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RENEWABLE ENERGY

SKYVOLT

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ABSTRACT

The world is facing an escalating crisis of pollution and environmental degradation driven by the heavy reliance on fossil fuels and inefficient, centralised power systems. Air pollution, carbon emissions, and industrial waste continue to harm our health, ecosystems, and climate, creating an urgent need for clean, sustainable alternatives. In this context, SkyVolt emerges as a practical, low-cost, and scalable clean energy solution. Using the power of the sun, SkyVolt can generate electricity both day and night without producing pollution, relying on thermal storage and thermoelectric generation to deliver continuous power. It is designed to be modular, easy to deploy in open lands or deserts, and capable of working alongside solar PV to create clean energy fields that transform sunlight into reliable electricity. SkyVolt represents a hopeful step toward a cleaner, resilient future, offering a pathway for communities and industries to reduce pollution while meeting their energy needs sustainably.

Keywords: Renewable energy; TEG; Temperature; Electricity; Pollution.

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1. HOW ENERGY PRODUCTION IS POLLUTING OUR WORLD

Energy production is necessary for running factories, homes, schools, and hospitals, but it is also one of the main causes of pollution in the world. Most of the energy we use comes from burning fossil fuels such as coal, oil, and natural gas. When these fuels are burned in power plants and engines, they release harmful gases into the air, such as carbon dioxide (CO_2), sulfur dioxide (SO_2), and nitrogen oxides (NOx). These gases cause air pollution, which leads to breathing problems, acid rain, and global warming. Acid rain damages crops, forests, and buildings, while global warming is causing glaciers to melt and sea levels to rise, leading to floods and climate change. The production of energy through burning fossil fuels also produces particulate matter (tiny particles of dust and ash) that remain in the air and enter our lungs when we breathe, causing asthma and lung diseases. Power plants that use coal produce a large amount of ash waste, which is often dumped in open areas, polluting the soil and nearby water sources. Energy production also causes water pollution. Power plants use large amounts of water for cooling, and the hot water released back into rivers and lakes increases water temperature, harming fish and aquatic life (this is called thermal pollution). Sometimes, power plants and oil refineries accidentally leak oil and chemicals into water bodies, making the water unsafe for drinking and harming animals. The extraction of fuels for energy, such as coal mining and oil drilling, also damages the environment. Mining coal destroys forests and makes the land barren, while the chemicals used in mining can leak into rivers and soil, causing pollution. Oil drilling in oceans can lead to oil spills, which kill fish, birds, and sea animals, and take many years to clean up. Nuclear power plants, which produce energy from uranium, do not release smoke like fossil fuels but create radioactive waste, which is very dangerous for living beings and remains harmful for thousands of years. If not handled properly, this waste can leak into the environment, contaminating water and soil, and can cause cancer and other serious diseases. Additionally, energy production using fossil fuels produces a lot of greenhouse gases, especially CO_2, which trap heat in the atmosphere and lead to global warming. This warming is causing changes in weather patterns, droughts, floods, and more intense storms, affecting the lives of millions of people around the world. In summary, the production of energy is polluting our world by releasing harmful gases and particles into the air, heating and contaminating water, damaging soil, and contributing to global warming and climate change. It also leads to deforestation and the destruction of wildlife habitats.

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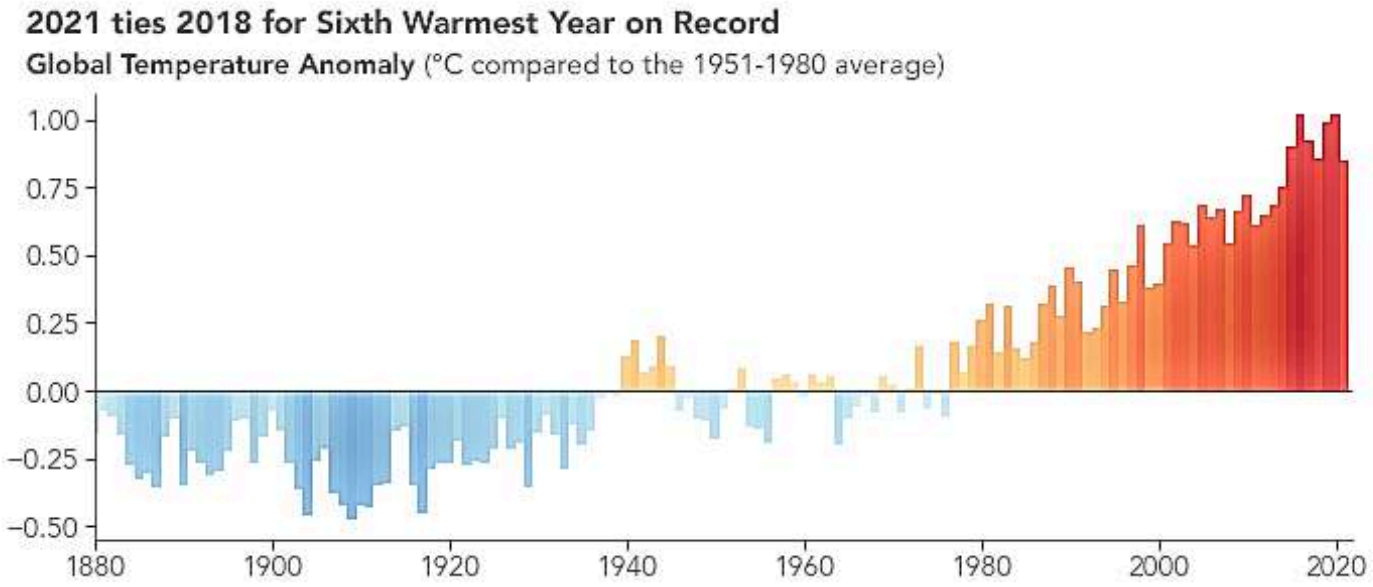
2. GLOBAL WARMING

This graph shows the global temperature anomaly from 1880 to 2021, comparing each year's temperature to the 1951-1980 average. The blue bars represent years when the Earth was cooler than average, while the red bars show years that were warmer. Over time, there is a clear trend of increasing temperatures, with recent years showing significant warming. In 2021, the global temperature tied with 2018 as the sixth warmest year on record, highlighting the ongoing issue of climate change and the urgent need to address rising global temperatures.



Ref: NASA EARTH OBSERVATORY

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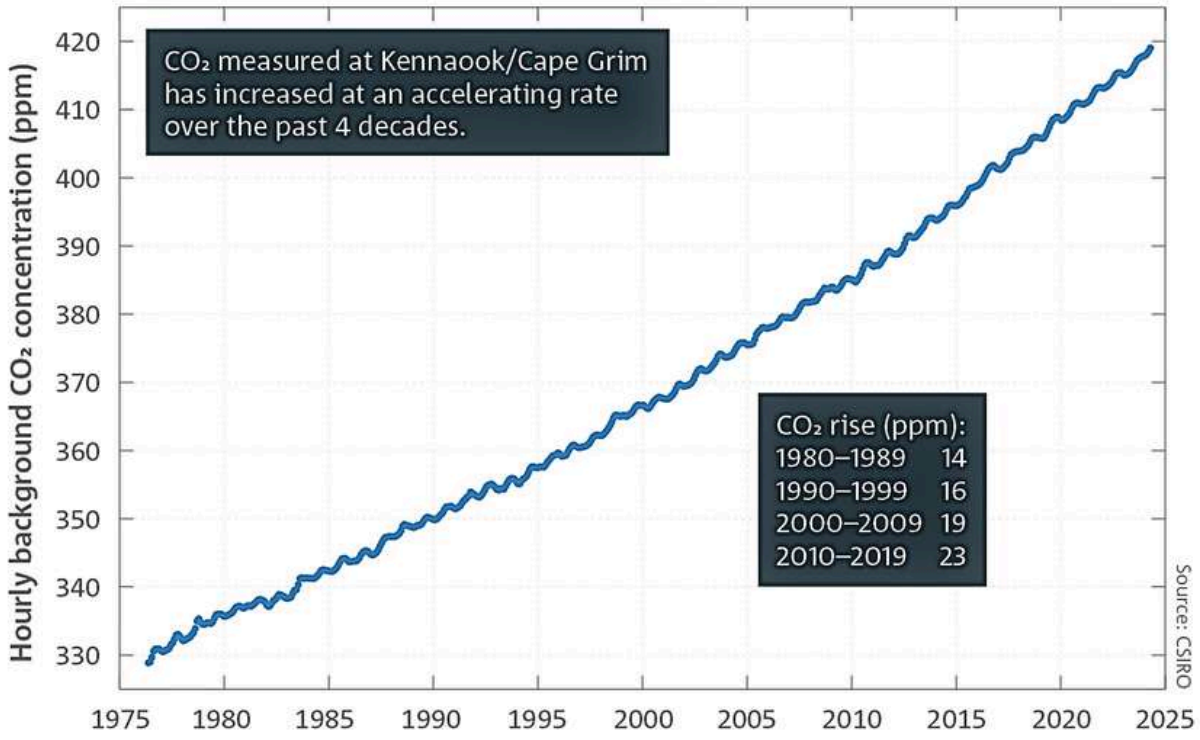
3. CO_2 LEVELS RISING

The graph from Kennaook/Cape Grim reveals a striking and continuous increase in atmospheric carbon dioxide (CO_2) levels over the past five decades. Starting at approximately 330 parts per million (ppm) in 1975, the concentration has climbed past 420 ppm by 2025, with each decade marking a steeper rate of growth. This acceleration highlights not only the persistent rise in emissions but also the intensifying pace at which human activity is altering the Earth's atmosphere. Cape Grim's data is particularly significant because it represents a clean baseline for global CO_2 monitoring, free from major pollution sources. The sharp upward trend serves as a wake-up call to the urgency of reducing greenhouse gas emissions and embracing sustainable energy solutions. More than just numbers, this graph tells the story of a changing climate—and the critical need for innovative responses grounded in science, policy, and public action.



Ref: CSIRO

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4. CONCEPT OF SKYVOLT

The core concept of SkyVolt is rooted in the physics of thermoelectric power generation driven by a sustainable temperature gradient between a heat source and a heat sink. When a material system maintains a temperature difference across its two sides, charge carriers (electrons or holes) in a thermoelectric material diffuse from the hot side to the cold side, creating a voltage and driving current—a phenomenon known as the Seebeck effect. SkyVolt leverages solar thermal energy as the heat source, absorbing and storing heat in a thermally conductive medium, while maintaining a comparatively lower temperature on the cold side using a radiative heat sink. The stored heat allows the system to sustain the temperature gradient even when direct sunlight is unavailable, enabling continuous power generation. The concept fundamentally relies on the physics that the efficiency and power output of a thermoelectric generator depend on the temperature gradient (ΔT) across it. By using materials with high thermal mass and effective solar absorption (for the hot side) and materials with high emissivity and reflectivity to stay cool (for the cold side), SkyVolt aims to maximise this ΔT sustainably. Additionally, because thermoelectric generation directly converts heat into electricity without moving parts, the system benefits from silent operation, minimal maintenance, and durability. In essence, SkyVolt embodies the physical principle of harvesting thermal gradients from renewable solar energy to generate continuous electricity, presenting a potential pathway for scalable, clean, and off-grid power solutions.

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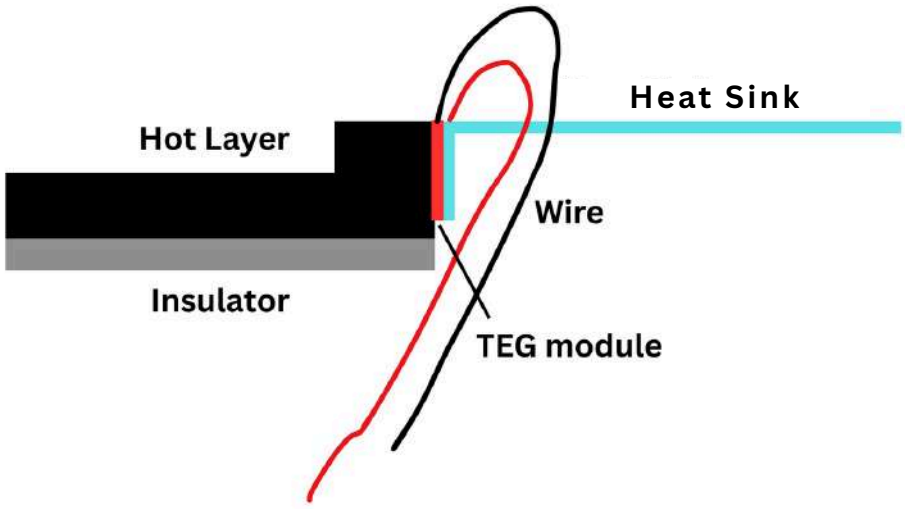
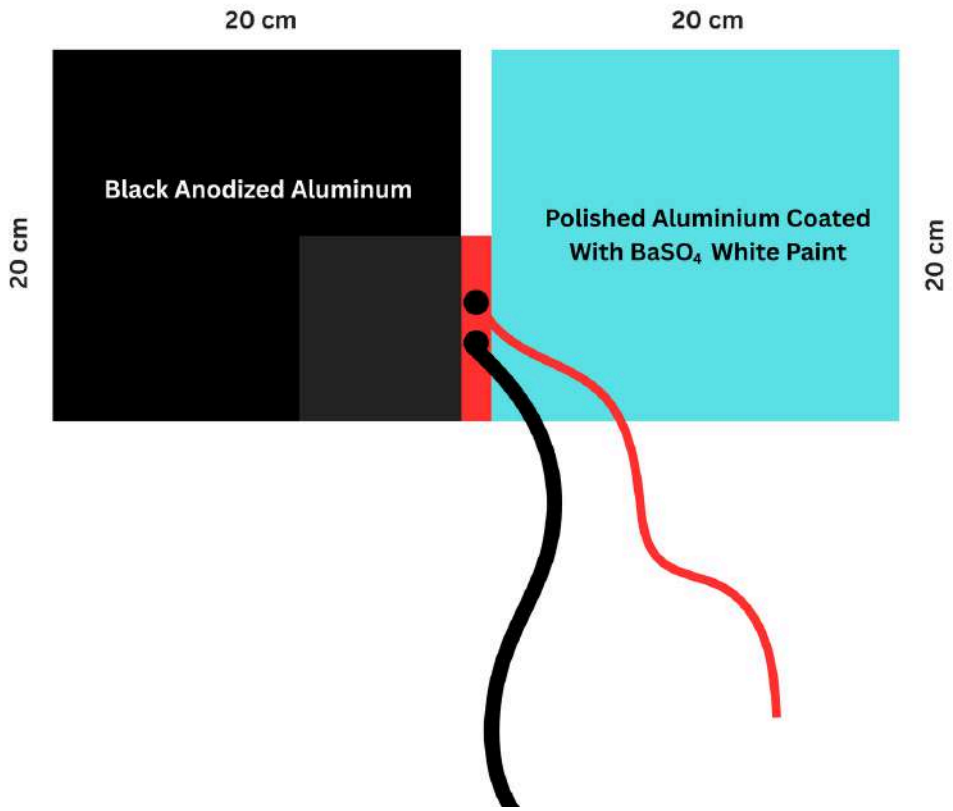
Side View



SKYVOLT

Top View



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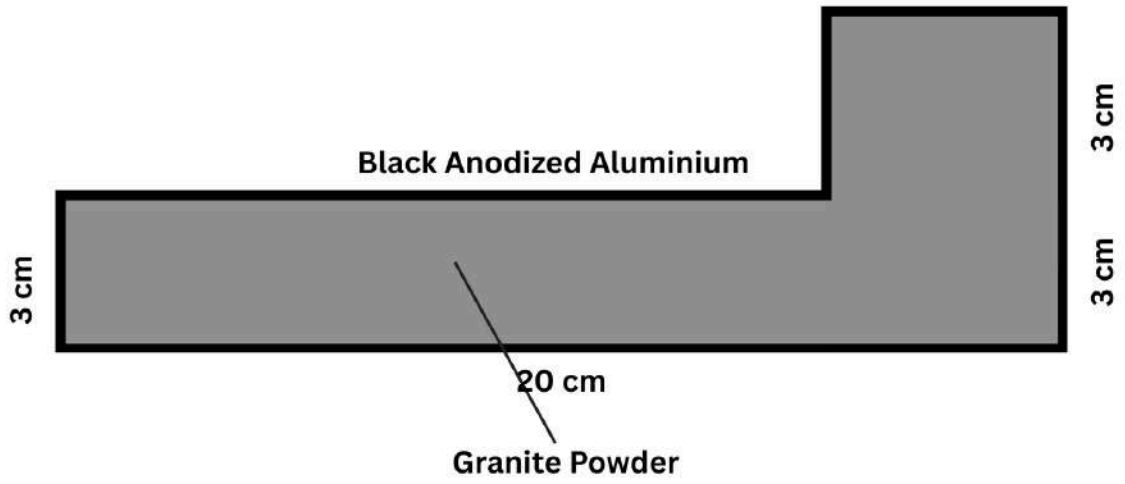
Internal of Hot Layer



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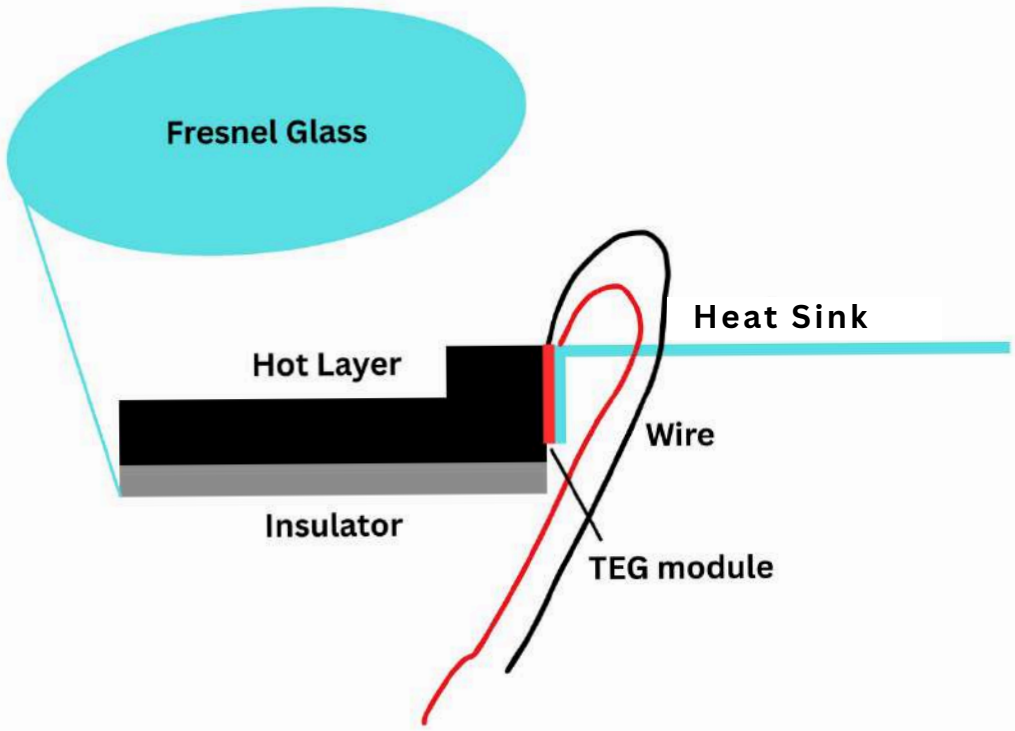
Side View



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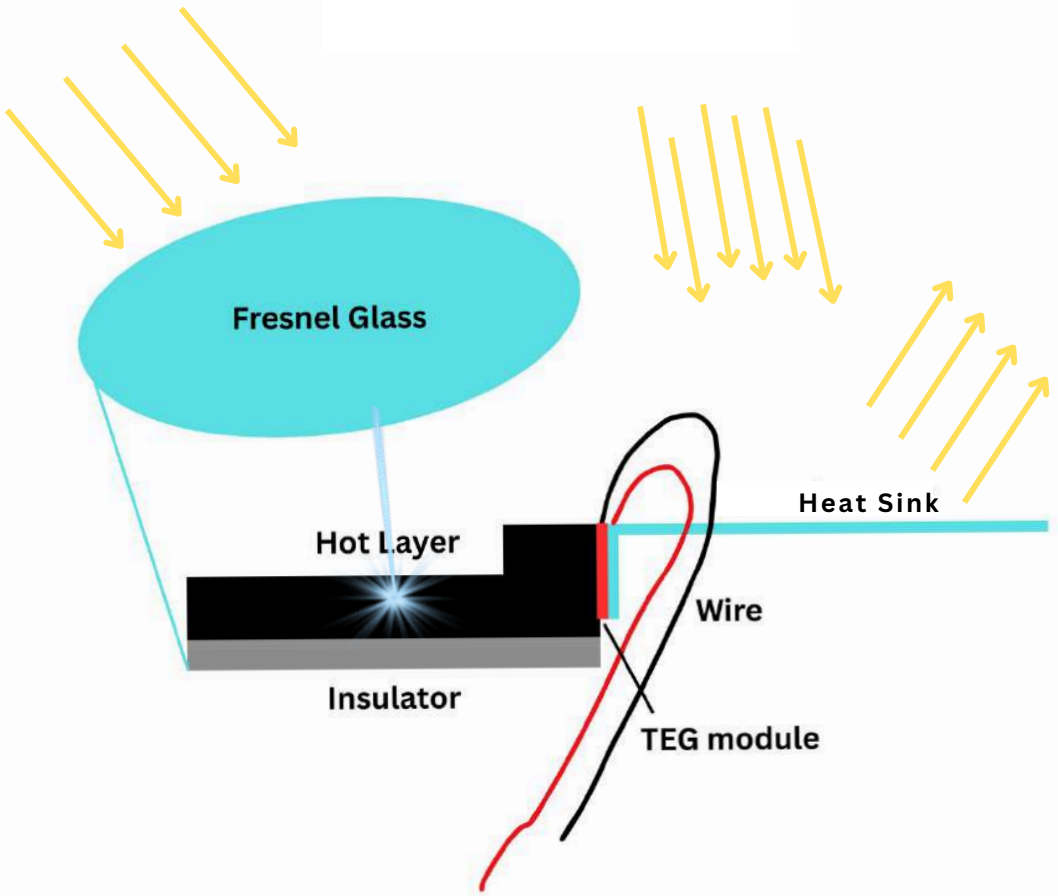
Mechanism



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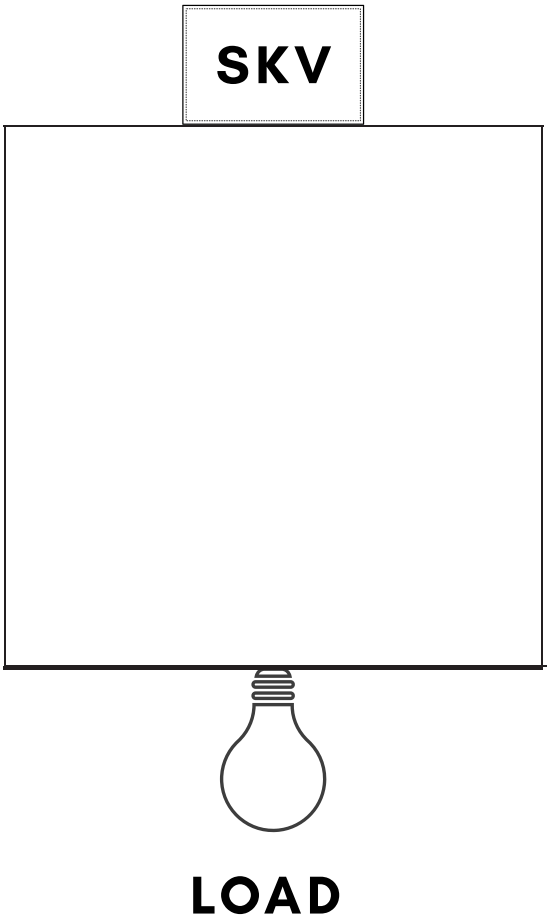
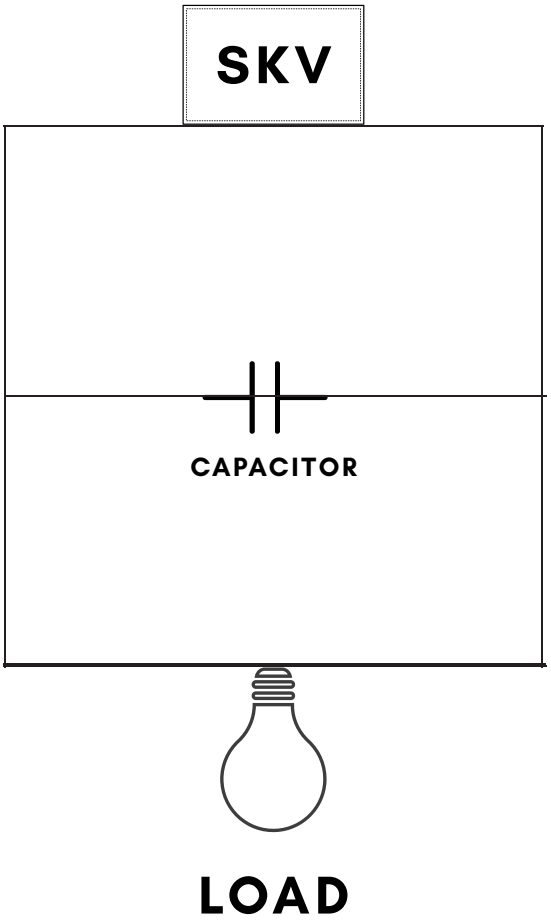
5. SIMPLE CIRCUIT





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6. REQUIREMENTS

SERIAL NO.	ITEM	AMOUNT
01	Black Anodized Aluminium Container	(20 cm × 20 cm × 3 cm) + (5 cm × 5 cm × 3 cm)
02	Black Granite Powder	3 Kg
03	TEG Module (HZ-14)	1
04	Ceramic Fibre Layer	(20 cm × 20 cm × 1 cm)
05	Polished Aluminium Sheet	(20 cm × 20 cm) +(5 cm ×3 cm)
06	$BaSO_4$ White Paint	20 grams
07	Wire	2
08	Fresnel Glass (30 cm Diameter)	1

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7. MECHANISM

SkyVolt's mechanism works as follows:

A black anodized aluminium container filled with granite or molten salt absorbs and stores heat from sunlight, forming the hot side of the system. A polished aluminium heatsink coated with $BaSO_4$ white paint forms the cold side, staying cool by reflecting sunlight and releasing heat into the air. A TEG module is placed between the hot and cold sides, where the temperature difference (ΔT) generates electricity as heat flows from the hot PCM through the TEG to the cold heatsink. During the day, sunlight heats the PCM, generating immediate power while storing heat for later use. At night, the heatsink cools rapidly in the cooler ambient air, maintaining a low temperature, while the stored heat in the PCM continues to flow through the TEG toward the heatsink. The heatsink quickly absorbs and releases this internal heat into the night air, maintaining the temperature difference needed to continue generating electricity even without sunlight, enabling continuous day-and-night power generation in a clean, silent, and low-maintenance system.

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8. POTENTIAL OUTPUT

SkyVolt is a compact off-grid thermoelectric generator that uses a 30 cm Fresnel lens to concentrate sunlight onto a (20 cm × 20 cm × 3 cm) + (5 cm × 5 cm ×3 cm) black anodized aluminium PCM block filled with granite or molten salt, allowing the hot side to reach 180–220°C while a 20 cm × 20 cm polished aluminium heatsink coated with $BaSO_4$ white paint remains around 35–40°C under sunlight. To minimize heat loss and improve heat retention, ceramic fibre insulation is placed only beneath the bottom of the PCM layer (ground-facing side), reducing downward heat loss while keeping the structure cost-effective and simple. A standard Hi-Z HZ-14 TEG module placed between the PCM block and the heatsink converts this temperature difference into electricity, generating 2.5–3 watts of power during midday sun, producing 12–15 watt-hours per TEG during 5 effective sun hours, and an additional 4–8 watt-hours overnight from the stored thermal energy. In total, each TEG delivers 16–23 watt-hours daily, and with four TEGs, the system can generate 60–80 watt-hours per day, providing a silent, low-maintenance, scalable renewable energy solution suitable for LED lighting, small device powering, and off-grid charging.

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9. BENEFITS

SkyVolt offers a powerful, clean, and sustainable off-grid energy solution by harnessing sunlight and stored heat to generate electricity day and night without relying on the electrical grid. Unlike solar panels, which generate power only during the day, SkyVolt uses a thermal storage system with granite or molten salt to store heat and continue generating electricity at night, ensuring continuous, reliable power for LED lighting, small devices, and sensors in rural areas, emergencies, and off-grid applications. Operating silently with no moving parts, SkyVolt requires minimal maintenance and can function for years without intervention. It is designed to be scalable, allowing additional TEG modules or larger PCM and heatsink blocks to be added easily to increase power output as needed. By using affordable, durable materials like anodized aluminium, granite or molten salt, and polished aluminium heatsinks coated with $BaSO_4$ white paint, SkyVolt remains cost-effective while delivering high thermal efficiency for consistent energy generation. SkyVolt performs reliably in harsh, hot environments where conventional solar panels may degrade, making it suitable for long-term outdoor deployment in variable weather conditions. The optional use of a Fresnel lens allows for sunlight concentration, achieving higher PCM temperatures and increasing the temperature gradient across the TEG for improved power output without significantly increasing system size or complexity. Importantly, SkyVolt produces no pollution, no emissions, and no noise, offering a completely clean, eco-friendly method of energy generation that does not contribute to air or environmental pollution. It is modular and portable, allowing it to be deployed in camps, remote field research stations, and emergency situations while providing a practical, hands-on educational tool for demonstrating renewable energy, thermal storage, and thermoelectric generation principles. SkyVolt's combination of quiet, pollution-free operation, continuous day-night power generation, affordability, and scalability makes it an ideal, sustainable energy solution for achieving clean energy independence while supporting a healthier environment.

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10. SOLUTION TO BAD WEATHER

SkyVolt's performance can decrease during bad weather (clouds, rain, or high humidity) due to reduced sunlight for heating. To maintain reliability and efficiency under these conditions, several enhancements can be applied. First, applying a high-quality, optically clear hydrophobic coating on both the Fresnel lens and the black anodized aluminium PCM container prevents water droplets and moisture from sticking during rain, fog, or humid conditions. This keeps the lens clear for effective light concentration and prevents water films on the anodized aluminium that could reduce heat absorption. Using a nano-coating designed for optical and high-temperature surfaces ensures no distortion, minimal light loss, and effective water repellency, reducing cleaning needs and improving long-term outdoor performance. Second, integrating a supercapacitor system with SkyVolt allows fast storage and delivery of small amounts of electricity, smoothing out power fluctuations during partly cloudy conditions. This ensures LED lights, sensors, and small devices continue running consistently even with intermittent sunlight. Third, adding a battery storage system enables SkyVolt to store excess energy generated during sunny periods for later use during extended cloudy or rainy conditions. Using stable, long-life batteries like $LiFePO_4$ ensures safe, reliable power for night-time or stormy days while maintaining SkyVolt's off-grid capabilities.

By combining hydrophobic coatings on the Fresnel lens and anodized aluminium, supercapacitor buffering, and battery storage, SkyVolt becomes a resilient, silent, pollution-free, off-grid energy system that can provide consistent power for lighting, device charging, and sensors even during bad weather, ensuring reliability in all conditions.

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11. DESERT IS THE ASSET NOW

If governments or large industries take structured, large-scale action, deserts and open grounds can transform into limitless clean energy fields by deploying SkyVolt and Solar PV systems in an alternating pattern—SkyVolt, Solar PV, SkyVolt—across vast land areas. During the daytime, both Solar PV panels and SkyVolt units generate significant electricity from sunlight. At night, while Solar PV panels rest, SkyVolt continues to generate power using its thermal storage, providing uninterrupted 24/7 energy generation without the need for fuel, noise, or pollution. Each SkyVolt unit can be equipped with 6–7 TEG modules, significantly increasing its energy output while remaining compact and scalable. When deployed systematically, these SkyVolt units can collectively produce megawatt-scale clean energy, working alongside solar PV arrays to stabilize the energy supply day and night. Importantly, the total project cost for governments or well-resourced organizations remains very low compared to traditional coal or nuclear power generation, avoiding the high operational, environmental, and maintenance costs associated with fossil fuels and nuclear waste management. SkyVolt and Solar PV systems are modular, easily replaceable, and can be upgraded over time, ensuring future adaptability. This combined approach transforms deserts and open lands into profitable, sustainable energy assets while creating local employment, ensuring energy security, and addressing climate goals. SkyVolt and Solar PV together form a powerful, low-cost, pollution-free energy generation combination, turning the limitless sunlight of our deserts and open spaces into a cornerstone for clean, resilient, scalable, and sustainable energy independence.

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12. WHAT WE NEED NOW

SkyVolt is not a fixed technology; it is a platform that can evolve as the scientific community progresses. Its design can be refined to become more efficient as new materials and methods are discovered, making it a living system adaptable to future energy needs. SkyVolt systems can integrate embedded software to monitor power generation, thermal losses, and system performance in real-time, providing valuable data for optimization and maintenance. External batteries and supercapacitors can be added for scalable energy storage, allowing SkyVolt to deliver stable power even during extended low-sunlight periods. Moreover, SkyVolt can work synergistically with solar PV systems—some of the electricity generated by Solar PV panels can power a small fan to maintain controlled airflow across the SkyVolt heatsink, further enhancing its efficiency during high ambient temperatures.

To move this idea from concept to impactful implementation, we need collective support:

- Researcher Attention:
Since SkyVolt is currently an idea with initial lab-level validation, it requires the active attention of researchers to study its scalability, system integration, and efficiency improvements further.

- Material Scientists:
To explore advanced PCM materials, high-emissivity coatings, corrosion-resistant anodizing, and cost-effective insulation strategies, material scientists are essential to enhance SkyVolt's longevity and efficiency.

- Electrical and Electronics Engineers (EEE):
We need skilled EEE engineers to design safe, efficient energy harvesting circuits, monitoring systems, and TEG integration strategies to maximize output and system safety.

- Initial Research Funding (~$1000):
To build, test, and measure a small but scalable SkyVolt prototype, an initial budget of around $1000 would cover Fresnel lenses, anodized aluminium, TEG modules, measurement sensors, PCM/insulation materials, and essential electronics for data logging and control, enabling proof-of-concept demonstration and testing under different environmental conditions.

With research, interdisciplinary collaboration, and small-scale funding, SkyVolt can become a clean, scalable, low-cost energy generation system, working in synergy with Solar PV to enable 24/7 renewable power generation while contributing to global energy resilience and sustainability goals.

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13. CONCLUSION

SkyVolt stands as a beacon of hope for a cleaner, more resilient future, proving that with creativity and careful design, we can harness solar energy not only during the day but also continue generating power throughout the night. By combining thermal storage, TEG technology, and scalable modular design, SkyVolt allows us to capture and utilise the sun's energy in a practical and affordable way, empowering communities and industries to move toward sustainable energy independence. Using multiple SkyVolt units in series, stabilised efficiently with a single capacitor across the system, we can generate consistent power for motors, bulbs, sensors, and small appliances without complexity. This approach makes SkyVolt easy to expand and manage, ensuring reliable, continuous energy delivery even in off-grid locations and harsh environments. It also demonstrates that we do not need to rely solely on expensive, centralised, polluting energy infrastructures when cleaner, decentralised alternatives are within our reach. SkyVolt, combined with solar PV systems, creates a powerful synergy that can transform deserts and open lands into valuable energy fields, providing power day and night with low cost and zero pollution. It offers a practical solution to energy challenges faced by many regions, especially where extending the grid is difficult or where renewable energy is urgently needed to reduce dependence on fossil fuels. Most importantly, SkyVolt shows that as scientific knowledge advances, we can continue to improve its efficiency and design, integrate smart monitoring, supercapacitors, and storage solutions, and adapt to new materials and methods that arise in the scientific community. It is a system designed not to remain static but to evolve as we progress, ensuring it remains practical and relevant in meeting our growing energy needs sustainably. Through systems like SkyVolt, we can envision a world where energy is accessible, clean, and constant, a world where we generate the energy we need anywhere, at any time, without harming our environment. It is not just an energy solution; it is a pathway toward a hopeful future, where technology, nature, and human ingenuity come together to build a resilient, energy-secure world for everyone.

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THANK YOU