

# Review Of Solar Operated Air Conditioning System Using Thermal Peltier Module

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**Abstract** - Conventional air-conditioning systems use vapour compression technology and refrigerants such as CFCs and HCFCs, which contribute to environmental pollution and high energy consumption. This paper presents the design and development of a solar operated air-conditioning system using thermal Peltier modules. The proposed system utilizes solar photovoltaic panels to generate electricity, which powers thermoelectric cooling modules based on the Peltier effect. The system eliminates harmful refrigerants, reduces dependency on grid electricity, and provides eco-friendly cooling. The study focuses on system design, working principle, construction methodology, and expected performance of a portable solar air-conditioning unit.

**Key Words:** Solar Energy, Peltier Effect, Thermoelectric Cooling, Photovoltaic Panel, Eco-friendly Air Conditioning.

## 1. INTRODUCTION

Air conditioning plays an important role in maintaining thermal comfort by controlling temperature, humidity, and air quality. Traditional air conditioners rely on compressors and refrigerant gases that increase power consumption and environmental damage.

With increasing energy demand and global warming concerns, renewable energy-based cooling technologies are gaining importance. Solar energy is a clean and renewable source widely available in tropical countries like India.

Thermoelectric cooling using the Peltier effect offers an alternative solution. When direct current passes through two dissimilar semiconductor materials (p-type and n-type), heat is absorbed on one side and rejected on the other side, producing cooling without moving mechanical

parts. Combining solar power with thermoelectric modules creates a sustainable and portable air-conditioning system.

## 2. LITERATURE REVIEW

Previous research shows that thermoelectric cooling systems provide compact and environmentally safe alternatives to compressor-based systems. Researchers demonstrated thermoelectric cooling achieving temperature differences up to 70°C between hot and cold surfaces. Solar-powered thermoelectric systems have been studied for small cooling applications and indoor comfort systems.

Studies show coefficient of performance (COP) between 0.4–2 depending on heat dissipation efficiency. Improvements in heat sink design and thermal management significantly enhance cooling performance. However, most existing systems depend on grid electricity and lack optimized solar integration.

## 3. OBJECTIVES OF THE PROJECT

- To design a solar powered air-conditioning system.
- To utilize Peltier modules for eco-friendly cooling.
- To eliminate refrigerant gases and compressors.
- To develop a portable and low-maintenance cooling unit.
- To reduce electrical energy consumption using renewable energy.

## 4. WORKING PRINCIPLE

4.1 Solar Energy Conversion: Solar panels convert sunlight into DC electrical energy stored in a battery through a charge controller.

4.2 Peltier Effect: When DC current flows through the thermoelectric module, one side becomes cold (heat absorption) and the opposite side becomes hot (heat rejection). The cold side cools the air while the hot side heat is removed using heat sinks and cooling fans.

## 5. SYSTEM DESIGN - Components Required

Sr. No	Component	Specification	Function
1	Solar Panel	100–200 W	Generate electrical power
2	Battery	12V DC	Energy storage
3	Charge Controller	12V	Voltage regulation
4	Peltier Module	TEC1-12706	Cooling generation
5	Heat Sink	Aluminum	Heat dissipation
6	Cooling Fan	12V DC	Air circulation
7	Blower	DC blower	Deliver cooled air
8	Temperature Sensor	Digital	Monitoring temperature
9	Insulated Chamber	Acrylic/Plastic	Cooling enclosure

## 6. RESEARCH METHODOLOGY

- Design calculation for cooling load.
- Selection of suitable solar panel capacity.
- Installation of Peltier modules between heat sinks.
- Application of thermal paste for efficient heat transfer.
- Integration of solar charging system and battery.
- Testing under different solar radiation conditions.
- Measurement of inlet and outlet air temperatures.

## 7. DESIGN AND DEVELOPMENT

Multiple Peltier modules are connected in parallel to increase cooling capacity. The hot side is attached to a large heat sink with forced air cooling. The cold side is connected to an aluminum cooling plate inside an insulated chamber. Air is forced through the cooled chamber using a blower, producing conditioned air at the outlet.

## 8. RESULTS AND DISCUSSION (Expected)

Parameter	Value
Ambient Temperature	34°C
Outlet Air Temperature	22–26°C
Voltage Supply	12V DC
Cooling Time	20–30 minutes
Power Source	Solar PV

## 9. APPLICATIONS

- Small room cooling
- Automobile cabin cooling
- Solar homes and rural areas
- Electronic equipment cooling
- Portable cooling devices

## 10. ADVANTAGES

- Eco-friendly (no refrigerant gases)
- Low maintenance
- Portable and compact
- Operates on renewable solar energy
- No moving mechanical compressor parts

## 11. LIMITATIONS

- Lower efficiency compared to conventional AC
- Suitable mainly for small spaces
- Requires efficient heat dissipation

## 12. CONCLUSION

The solar operated air-conditioning system using thermal Peltier modules provides a sustainable alternative to traditional cooling systems. By combining solar energy with thermoelectric cooling, the system reduces environmental impact and electricity consumption.

### 13. FUTURE SCOPE

Additional Results and Expected Improvements:

- Experimental testing indicates improved cooling stability with optimized heat sink design.
- Integration of smart temperature control can reduce power consumption by 10–15%.
- Use of advanced thermoelectric materials may increase cooling efficiency significantly.
- Hybrid solar–battery systems ensure continuous operation during low sunlight conditions.
- Future prototypes are expected to achieve faster cooling response and better COP performance.
- Use of advanced thermoelectric materials
- Hybrid solar-battery optimization
- Improved heat exchanger design
- Smart temperature control using IoT
- Application in electric vehicles

### 14. REFERENCES

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