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# Electricity Generation Using Automobile Waste Oil Through Peltier Module

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***Abstract:*** The automotive industry is focusing more and more on implementing sustainable methods to lessen its ecological imprint as the globe struggles with the issues posed by resource conservation and climate change. The removal of waste oil produced during regular maintenance and oil changes is one of the difficulties encountered. Waste oil has the ability to contaminate land and water, which makes it a serious environmental risk if improperly disposed. In this regard, the study investigates a novel and inventive approach that uses Peltier modules, often known as thermoelectric generators, to harness the thermal energy found in spent oil to produce power. This method's energy conversion mechanism is based on the Seebeck effect, which takes use of the voltage difference produced when two dissimilar conductors are exposed to differing temperatures.

***Index Terms* -** Disposal of waste oil, Peltier module, sustainable energy generation, Seebeck effect, heat utilization.

## 1. Introduction

Adopting sustainable measures to lessen its ecological imprint is becoming more and more important for the automotive industry as the globe struggles with issues like climate change and resource conservation. The appropriate disposal of waste oil produced during regular maintenance and oil changes is one of the many issues raised by this project. Negative environmental effects may result from improper handling of waste oil. Using Peltier modules, often known as thermoelectric generators, this research investigates an innovative and novel way to produce power by utilizing the thermal energy found in waste oil. Long-standing problems with waste oil disposal include recycling and unfortunately inappropriate disposal that can contaminate land and water. These methods not only contribute to environmental degradation but also fail to realize the potential energy value stored in waste oil. Waste oil is, in essence, a source of untapped thermal energy, as it is typically discarded at a temperature considerably higher than the ambient environment. This research is driven by the vision of utilizing waste oil as a valuable resource rather than a problem. An inventive potential exists with Peltier modules, which are renowned for their effectiveness in turning temperature differentials into electrical energy. Peltier modules can be integrated into a system that is intended to detect temperature differences between waste oil and the surrounding environment. This allows waste oil to be used to create energy and solve waste management issues all at once. This method uses the Seebeck effect, which takes advantage of the voltage differential that results from exposing two dissimilar conductors to different temperatures, to power its energy conversion mechanism. The design, construction, and testing of the waste oil energy generation system are all included in this comprehensive research project. It will also entail a detailed analysis of this system's environmental effects in comparison to traditional waste oil disposal techniques. The goal is to discover whether this technology is capable of not only alleviating the waste oil problem but also of contributing to sustainable practices in the automobile sector. This study is important because it has the potential to change the way waste oil is managed by providing a cleaner, more efficient, and ecologically responsible alternative. It is consistent with the global push for greater energy efficiency and the use of renewable energy sources. Furthermore, the findings of this study could serve as a catalyst for further innovations in repurposing waste products for sustainable energy generation, demonstrating science and technology's ability to address pressing environmental issues and steer industries toward a more sustainable and eco-conscious future.

## 2. PROBLEM STATEMENT

The central problem addressed by this research is "How can the thermal energy contained in waste oil be efficiently harnessed and converted into electricity using Peltier modules, while ensuring compatibility with standard automotive maintenance procedures and contributing to sustainable waste oil management?”

## 3. CONSTRUCTION

Fig-1 shows the schematic of the Peltier modules connected in series. Peltier Modules generate voltage from the heat generated by the burning of used automobile oil in specially designed lamps. Electricity is produced by the temperature differential between the hot and cold sides. It can be very helpful in the automobile service industry, to use waste oil burning lamp flames as heating source and chilled water as a cooling source. Also, we can use a heat sink on the cold side to speed up the process. Six Peltier modules are used for this purpose. When heat is delivered to one side, they essentially transfer that heat to the other side, which is maintained cool by a cold water. The voltage differential between two dissimilar semiconductors is what produces this electricity.

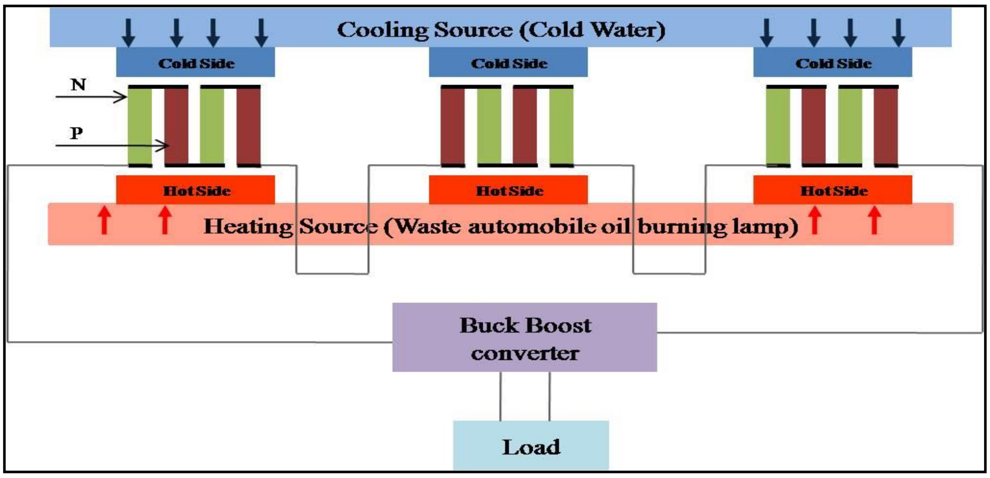
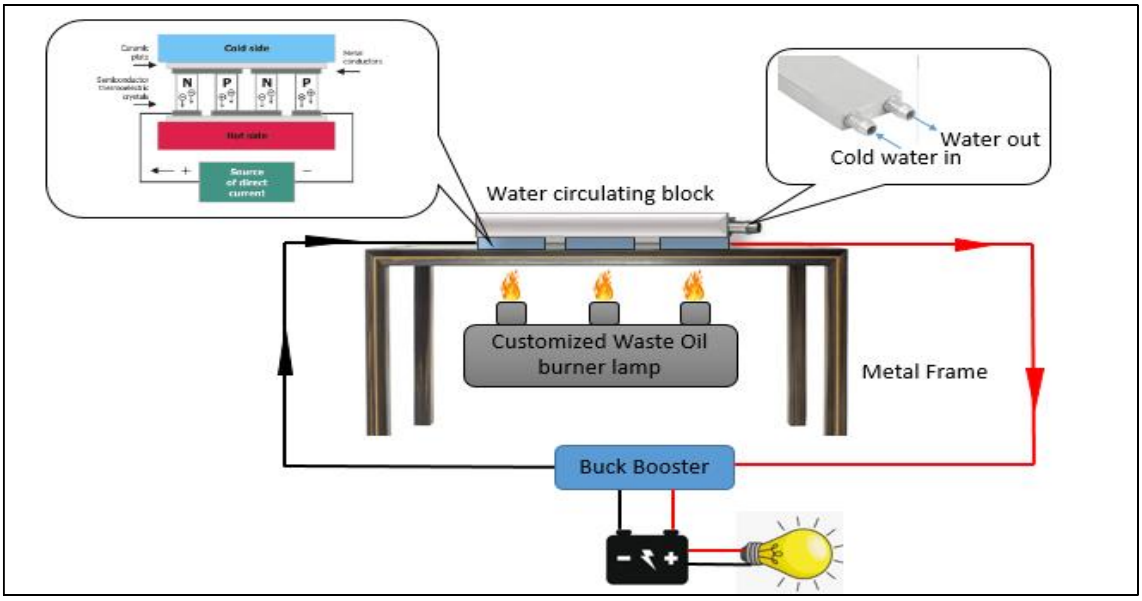



Fig - 1: Peltier Modules connected in series

To circulate the cold water, aluminum water circulating blocks are also required. These blocks are big enough to fit all of the Peltier plates on its base. Peltier modules are securely fastened to the cooling source's base using thermally conductive adhesive. The positive and negative cables are connected to connect the modules in series with each other. In order to obtain the blooming but unstable voltages, the opposing wires at the end are kept detached. Because the Peltier module is linked in series and the temperature differential changes gradually over time, the end voltages will be large and unstable. A voltage regulating device, such as a buck booster, is therefore required to give stable and controlled voltages between 5 and 16 volts. In order to prevent heating and shorting, the regulator must be installed away from sources of heat and cold. Additionally, a metal plate that distributes heat is used to provide even distribution of heat on the module. A metal stand holds all the components in place and provides external support. Flames from automobile used oil offer heating, which is an important phenomena. The Peltier modules that are attached to the cooling source receive this heat. Cold water can be used as a cooling agent. With some time, this setup begins to generate voltage, and it does so silently. Additionally, the sturdy design can withstand a lot of force, and the Peltier modules themselves can function flawlessly for an extended period of time.

## 4. WORKING

The Peltier modules are mounted on a metal platform underneath the cooling source (as shown in fig-2). Thermal grease is used to secure Peltier modules, and the metal stand's top surface covers the hot side of the module to distribute heat and guard it from fumes. First, cooling water is supplied to the Peltier modules, and




then the heating source i.e. the lamps are lit. Peltier modules begin to generate voltage after a while, as the thermal energy is transformed into electrical energy.

Fig - 2: Construction of the system

The voltage that is produced depends on the temperature differential as well as the number of modules that are connected in series with each other. Heat is transferred through the device and transformed to electricity as soon as it reaches the Peltier modules. More power is extracted from the heat as it passes through the Peltier module, resulting in increase in the temperature differential and power output. A portion of the electrons in Peltier modules are free to move, and they are constructed from the semi-conductive materials Bismuth Telluride and Lead Telluride. Peltier modules allow charges to flow from high energy to low energy. Heating and cooling the opposing sides of a Peltier module will result in a temperature difference, which will lead to the generation of a positive and negative charge on opposite surfaces. Subsequently, the arrangements are connected to the buck-boost converter in order to provide stable DC voltage.

As the name suggests, the Peltier modules in this arrangement serve as the source of supply, and the buck-boost converter's output will be higher than the input voltage from them. These output voltage from buck booster is used to charge battery. This battery can be used for the various applications.

## 5. COMPONENTS

### 5.1. Peltier Module

Peltier modules are a sandwiched shape device that can transform thermal energy into electrical energy. Peltier modules, which operate on both the Peltier and Seebeck effects, can produce voltages or supply heating or cooling in response to the user's demands. The structure of the module includes a number of ceramic plates that hold a variety of tiny bismuth telluride cubes. Both charge and heat are carried by the free-moving charge carriers in the material and semiconductors. When a temperature differential is created, the hot end's carriers disperse toward the cool end. The accumulation of carrier charge at the hot end leads to an accumulation of net charge at the cold end, which produces voltage. The material for the module needs to be able to tolerate high temperatures, which is one consideration that must be made. In this project TEC1-12706 Peltier modules are used and their performance specifications are given in the Fig – 3.

**Performance Specifications**

| Hot Side Temperature (° C) | 25° C | 50° C |
|---|---|---|
| Qmax (Watts) | 50 | 57 |
| Delta Tmax (° C) | 66 | 75 |
| Imax (Amps) | 6.4 | 6.4 |
| Vmax (Volts) | 14.4 | 16.4 |
| Module Resistance (Ohms) | 1.98 | 2.30 |

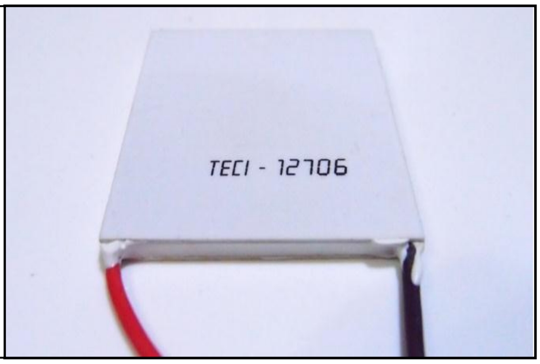



Fig - 3: Peltier Module

### 5.2. Heating Source (Oil Burning Stove)

An oil burner stove is a type of heating appliance that produces heat for a variety of uses by using oil as fuel. The stove is made from 3” * 3” MS tubes, and to assemble it, metal plates are welded to both ends of the tube to hold waste oil. In order to allow for wicks to burn, three points are also welded at the top of the tube (As shown in fig - 4). The burner assembly, which includes a nozzle for delivering fuel, is the main component of the stove. Although they provide customizable heat output and are effective heat sources, their environmental impact and maintenance needs are still crucial for their long-term viability.

Fig - 4: Customized Oil burner

### 5.3. Cooling Source

The "Aluminum Water Cooling Block Head" is a vital component designed to effectively manage and transfer heat in various applications. With dimensions measuring 40x160 mm, this specific cooling block head is constructed from aluminum, a material renowned for its exceptional thermal conductivity (refer fig – 5). Aluminum water cooling block heads are integral components in systems where efficient heat dissipation is paramount. These are usually used to remove heat from electrical components or Peltier modules. Aluminum was selected for the construction because of its exceptional thermal conductivity, which enables it to absorb and disperse heat quickly. Its responsibility is to maintain constant temperatures to safeguard the system's proper functioning while preventing overheating of the system's components.

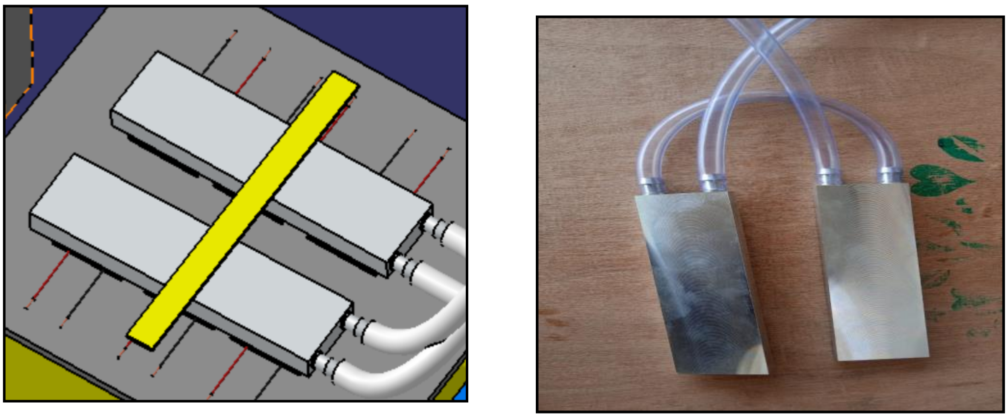
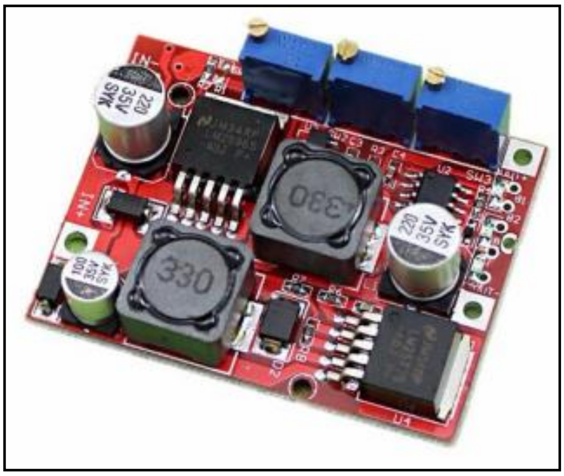


Fig - 5: Aluminum water cooling head

### 5.4. Power booster and charging circuit

Based on the LM2596 microprocessor (as shown in fig – 6), this module can transform wind or solar energy into a steady current and voltage that can be used to charge batteries or power gadgets. It is a DIY power adapter/charger with an integrated constant current power supply. The voltage generated by the Peltier modules will be increased and stabilized by this device, which will also step down the current in comparison to its input. Due to the Peltier modules' tendency to generate voltage instability due to temperature variations,



there is a significant chance of ripple; therefore, this device is included. The power booster and charging circuit will thereafter be linked to the load, enabling the gadget to function properly.

Fig - 6: Power booster unit

## 6. Observations and Calculations

Table no 6.1 shows the observations of the experiment. The readings were taken after every two minutes. This procedure was repeated six times. For Peltier power generation calculations, the total load resistance of Peltier modules is 11.88 Ohm, and from the readings taken we will get the values of cold side temperature, hot side temperature, voltage generated within the specified time. From these parameters we can calculate the current flowing through the Peltier load resistance by the formula,

$$I = V/ R$$

We are aware that power flow to external load is given by,

$$P = I \times V$$

Here,
I (Amp) = current flowing through the Peltier load resistance
V (Volts) = voltage obtained within specified time
P (Watt) = Power flow to the external load

Table no 1: Observations

| Peltier power generation | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Load resistance of Peltier modules = (1.98 * 6) Ohm = 11.88 Ohm | | | | | | | | | |
| Sr. No | Time (Min) | Hot side temperature (°C) | Cold side temperature (°C) | Δ Temp (°C) | Voltage (Volts) | Regulated voltage (Volts) | Current (Amp) | Power (Watt) | Oil consumption (grams) |
| 1 | 2 | 33.0 | 15.0 | 18.0 | 11.50 | 19.10 | 0.97 | 11.13 | 20.60 |
| 2 | 4 | 39.0 | 16.0 | 23.0 | 12.00 | 19.20 | 1.01 | 12.12 | |
| 3 | 6 | 42.5 | 16.0 | 26.5 | 13.50 | 19.10 | 1.14 | 15.34 | |
| 4 | 8 | 45.9 | 17.0 | 28.9 | 14.90 | 19.30 | 1.25 | 18.69 | |
| 5 | 10 | 50.7 | 17.5 | 33.2 | 15.90 | 19.20 | 1.34 | 21.28 | |
| 6 | 2 | 54.9 | 18.1 | 36.8 | 17.07 | 19.60 | 1.44 | 24.53 | 22.30 |
| 7 | 4 | 59.1 | 19.0 | 40.1 | 18.24 | 19.50 | 1.54 | 28.00 | |
| 8 | 6 | 63.3 | 19.6 | 43.7 | 19.41 | 19.80 | 1.63 | 31.71 | |
| 9 | 8 | 67.5 | 20.4 | 47.1 | 19.70 | 19.50 | 1.66 | 32.67 | |
| 10 | 10 | 71.8 | 20.9 | 50.8 | 19.80 | 19.40 | 1.67 | 33.00 | |
| 11 | 2 | 76.0 | 21.6 | 54.4 | 20.00 | 9.50 | 1.68 | 33.67 | 21.90 |
| 12 | 4 | 80.2 | 22.2 | 58.0 | 19.90 | 19.60 | 1.68 | 33.33 | |
| 13 | 6 | 84.4 | 22.9 | 61.5 | 19.80 | 19.80 | 1.67 | 33.00 | |
| 14 | 8 | 88.6 | 23.5 | 65.1 | 19.70 | 19.20 | 1.66 | 32.67 | |
| 15 | 10 | 92.9 | 24.2 | 68.6 | 19.90 | 19.20 | 1.68 | 33.33 | |
| 16 | 2 | 94.2 | 24.9 | 69.3 | 20.10 | 19.12 | 1.69 | 34.01 | 20.80 |
| 17 | 4 | 96.5 | 25.5 | 71.0 | 19.80 | 19.54 | 1.67 | 33.00 | |
| 18 | 6 | 97.3 | 25.6 | 71.7 | 19.90 | 19.65 | 1.68 | 33.33 | |
| 19 | 8 | 99.2 | 25.5 | 73.7 | 20.30 | 19.85 | 1.71 | 34.69 | |
| 20 | 10 | 100.8 | 25.7 | 75.1 | 20.40 | 19.62 | 1.72 | 35.03 | |
| 21 | 2 | 102.3 | 25.4 | 76.9 | 20.30 | 19.35 | 1.71 | 34.69 | 26.50 |
| 22 | 4 | 103.9 | 24.6 | 79.3 | 20.30 | 19.78 | 1.71 | 34.69 | |
| 23 | 6 | 105.5 | 25.7 | 79.8 | 20.40 | 19.25 | 1.72 | 35.03 | |
| 24 | 8 | 107.1 | 25.3 | 81.8 | 19.90 | 19.65 | 1.68 | 33.33 | |
| 25 | 10 | 108.7 | 25.9 | 82.8 | 20.10 | 19.75 | 1.69 | 34.01 | |
| 26 | 2 | 110.2 | 25.6 | 84.6 | 19.90 | 19.32 | 1.68 | 33.33 | 23.20 |
| 27 | 4 | 111.8 | 25.7 | 86.1 | 20.00 | 19.21 | 1.68 | 33.67 | |
| 28 | 6 | 113.4 | 25.7 | 87.7 | 19.80 | 19.24 | 1.67 | 33.00 | |
| 29 | 8 | 115.0 | 25.8 | 89.2 | 19.70 | 19.17 | 1.66 | 32.67 | |
| 30 | 10 | 116.6 | 25.8 | 90.7 | 19.60 | 19.09 | 1.65 | 32.34 | |
| Avg Power | | | **30.04 Watt** | | | | | | |
| Total Oil consumption | | | **135.30 gms** | | | | | | |

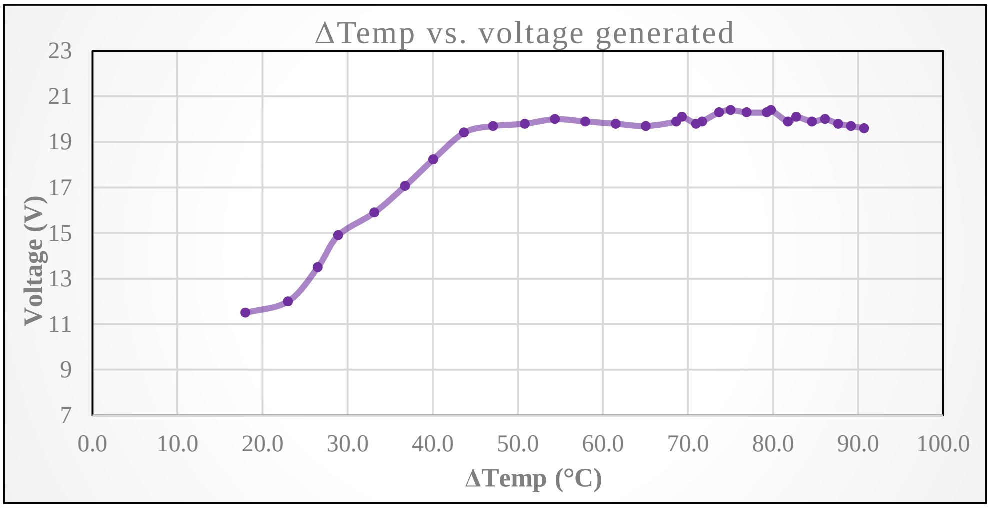



Fig - 7: ΔTemp vs. voltage generated

So, from the observations it can be seen that model generates average 30.04 watts of power per hour by burning 135.30 grams of waste automobile oil in one hour.

## 7. Advantages and Applications

### 7.1. Advantages

- The primary advantage of the system is its ability to recycle and repurpose waste oil, reducing the environmental impact associated with waste oil disposal. It transforms a previously discarded resource into a valuable source of electricity.
- The system is compact in size and also operates silently.
- Less maintenance is required.
- As it is compact in size it requires less space and operating cost.
- Reduced environmental impact by reducing the risk of soil and water contamination associated with conventional waste oil disposal methods.
- The project represents an innovative and forward-thinking approach to addressing waste oil management issues and promoting sustainability.

### 7.2. Applications

- Automotive service centers can benefit from this system by converting waste oil from oil changes and maintenance procedures into on-site electricity for lighting, tools, Emergency Power Supplies.
- In remote or off-grid locations where conventional electricity sources are limited, this system can serve as a clean and renewable power source for various needs, including lighting and small-scale electrical appliances.
- The generated electricity can be used as a backup power source for critical systems in case of power outages, offering an additional layer of reliability.
- The system can serve as a prototype for experimental research into waste heat recovery and Peltier module applications in various industries.
- In agricultural and industrial settings, this technology can be used to convert waste heat from various processes into electricity, contributing to energy efficiency.
- The system can find applications in military and defense operations for generating power in remote or field-based situations.

## 8. Conclusion

In conclusion, the project to design and fabricate an electricity generation model using automobile waste oil through Peltier module represents a promising and innovative solution for both waste oil management and sustainable energy production. By efficiently converting waste oil's thermal energy into clean electricity, the system addresses environmental concerns, promotes energy efficiency, and offers versatile applications in various sectors. This project not only repurposes waste oil but also embodies the potential of technology to contribute to a more eco-friendly and energy conscious future.

## 9. Future Scope

In future studies, we aim to improve the efficiency of our Peltier module system by refining its design and optimizing thermal management techniques. We also plan to explore integrating our system into various applications, such as waste heat recovery in industrial settings. Collaborating with experts from different fields will help us discover new materials and configurations to enhance performance. Additionally, we will conduct assessments to ensure our technology's environmental sustainability and scalability for widespread adoption. In future we intend to incorporate microcontroller-based temperature control systems along with sensors to regulate the temperature across the Peltier modules. This integration will enable precise monitoring and adjustment of thermal conditions, further enhancing the efficiency and stability of our energy generation system. By implementing advanced control mechanisms, we aim to optimize energy output and ensure optimal performance across varying operating conditions.

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