

# Energy Generation from Waste Material

Submitted by

**1.Vaibhav Meshram**

**2.Tanishq Fulekar**

**3.Saurabh Bhokre**

Guided by

Name of the Guide

**Dr. Sanjay Sajjanwar**

Asst. Prof. Mechanical Engineering

JIT, Nagpur

Department of Mechanical Engineering

Jhulelal Institute of Technology

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## ABSTRACT

**Abstract:** In the modern world, the ever-increasing demand for energy, coupled with the growing challenges of waste management, has created a critical need for sustainable and eco-friendly solutions. Rapid urbanization, industrialization, and population growth have led to excessive generation of waste materials and a significant rise in energy consumption. Conventional energy sources such as fossil fuels are not only depleting rapidly but also contributing heavily to environmental pollution and global warming. In this context, the project titled “Energy Generation from Waste Material using Peltier Modules” presents an innovative approach to address both energy scarcity and waste disposal issues simultaneously.

This project is based on the concept of thermoelectric power generation, which involves the direct conversion of heat energy into electrical energy without the use of moving parts. The working principle primarily relies on the Peltier effect, where a voltage is generated across a material when there is a temperature difference between its two sides. The core component used in this system is a Peltier module (thermoelectric generator), a semiconductor device capable of converting thermal gradients into electrical energy.

The experimental setup consists of a combustion chamber, typically constructed using a heat-resistant metal enclosure such as aluminium. In this chamber, various types of waste materials—including paper, dry leaves, cardboard and other combustible waste—are burned to generate heat. This process not only helps in reducing waste volume but also produces a considerable amount of thermal energy that would otherwise be lost to the environment.

The generated heat is directed toward the hot side of the Peltier module, while the cold side is maintained at a lower temperature using cooling techniques such as heat sinks, air cooling fans. The temperature difference between the hot and cold surfaces creates a movement of charge carriers within the semiconductor layers of the module, thereby producing direct current electricity. The magnitude of the generated voltage depends on the temperature gradient, making thermal management a key factor in optimizing system performance.

To enhance the output, multiple Peltier modules can be connected in series to increase voltage and in parallel to increase current. The generated electricity can be stored in rechargeable batteries or directly utilized to power low-energy devices such as LED bulbs.

## CHAPTER 1

### INTRODUCTION

Energy generation from waste material has emerged as a significant and sustainable approach to address the dual challenges of increasing energy demand and effective waste management. Rapid urbanization, industrialization, and population growth have led to a substantial rise in the generation of waste materials, including municipal solid waste, agricultural residues, and industrial by-products. Traditionally, these wastes have been disposed of in landfills or through open dumping, causing serious environmental issues such as air, water, and soil pollution, along with the emission of greenhouse gases.

In recent years, waste has been increasingly recognized as a valuable resource for energy production. Various technologies have been developed to convert waste into useful forms of energy such as electricity, heat, and biofuels. Common methods include incineration, anaerobic digestion, gasification, and pyrolysis. These processes not only reduce the volume of waste but also recover energy that would otherwise be lost. Additionally, biological processes like biogas generation utilize organic waste to produce methane-rich fuel, which can be used for cooking, heating, or electricity generation.

An emerging and innovative approach in this field is the use of thermoelectric systems based on the Peltier Effect. These systems convert temperature differences, often generated from waste heat, directly into electrical energy without the need for moving parts. This makes them reliable, compact, and suitable for small-scale applications such as energy recovery from industrial equipment, automobile exhaust systems, and even household waste heat sources. Although the efficiency of thermoelectric devices is currently lower compared to conventional methods, ongoing research is focused on improving material properties and system design to enhance performance.

The concept of waste-to-energy (WTE) not only contributes to sustainable energy production but also plays a crucial role in reducing environmental pollution and conserving natural resources. By minimizing landfill usage and lowering greenhouse gas emissions, WTE technologies support global efforts toward environmental protection and climate change mitigation. Furthermore, these technologies offer economic benefits by generating energy from low-cost or readily available raw materials, thereby reducing dependency on fossil fuels.

Despite its advantages, the implementation of energy generation from waste materials faces several challenges, including high initial investment costs, technological limitations, and the need for proper waste segregation and management systems. Addressing these challenges requires continuous research, technological innovation, and supportive government policies.

The integration of thermoelectric generators (TEGs) with waste systems has shown promising results, especially in recovering low-grade heat energy that cannot be efficiently utilized by conventional methods. For example, waste heat from industrial furnaces, automobile exhaust systems, and even domestic cooking processes can be partially converted into electrical energy using Peltier modules. Although the efficiency of these systems is relatively low, recent advancements in thermoelectric materials, such as nanostructured semiconductors and improved heat transfer mechanisms, are contributing to performance enhancement.

From an environmental perspective, energy generation from waste significantly reduces the burden on landfills, minimizes pollution, and lowers greenhouse gas emissions. It also supports the concept of a circular economy, where waste is treated as a resource rather than a disposal problem. Economically, WTE systems can provide cost-effective energy solutions, particularly in developing regions where waste availability is high and energy demand is continuously increasing.

However, the implementation of waste-to-energy technologies is not without challenges. High capital costs, technical complexity, inefficient waste segregation, and lack of awareness are major barriers to large-scale adoption. In

addition, maintaining optimal operating conditions, especially in thermoelectric systems where temperature difference plays a critical role, requires careful system design and effective thermal management.

### **PELTIER MODULE**

Peltier modules, also known as thermoelectric modules, are semiconductor devices composed of multiple pairs of p-type and n-type materials connected electrically in series and thermally in parallel. Although these modules are commonly used for cooling applications (based on the Peltier effect), they can also operate in reverse mode to generate electricity when subjected to a temperature gradient. In this project, Peltier modules are utilized as thermoelectric generators to harness waste heat produced from the combustion of waste materials.

The experimental setup of the project consists of a combustion chamber, heat transfer components, thermoelectric modules, and an electrical output system. Waste materials such as paper, dry leaves, and other combustible substances are burned inside a specially designed metal chamber. The heat generated during combustion is transferred to one side of the Peltier modules, known as the hot side. The other side of the module, referred to as the cold side, is maintained at a lower temperature using cooling mechanisms such as heat sinks and fans. This temperature difference creates a flow of charge carriers within the semiconductor material, resulting in the generation of direct current (DC) electricity.

The performance of the system largely depends on the magnitude of the temperature difference between the hot and cold sides. A higher temperature gradient results in greater voltage generation. Therefore, efficient heat transfer to the hot side and effective cooling of the cold side are crucial for maximizing the output. The electrical energy generated by the modules can be collected and used to power small devices such as LEDs, low-power electronics, or can be stored in batteries for future use. By connecting multiple Peltier modules in series and parallel configurations, the voltage and current output can be increased to meet specific requirements.

This project emphasizes the importance of utilizing waste heat, which is often lost in conventional systems. In many industrial processes, a large amount of heat energy is wasted and released into the environment. By capturing and converting this waste heat into electricity, overall energy efficiency can be improved. This concept has significant applications in industries, automobiles, and even household systems, where excess heat can be effectively utilized.

Despite its advantages, thermoelectric energy conversion also has certain limitations. The efficiency of Peltier modules is relatively low compared to traditional energy conversion methods. Heat losses due to poor insulation, uneven temperature distribution, and inadequate cooling can further reduce system performance. Additionally, prolonged exposure to high temperatures can damage the modules, affecting their durability and efficiency. Therefore, proper design considerations, material selection, and system optimization are essential to enhance the effectiveness of the project.

The significance of this project lies in its ability to provide a simple, cost-effective, and environmentally friendly solution to two major global challenges—energy shortage and waste management. It demonstrates how locally available waste materials can be utilized to generate useful energy, thereby reducing dependence on fossil fuels and minimizing environmental pollution. Furthermore, the project serves as an educational model to understand the principles of thermoelectricity and renewable energy systems.

### Salient Features of the Project:

- Direct conversion of heat energy into electrical energy without moving parts
- Utilization of waste materials as a fuel source
- Compact, simple, and low-cost design
- Environmentally sustainable and pollution-reducing approach
- Suitable for small-scale and decentralized energy generation

#### 1.1 Overview

This project presents an innovative approach to generating electrical energy from waste materials using thermoelectric (Peltier) modules. It addresses two major challenges of modern society—rising energy demand and inefficient waste management—by converting waste heat into useful electrical power. In this system, waste materials such as paper, dry leaves, and other combustible substances are burned inside a controlled combustion chamber to produce thermal energy.

The generated heat is applied to the hot side of Peltier modules, while the cold side is maintained at a lower temperature using heat sinks. This temperature difference creates a voltage through the Peltier effect, enabling the direct conversion of heat energy into electrical energy without any moving parts. The produced electricity can be utilized to power small devices such as LEDs or stored for later use.

The project is simple, cost-effective, and environmentally friendly, making it suitable for small-scale applications and educational purposes. It also highlights the potential of waste-to-energy technologies and thermoelectric systems in promoting sustainable development and improving energy efficiency, especially in rural and resource-limited areas.

#### 1.2 PROBLEM STATEMENT

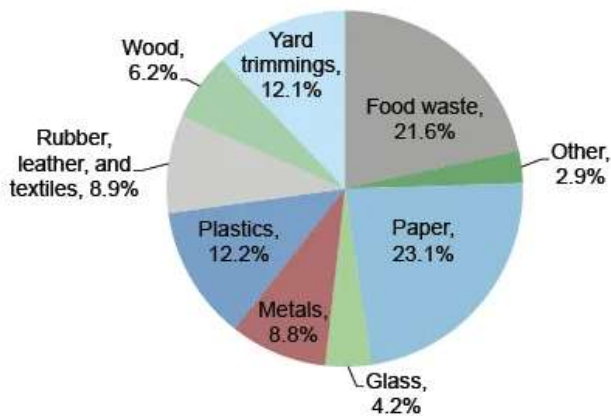
Electricity is a necessity in the modern world. Thus, a variety of fuels including coal, gas, diesel, uranium, etc. are used to generate electricity. There is a limitless supply of each of these fuels. Frequently used items like product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries are included in municipal solid waste (MSW), also known as trash or garbage. This is produced in our residences, workplaces, schools, and hospitals. Different power plants use these fuels to produce electricity. For instance, the fuel used to produce electricity in thermal power plants, nuclear power plants, gas power plants, and diesel power plants is coal, uranium, gas, and diesel, respectively. An important ecological concern relates to how to manage waste plastics. For the management of plastic waste, a variety of approaches have been used, along with sorting and processing waste plastic, dumping it in landfills, and recycling. Even so, the low quality of recycled products severely limits the scope of their use. Filling up land with waste makes it completely useless for other purposes while occupying productive land. Hazardous atmospheric pollutants like CO<sub>2</sub> (a greenhouse gas) and persistent organic pollutants like dioxins, including polyaromatic hydrocarbons, are released as a result of the incineration and pyrolytic conversion processes used to dispose of waste plastics.

#### Sources of waste materials

Waste materials come from a variety of sources. Which seem to be present in the form of garbage, waste materials, coming out of homes, factories, and different types of industrial institutions, in addition to municipal corporations, and which are extremely hazardous to the environment. There are numerous sources, which would include plastic, rubber and trash.

Municipal Solid Waste (MSW), commonly called “trash” or “garbage,” includes wastes such as durable goods (e.g., tires, furniture), nondurable goods (e.g., newspapers, plastic plates/cups), containers and packaging (e.g., milk cartons, plastic wrap), and other wastes (e.g., yard waste, food). This category of waste generally refers to common household

waste, as well as office and retail wastes, but excludes industrial, hazardous, and construction wastes. The handling and disposal of MSW is a growing concern as the volume of waste generated in the INDIA continues to increase



**Fig 1.1 Pie chart of Waste**

## CHAPTER 2

### LITERATURE SURVEY

#### LITERATURE SURVEY

1) Fernández-Yáñez, P., Romero, V., Armas, O., & Cerretti, G. (2021) says in his paper that: Thermoelectric generators convert heat into electric power, but the low conversion efficiency of thermoelectric materials involves a challenge in the integration of thermoelectric generators to heat sources, as more energy losses than savings can be caused.

2) Tohidi F. et al. (2022) says in his paper that: Thermoelectric generators are a kind of heat engines capable of offering solutions for these challenges if they reach their expected potentials. The advantages for such technologically advanced devices are manifold; they are environmentally friendly, highly scalable, reliable, and have long lifespan. Additionally, by applying thermoelectric generators, one can improve the existing systems' efficiency or supply the electricity demand of different systems with high flexibility.

3) Daniel Champier (2017) says in his paper that: Electricity production is an important issue for our societies. Waste heat is also an important topic. It is in this context that thermoelectric generators (TEGs) are currently taking off. TEGs consist of a set of thermoelectric (TE) modules inserted between two heat exchangers.

4) Sonal Renge, Yashika Barhaiya, Shikhar Pant, and Shubham Sharma (2017) says in his that: A thermoelectric device is a solid-state semiconductor based electronic component capable of converting a voltage input into a temperature difference which can be used for either heating or cooling. Conversely, when a temperature difference is applied to the device, it has the capability of producing DC electrical power.

5) Kadu, A., Patil, T., & Somatkar, A. (2026) says in his paper that: A thermoelectric generator (TEG) system was designed, modelled, and experimentally validated to convert waste heat into electrical energy using the Seebeck effect. Thermoelectric modules were selected based on a high Seebeck coefficient and low thermal conductivity to minimize energy losses while maintaining a large temperature gradient across the system.

## CHAPTER 3

### AIM AND OBJECTIVE

#### 3.1 AIM

To design and implement an innovative system for generating electrical energy by utilizing waste heat produced from the combustion of waste materials, using thermoelectric (Peltier) modules based on the Seebeck effect. The project aims to effectively convert otherwise lost thermal energy into usable electrical power by creating a temperature difference across the Peltier modules. Additionally, this system focuses on promoting sustainable waste management practices, improving energy efficiency, and developing a cost-effective and eco-friendly solution for small-scale power generation applications

#### 3.2 OBJECTIVE

1. To design and develop an efficient system for generating electrical energy from waste materials by utilizing thermoelectric (Peltier) modules based on the Peltier effect, ensuring proper heat transfer and temperature difference across the modules.
2. To effectively utilize heat energy produced from the combustion of waste materials such as paper, dry leaves, and other combustible substances, and convert this thermal energy into useful electrical energy in an environmentally friendly and sustainable manner.
3. To demonstrate a cost-effective and practical solution for waste-to-energy conversion, highlighting its potential applications in small-scale power generation, rural electrification, and promoting awareness about renewable energy technologies.

## CHAPTER 4

### METHODOLOGY

The proposed methodology for the project titled “Energy Generation from Waste Material using Peltier Modules” is centred on the development of a thermoelectric energy conversion system that effectively utilizes heat generated from the combustion of waste materials. The overall approach involves the integration of a controlled combustion chamber with thermoelectric modules to convert thermal energy into electrical energy through the Peltier effect. The methodology begins with the conceptual design of the system, focusing on achieving efficient heat transfer and maintaining a sufficient temperature difference across the thermoelectric modules, which is the key requirement for power generation.

A metallic combustion chamber is fabricated to serve as the primary heat generation unit. The chamber is designed in such a way that it allows proper airflow for sustained combustion while also retaining sufficient heat within the system. Waste materials such as paper, dry leaves, and other combustible substances are used as fuel inside the chamber. Upon ignition, these materials produce a significant amount of heat energy, which becomes the primary input for the thermoelectric conversion process. The use of waste materials not only ensures cost-effectiveness but also contributes to environmental sustainability by reducing waste accumulation.

The generated heat is transferred from the combustion zone to the thermoelectric modules through a conductive medium, typically a metal plate with good thermal conductivity. This ensures that the heat is distributed uniformly across the surface of the modules. The Peltier modules are carefully positioned such that one side is exposed to the high-temperature region (hot side), while the opposite side is exposed to a relatively lower temperature environment (cold side). This arrangement creates the required temperature gradient across the module. The efficiency of the system largely depends on how effectively this temperature difference is maintained, as the output voltage is directly proportional to the temperature gradient.

On the cold side of the modules, cooling is achieved primarily through natural convection, where ambient air absorbs and dissipates heat from the surface. In some cases, additional cooling mechanisms such as heat sinks or forced air cooling can be incorporated to enhance the temperature difference. However, in the present implementation, the

system relies mainly on passive cooling, making the design simple and cost-effective. Despite this limitation, a measurable voltage output is achieved, demonstrating the feasibility of the concept.

The electrical output generated by the Peltier modules is collected through conductive wiring. The modules can be connected in series to increase the voltage output or in parallel to increase the current output, depending on the requirement of the load. In this project, the generated direct current (DC) is utilized to power a low-voltage load such as an LED panel, which serves as a visual indicator of successful energy generation. A digital multimeter is used to measure the output voltage and monitor the system performance under different operating conditions.

Experimental analysis is carried out by varying the type and quantity of waste material, as well as observing the changes in temperature and corresponding electrical output. The relationship between heat intensity and voltage generation is studied to understand the performance characteristics of the system. It is observed that higher combustion intensity results in increased temperature on the hot side, thereby improving the voltage output. However, the absence of efficient cooling limits the overall temperature difference, which in turn restricts the maximum achievable output.

During the experimentation phase, certain limitations are identified, including heat losses due to the open structure of the chamber, uneven heat distribution across the modules, and the use of materials with lower thermal conductivity in some parts of the setup. These factors affect the overall efficiency of the system. To address these issues, potential improvements such as better insulation, use of high-conductivity materials like aluminum, and the addition of active cooling systems are considered for future development.

The methodology adopted in this project emphasizes simplicity, cost-effectiveness, and practical implementation. It demonstrates the ability to convert waste heat into electrical energy using a compact and easily constructible system. The absence of moving parts reduces mechanical losses and increases system reliability. Furthermore, the use of waste materials as a fuel source highlights the dual benefit of waste management and energy generation.

In conclusion, the proposed methodology successfully establishes a functional framework for thermoelectric energy generation from waste materials. It provides a clear understanding of the working principles, system design, and performance characteristics of a thermoelectric generator. Although the current system operates at a small scale with limited efficiency, it serves as a strong foundation for further research and optimization. With advancements in thermoelectric materials and improved system design, this approach has the potential to be developed into a viable solution for sustainable and decentralized energy generation..





CHAPTER 5

FLOW CHART



Fig 5.1 Flow Chart of energy generation

**1. Waste Material**

Different types of waste such as food waste, plastic, paper, agricultural waste, and municipal solid waste are collected from homes, industries, or markets.

**2. Segregation**

- The collected waste is separated into categories like:
- Organic waste
- Plastic waste

- Metal waste
- This step is important because different wastes require different processing methods.

### 3. Processing

- The waste is prepared for energy conversion by:
- Shredding – breaking waste into small pieces
- Drying – removing moisture
- This makes the waste easier to convert into energy.

### 4. Energy Conversion

- The processed waste is converted into energy using different technologies such as:
- Incineration (burning waste to produce heat)
- These processes produce heat or gas.

### 5. Electricity Generation

The produced heat or gas is used to generate electricity by running generators or turbines.

### 6. Energy Storage / Usage

- The generated electricity is:
- Stored in batteries
- Used directly for powering devices.

## CHAPTER 6

### HARDWARE REQUIREMENT

#### HARDWARE COMPONENT

1. MAIN FRAME
2. THERMOELECTRIC GENERATOR
3. BATTERY'S
4. MULTIMETER
5. BOOST CONVERTOR
6. PELTIER ELEMENT
7. CABLES AND CONNECTORS

### THERMOELECTRIC GENERATOR

A Thermoelectric Generator (TEG) is a solid-state energy conversion device that converts thermal energy directly into electrical energy based on the principle of the peltier effect. When a temperature difference is created between the hot and cold sides of a thermoelectric material, charge carriers move from the hot region to the cold region, generating a direct current (DC) voltage. This process does not involve any moving parts, making the system highly reliable, silent, and low in maintenance.

TEGs are typically made of semiconductor materials arranged in p-type and n-type pairs, which enhance the efficiency of energy conversion. They are widely used for waste heat recovery applications, where unused heat from sources such as combustion systems, industrial processes, and exhaust gases is converted into useful electrical power. Although the efficiency of thermoelectric generators is relatively low compared to conventional systems, their ability to utilize waste heat and operate in harsh environments makes them a promising technology for sustainable energy generation.

Due to their compact size, durability, and eco-friendly nature, thermoelectric generators are increasingly being explored for applications in remote power systems, automotive industries, and renewable energy solutions, contributing to improved energy efficiency and reduced environmental impact.1 Peltier Module A sandwiched shape device which can convert heat energy into electrical energy can be the fundamental introduction of Peltier modules. Working on both the Peltier effect, Peltier modules have the ability to generate voltages or to provide heating or cooling depending on the need of the user. Fig-6: Peltier module construction of the module contains a couple of ceramic plates inside which an array of small bismuth telluride cubes are stored. The charge carriers inside the material and the semiconductors move freely while carrying both charge and the heat. Creating temperature difference causes the carries at hot end to diffuse at the cold end. This buildup of carrier charge at hot end results into a buildup of net charge at the cold end thus resulting in the voltage production. The semiconductors are highly doped by pollutants to increase the electric conductivity. One thing which must be kept in mind while selecting the material for the module is that it must be able to withstand high temperatures. Bismuth Telluride is one of the materials which have the tendency toward the pelteir effect hence a module made of it produces the voltage. However one must note that they have high electric conductivity and low thermal conductivity. Modules have a very high operating temperature.

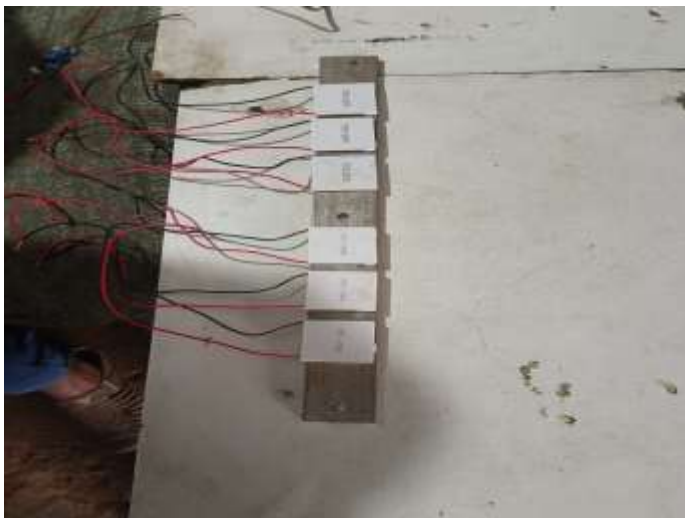


Fig 6.1 Peltier Module

- BATTERY**

An electric battery is a device consisting of one or more electrochemical cells that convert stored chemical energy into electrical energy. Each cell contains a positive terminal, or cathode, and a negative terminal, or anode. Electrolytes allow ions to move between the electrodes and terminals, which allows current to flow out of the battery to perform work



Fig 6.2 Battery

### MULTIMETER

Multi meter A measuring device that can assess various electrical characteristics is a multimeter .The term "volt-ohmmilliammeter" (VOM), which refers to a multimeter that has the ability to measure voltage, resistance, and current, is also used to refer to a typical multimeter that is capable of doing so. Some include the measurement of extra characteristics like capacitance and temperature. Readings are displayed on an analogue multimeter's microammeter, which has a moving pointer.



**Fig 6.3 Multi meter**

### LED BULB

LED Bulb Two-lead semiconductor light sources are known as lightemitting diodes (LEDs). As soon as we provide the electricity to the led it starts to light up.



**Fig 6.4 LED BULB**

### Buck-Boost

The Buck-Boost converter will step up the voltages produced from the Peltier modules and also it will stabilize them and at the same time current will be stepped down comparing with its input. The Buck-Boost converter includes semiconductors such as diodes and transistors. It also has one of the energy storing elements such as inductor or capacitor. As the Peltier modules have the tendency of unstable voltage because of temperature difference so chances of ripple will be high hence filter made of the capacitor will be added. Later, the load will be connected to the buck-boost converter which allows the device to run smoothly.



**Fig 6.5 Buck boost**

## CHAPTER 7

### IMPLEMENTATION OF PROPOSED SYSTEM

The proposed system for energy generation from waste material using Peltier modules is implemented through the design and fabrication of a compact and efficient thermoelectric setup that converts waste heat into usable electrical energy. The system primarily consists of a combustion chamber, heat transfer mechanism, thermoelectric modules, and an electrical output unit. The combustion chamber is fabricated using mild steel sheets due to their strength, durability, and ability to withstand high temperatures. The chamber is designed in a rectangular shape with perforated side walls to ensure proper air circulation, which is essential for efficient combustion of waste materials such as paper, plastic, and biomass. The chamber is mounted on a rigid metal stand to provide stability and to minimize heat loss to the ground. When waste material is burned inside the chamber, a significant amount of thermal energy is generated, creating a high-temperature zone within the system.

To effectively utilize this heat, a metal plate made of aluminium is attached to the outer surface of the combustion chamber. This plate acts as a heat transfer medium, conducting heat from the combustion zone to the thermoelectric modules. Peltier modules, which operate on the principle of the Seebeck effect, are mounted on this heated surface. Each module has two sides: a hot side and a cold side. The hot side is in direct contact with the heated metal plate, while the cold side is exposed to the surrounding environment. In this project, natural air cooling is used to maintain the temperature difference, although the efficiency can be further improved by using heat sinks or forced air cooling systems. The presence of a temperature difference between the two sides of the module causes charge carriers within the semiconductor materials to move, thereby generating a current voltage.

Multiple Peltier modules are connected electrically in series and/or parallel combinations depending on the required voltage and current output. Series connections increase the total voltage output, while parallel connections increase the current capacity. The generated electrical energy is transmitted through connecting wires (typically red for positive and black for negative terminals) to an external circuit. A digital multimeter is used to measure the output voltage and current produced by the system. In the experimental setup shown, the system was able to generate approximately 2.6 volts, which was sufficient to power a low-voltage LED panel, demonstrating the practical feasibility of the project. For further enhancement, a DC-DC boost converter can be incorporated into the circuit to step up the voltage to a higher level, making it suitable for charging batteries or powering small electronic devices.

The performance of the system depends largely on the magnitude of the temperature difference across the Peltier modules. Greater the temperature difference, higher will be the voltage generated. Therefore, improving heat transfer on the hot side and enhancing cooling on the cold side are critical factors for increasing efficiency. The system is tested by igniting waste material inside the chamber and continuously monitoring the voltage output using the multimeter while observing the performance of the connected load. This implementation demonstrates an innovative

and eco-friendly method of converting waste heat into electrical energy, contributing to both waste management and renewable energy generation. Although the system has certain limitations such as low conversion efficiency, dependency on temperature gradient, and limited power output, it provides a strong foundation for further research and development in thermoelectric energy harvesting systems and can be effectively utilized in small-scale applications such as rural energy supply, portable power generation, and industrial waste heat recovery.

CHAPTER 8

COST ANALYSIS

SR NO	COMPONENTS	QUANTITY (NO)	COST (RS)
1	Peltier Module	10	2500
2	Metal combustion chamber	1	3000
3	Aluminium plate	1	600
4	Heat sink	2	400
5	Wiring and Connector	-	400
6	Digital Multi meter	1	500
7	LED panel load	1	100
8	12V battery	1	1500
9	Miscellaneous (nuts bolts insulation labour)	-	1000

1	B	1	2
0	u		0
	k		0
	b		
	o		
	s		
	t		
1	F	-	5
1	a		0
	b		0
	r		0
	i		
	c		
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	o		1
	n		5
			2
			0
			0

CHAPTER 9

RESULT ANALYSIS & DISCUSSION

RESULT

SR NO	Types of waste	Quantity	Voltage generated	Timing
1	Paper	1kg	2.6	5 min
2	Cardboard	1kg	2.8	8min
3	Clothes and wood	1kg	4.2	15min
4	Dry leaves	1kg	2.2	3min

Fig 8.1 Result

During the experiment the temperature was varied from 35o C to 155o C. We observed increased in power output with the increase in temperature. The variation of power, current and voltage produced by the TEG are plotted against the temperature in the figures 3, 4 and 5 respectively.

As a reference, some SP1848-27145 thermoelectric modules also have data sheets indicating that they can generate approximately:

- 20 degrees temperature difference: 0.97V and 225 mA
  - 40 degrees temperature difference: 1.8V and 368 mA
  - 60 degrees temperature difference: 2.4V and 469 mA
  - 80 degrees temperature difference: 3.6V and 558 mA
- 100 degrees temperature difference: 4.8V and 669 mA

## **DISCUSSION**

Based on the experimental results and observations, it can be concluded that the proposed system of energy generation from waste material using Peltier modules is technically feasible and successfully implemented. The system effectively demonstrates the principle of thermoelectric power generation by converting waste heat into usable electrical energy. The generation of approximately 2.6 volts and the successful operation of an LED load confirm the practical working of the model.

However, the system is best suited for low-power applications due to its limited efficiency and output. With further improvements such as enhanced heat transfer, better cooling mechanisms (heat sinks or fans), proper insulation, and the use of power conditioning circuits like boost converters, the performance of the system can be significantly increased.

## **CHAPTER 10**

### **9.1 CONCLUSION**

This paper describes the basic concepts of power generation by thermoelectric generators and its relevant applications in the waste heat recovery systems. The study is useful in power generation by using Bismuth Telluride TEG where availability of waste heat is high like engine exhaust, furnaces, heaters, stoves etc. This study shows that the power produced is directly proportional to the temperature of the hot surface. Maximum power output obtained was 650mW and further experiments are being conducted to improve the performance by using effective heat exchanger

### **9.2 FUTURE SCOPE**

#### **Increase Power Output**

Use multiple Peltier Module units connected in series or parallel to generate more electricity.

#### **Improved Heat Source**

Utilize higher temperature waste materials to increase the efficiency of the Peltier Effect.

#### **Energy Storage System**

Integrate rechargeable batteries or supercapacitors to store generated energy for later use.

#### **Large-Scale Implementation**

Apply the system in industries, kitchens, or waste processing plants where large amounts of heat waste are available.

#### **Automation and Monitoring**

Add sensors and microcontrollers (like temperature sensors) to monitor heat and power generation automatically.

### **Improved Cooling System**

Use better heat sinks or water cooling systems to maintain a large temperature difference across the module.

### **Hybrid Energy System**

Combine this system with Solar Energy or other renewable sources to increase efficiency.

### **Cost Optimization**

Research cheaper materials and better module designs to make the system affordable for large-scale use.

## CHAPTER 11

### **ADVANTAGE AND DISADVANTAGES**

#### **Advantages :**

- Utilizes waste materials → reduces environmental pollution
- Uses Waste Heat Energy
- Converts unused heat into useful electricity
- No Moving Parts
- Less wear and tear → low maintenance
- Simple Design
- Easy to fabricate and operate
- Silent Operation
- No noise as compared to generators
- Can be installed in small areas
- Direct Energy Conversion
- No need for turbines or complex machinery
- Safe for Small Applications
- Suitable for LED lighting and low-power devices

#### **Disadvantages :**

- Low Efficiency (Major Drawback)
- Only ~5–8% energy conversion
- Low Power Output
- Cannot run heavy electrical appliances
- Requires High Temperature Difference
- Performance depends on heat vs cooling
- Heat Loss Problem
- Not all heat is converted → energy waste
- Cooling Requirement
- Needs proper cooling for better output
- Cost per Watt is High
- Expensive compared to output power
- Limited Practical Use (Large Scale)
- Not suitable for industrial power generation

#### **Applications**

- Waste Heat Recovery Systems
- Used in industries to utilize exhaust heat
- Rural Energy Generation

- Small electricity generation in villages
- Camping, remote areas
- Convert engine heat into electricity

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