LED strips come with an adhesive backing, allowing easy installation on walls, ceilings, or furniture. DC LED strips can usually be cut at specified intervals to fit custom lengths.

Fig.6

G) DIMMER :- A dimmer is an electrical device used to adjust the brightness of a light. It works by varying the voltage supplied to the light bulb, enabling users to control the intensity of light output. Dimmer switches are commonly used for energy-saving, ambiance creation, and extended bulb life. hey allow the user to make the lighting different for various uses, such as reading, by bright light or softer, warmer light for a relaxing atmosphere. y reducing the intensity of the light, dimmers help reduce energy consumption and save energy. Dimming could reduce power use, prolonging the life of the bulbs, and saving money on electricity**.**

Fig.7

H) RING :- A polycarbonate ring refers to a circular or ring-shaped object made from metal, which can be used in a wide variety of applications across different industries.

Fig.8

I) FAN :- Cooling fan is the device used for temperature regulation to cool down the area, object, or the component by the circulation of air. The primary principle behind the cooling fan is to circulate air across the surfaces in order to dissipate heat, preventing overheating, and thus giving optimal performance.

Fig.9

DESIGN CALCULATIONS :

To calculate a sun tunnel's performance or properties, we often focus on its light output, efficiency, and illumination area. Here's a step-by-step process for basic calculations for a sun tunnel with a diameter of 300 mm (0.3 m):

Area of the Aperture

1. The aperture is the circular opening through which sunlight enters. The area can be calculated using the formula for the area of a circle:

$A = \pi \times \left(\frac{D}{2}\right)^2$

Where:

= Diameter of the sun tunnel = 300 mm = 0.3 m

$A = \pi \times \left(\frac{0.3}{2}\right)^2 = \pi \times (0.15)^2 = 0.0707 \, \text{m}^2$ So, the area of the sun tunnel's aperture is 0.0707 m^2

2. Solar Illumination Through the Tunnel

Solar illumination depends on the sunlight intensity () at the location, typically around 1000

W/m^2 on a sunny day.

$P = I \times A$

Where:0

= Power of light entering the sun tunnel (in watts)

= Sunlight intensity = 1000 W/m^2

= Aperture area = 0.0707 m^2

$P = 1000 \times 0.0707 = 70.7$, watts

The raw power of sunlight that enters the tunnel is about 70.7 watts.

Output Illuminance Lux

Illuminance () is the light output per square meter at the end of the sun tunnel. The calculation depends on the efficiency of the tunnel as well as the spread of light over the illuminated area.

Let's consider

Efficiency () = 70% = 0.7; accounting for reflection losses, bends, and diffuser losses

Area illuminated by the light at the output () = (varies with height and spread)

$E = \frac{P \times \eta}{A_{\text{illuminated}}}$

$E = \frac{70.7 \times 0.7}{2} = 24.75 \,, \text{lux}$

Therefore, the value of illuminance at the output is approximately 24.75 lux.

3. Spread and Coverage Area

The area of illumination by a sun tunnel will depend on diffuser design as well as ceiling height. Here is a rough estimate:

300 mm sun tunnel can illuminate the area of about 10 to 14 m^2 effectively during direct sunlight.

. Summary of Results

Aperture Area: 0.0707 m^2

Power entered by sun light: 70.7 W

4. Illuminance output: ~24.75 lux with 70% efficiency and 2 m^2 area coverage Effective illumination area: 10–14 m^2 depending upon the ceiling height and quality of the diffuser. Values would depend on real-time variables such as weather, length of the tunnel and the bends.

Results:

The study found out that lighting based on the availably of electricity from the main grid was dominant in rural application. The responses showed that only 10.5% people lacked power whilst 89.5% obtained it. Several reasons were noticed for the grid power non availably including cases of illegal residence, inability of paying and for non-payment as well. The researchers still found widespread power outages despite having access to electricity. They were in the remote forests and hilly terrains and mainly caused by load shedding and other natural calamities like rainstorms. Because of this, the people are left with using fossil fuels to light up the houses. Of course, there were 70% of respondents using kerosene lamps, candles, lanterns, and wick lamps.

Conclusion:

The successful design and implementation of a Micro Solar Dome can revolutionize how we harness and use solar energy in a range of practical applications. By leveraging solar power efficiently in a compact and self-sustaining system, the Micro Solar Dome offers a scalable solution that can be deployed across diverse environments. Even though there are costs and maintenance issues, off-grid and remote, in particular, are highly promising as far as this type of technology is concerned with the future generation of green energy.

REFERENCES :

1. 1. D.R. Thomas et al.Effects of Rural Electrification in India: An Instrumental Variable Approach at Household Level Journal of Development Economics (2020)
2. S. Scherer et al.Emission rates from simple kerosene lamps. Energy for Sustainable Development (1995)
3. G.R. Timilsina et al. Solar energy: Markets, economics and policies Renew Sustain Energy Rev (2012)
4. 4. A. Chaurey et al. Solar lanterns for domestic lighting in India: Viability of central charging Station Model Energy Polic (2009)
5. R. Sharma et al. Who is willing to pay for solar lamps in rural India? A longitudinal study Renew Sustain Energy Rev 2021