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POWER GENERATION USING TEG MODULE IN SUSTAINABLE BUILDING DESIGN

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ABSTRACT

Generally in the forest areas it is difficult to transmit the power from generating station,if we do so there are so many difficulties we need to face. By transmitting the power from station weget the problems like transmission losses due to corona effect, proximity effect etc… Hence itis not much efficient to transfer the power from generating station to forest areas through transmission lines. The purpose of this project is provide the electricity to the people who are working in the forest for collecting the forest products like hard wood, soft wood, ayurvedic medicines etc…here availability of supply source is critical. In this regard we are generating the power by constructing mini power plant in the forest itself. This power plant will not onlybenefit to the people who are working in the forest but also to the tribals who are living nearbysurrounding. The tribals are not much aware of what is going around the world because they do not have television and cell phones (most of the forests don't have cell phone towers due tolack of supply source). So, this power plant will be the solution for above problems.

Fundamental Components: TEG modules, Temperature sensor (LM35), Assembly of metal furnace , 7085 Regulator, Heatsink , Arduino uno processor , 16x2 LCD(Liquid crystal diode), LED's, mini fan etc…

1. INTRODUCTION

The goal of the proposed idea is to generate electricity in densely forested regions where it is difficult to collect solar energy or power because of the dense undergrowth. The main feature of the sustainable building design is a furnace that burns waste wood, leaves, and other forest debris to produce power. People who work for the forest service usually live in isolated woodland locations without access to power. Because there is a severe shortage of supplies, forest guards might get agitated at times. A portable device with Thermo Electric Generator (TEG) modules installed is suggested as a solution to these problems. The idea is simple: collect scrap forest wood, light it in the furnace (which is why the TEGs are linked to the furnace), and the device will use the TEG modules to create energy to power all of the electronics.

The project's goal is to burn forest debris to create power.A prototype of a tiny, rectangular furnace constructed of mild steel plates will be created to illustrate this. Due to the prototype module, we are only able to demonstrate this idea with 4 TEG modules here; however, in a real-time application, more TEG modules are needed in order to create a significant amount of power. Now let's talk about the electrical portion of the project, which entails keeping an eye on crucial variables like boiler voltage and temperature. Sensors mounted on the furnace provide the data, which is then transformed into digital signals by an inbuilt Analog-to-Digital converter (ADC) of a processing unit—in this example, an Arduino Uno controller. Currently connecting an Arduino Uno controller to a 16x2 LCD to display digital signals on the screen. The C/C++ programming language is used to create code for Arduinos; it consists of a collection of functions that you may use to write code into

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the device using a personal computer. Even for novices, writing and uploading programmes to the board is made simple by the Arduino software.

2. LITERATURE SURVEY

The article titled "Theoretical and experimental studies of impacts of heat shields on heat pipe evacuated tube solar collector" was written by X. Huang.As a result of their poor efficiency and the fact that they operate at medium temperatures, heat pipe evacuated tube solar collectors are not often used. These collectors do not concentrate, do not track, and operate at medium temperatures. Even while operating at high temperatures, the heat loss has a significant and detrimental impact on the functioning of the device. Because of this, heat shields were placed in between the absorber plate and the glass tube in order to reduce the amount of heat that was lost. In order to assess the thermal performance of the unique heat pipe evacuated tube solar collectors as well as the classic collectors, both experimental and theoretical work was carried out. In accordance with the findings of the experiments, the heat shields demonstrated an improvement in thermal efficiency at temperatures ranging from around 20 to 150 degrees Celsius for the intake water, while the solar collector shown superior performance at higher inlet water temperatures. At an intake temperature of roughly 150 degrees Celsius and solar radiation of approximately 820 watts per square metre, the innovative one had a thermal efficiency that was 11.8% higher than the previous one. To add insult to injury, the efficiency coefficients of the innovative one in the instantaneous efficiency curves, which may represent the rate of loss in instantaneous thermal efficiency, resulted in a drop of 28.4% and 29.9%, respectively. In the meanwhile, the results of the simulations demonstrated that the thermal efficiency increments of the novel collector exhibited an increase in comparison to the standard collector when the solar radiation was weaker and the ambient temperature was lower at each input water temperature.

3. TEG MODULE INSUSTAINABLE BUILDING DESIGN

The concept is to produce electricity from tree detritus. The mechanical construction uses aluminium heat sink, metallic furnace, Arduino Uno microcontroller, LCD, and thermo-electric device material to generate 6 to 8 volts dc electricity via TEGs connected to the hot metal body. These TEGs generate electricity from heat.The working component involves welding aluminium metal sheets into a rectangular furnace and assembling a chimney on top. The chimney exhausts furnace smoke. The furnace has a temperature sensor (LM35) and four TEG modules (hot side is hooked to furnace). TEGs use the "Seebeck effect" to directly convert heat into electricity utilising the temperature differential between hot and cold sides. This technique requires thermoelectric materials that significantly display the thermoelectric effect. The Seebeck effect or Peltier effect may produce an electric potential from a temperature differential. Most materials have some thermoelectric effect, but few have enough to be useful. These materials are utilised in power generating and refrigeration. They're also being studied for their ability to regenerate electricity, making them useful in energy technology.

A) INTERFACING OF 16X2 LCD DISPLAY WITH ARDUINO UNO R3 PROCESSOR

LCD screens are common in electronic systems owing to their adaptability and usefulness. LCD screens can show numbers, characters, and images, unlike seven-segment LED displays. Engineers favour them for various applications because of their versatility. LCD screens may store data until the controller signals them to delete or refresh it. Once data is transferred to the LCD, it stays visible until the system changes it. Data may also be kept in the LCD's memory and refreshed for future activities, improving efficiency and usefulness. LCD panels provide more functionality and adaptability than seven-segment LED displays, making them ideal for many electrical systems.

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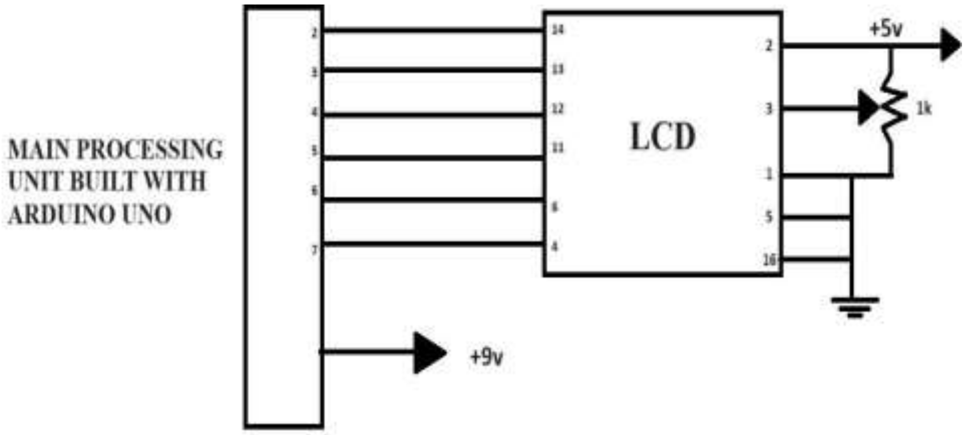

Figure 1. Arduino UNO

This LCD has 16 pins—8 data and 3 control. Figure displays the Microcontroller-display unit interface. The figure above shows, Pins 7 to 14 are data pins for character selection, while pins 4 to 6 are control signal pins for Register bank selection, Read/Write, and Enable. Display contrast may be changed by altering pin 3 voltage.LCD modules interface with Arduino digital pins 2, 3, 4, 5, 6, and 7. LCD modules need 5 volts to operate. In many applications, a voltage regulator like the L7805 provides a consistent 5-volt output from a higher input voltage, usually from the Arduino's power supply or an external power source. Proper voltage management protects the LCD module and ensures dependable operation. The LCD pins 14 13 12 11 6 4 receive whatever data is provided. Data pins are 14,13,12, and 11 while control pins are 6 and 4.TEGs create 6–8 volts, as shown in the circuit diagram. LEDs and the tiny fan work with this voltage, however the Arduino board needs 8 to 20 volts to run continually. Thus, the Arduino may only work occasionally.Time reduces temperature disparity to room temperature. To fix this, install a 9V battery.

B) BATTERY

The battery stabilises the system, guaranteeing Arduino functioning without interruption. TEGs yield 6 to 8 volts at maximum temperature, however this prototype module is for demonstration. Keeping the Arduino running even if the thermoelectric generator output changes. This ensures system stability and dependability, keeping the Arduino running smoothly.

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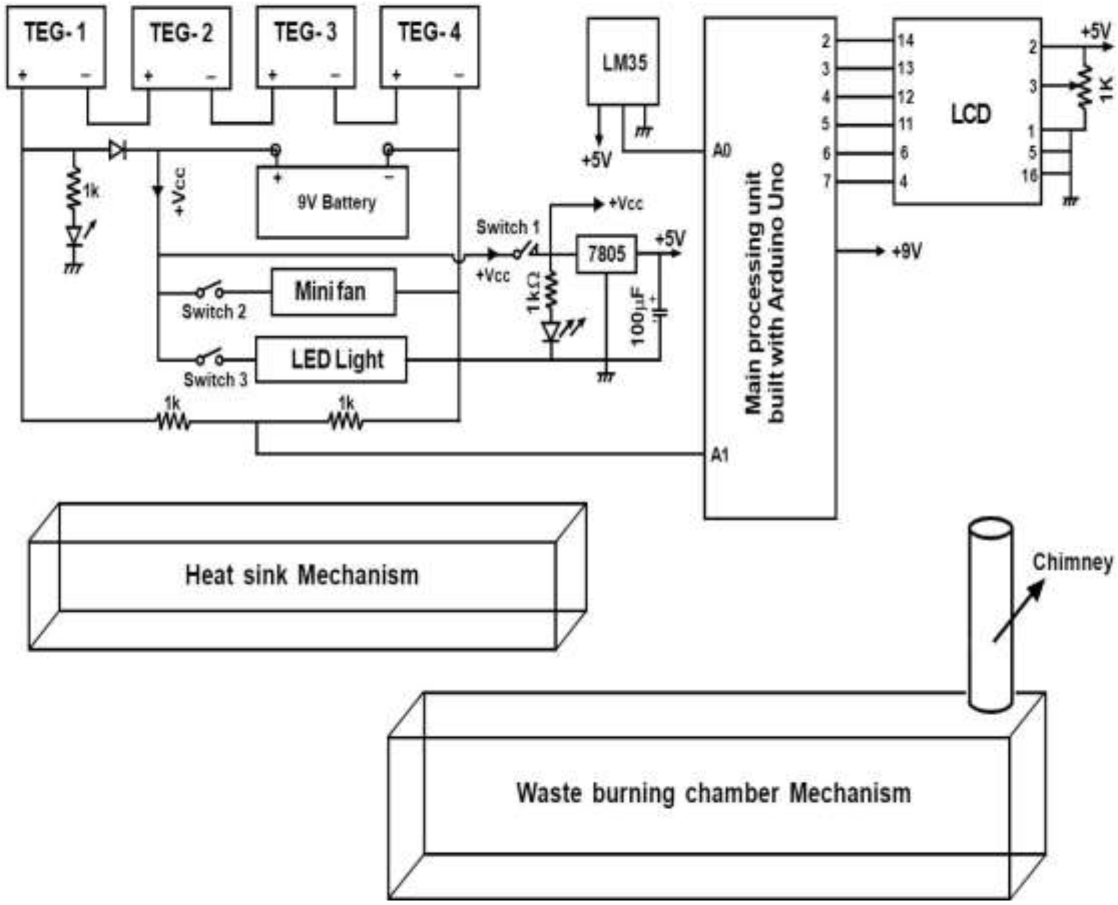

Figure 2. TEG module insustainable building design

C) COMPONENT DETAILS

TEG (Thermo Electric Generator):A thermo electric generator (TEG) uses Seebeck effect to turn heat into electricity. Applied temperature differential across a semiconductor material generates voltage and power. Waste heat recovery, automotive systems, and remote sensors employ TEGs.The Seebeck effect, a thermoelectric effect, powers solid-state devices that turn heat directly into electricity. Heat engines and thermoelectric generators are similar but smaller and have no moving components. Power facilities may employ thermoelectric generators to convert waste heat into electricity, and cars can use them to improve fuel economy.

Seebeck effect; In thermoelectric generators (TEGs), the Seebeck effect is crucial for electricity generation. This phenomenon occurs when there's a temperature differential across the module, achieved by heating one side of the module while cooling the opposite side. A Seebeck Module functions as a TEG, harnessing this effect to produce electrical power. For optimal power output, it's essential to expose the hot side of the module to temperatures well above the 150°C range. However, merely heating one side isn't sufficient; efficient heat management on the cold side is equally vital. Without proper technology to remove heat and maintain appropriate temperatures on the cold side, the TEG module won't yield effective power output.

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D) WORKING PRINCIPLE

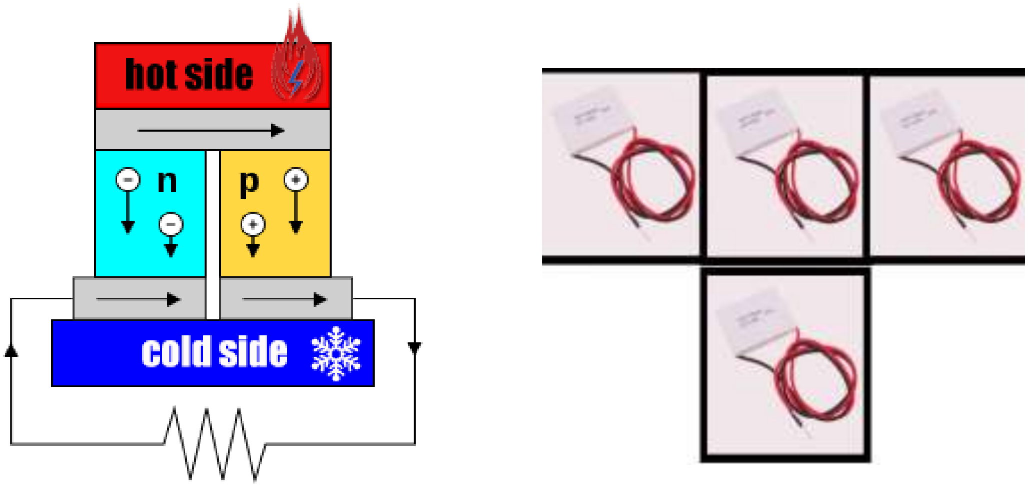

Figure 3. Thermoelectric Generator

A Thermoelectric Generator (TEG) uses the Seebeck phenomenon to convert a temperature differential between two conductors into electrical power. The process is explained step-by-step:

Thermoelectric Materials: TEGs use high-Seebeck semiconductors. These materials are selected for effective heat-to-electricity conversion. This device uses bismuth telluride, bismuth sulphide, tin telluride, indium arsenide, germanium telluride, and others.

Temperature Gradient: TEGs work with a temperature differential between their sides. One side is heated by a combustion chamber or hot surface, while the other is cooled.

Generation of Voltage: When the hot and cold sides of the TEG have different temperatures, electrons pass through the thermoelectric material. Charge carriers pass across the TEG, creating voltage.

Electrical Output: TEG voltage may power devices or be stored in batteries. Temperature gradient, thermoelectric material qualities, and TEG size affect power production.

Continuous Operation: TEGs can run constantly if the hot and cold sides have different temperatures. Waste heat from car exhaust systems, industrial operations, and power plants is utilised to create electricity and enhance energy efficiency.

E) Regulator

A circuit's voltage regulator stabilises voltage levels, filters out noise, protects components from voltage fluctuations, and allows voltage conversion regardless of input voltage or load conditions. Based on need, there are numerous voltage regulators. Electronic circuits employ linear voltage regulators to regulate voltage.

F) Arduino Uno Processor

Open-source electronics platform Arduino has user-friendly hardware and software. The boards, which use an 8-bit or 32-bit microprocessor, provide USB ports, analogue inputs, and GPIO pins for adding boards. Custom circuits need GPIO (General Purpose Input and Output).

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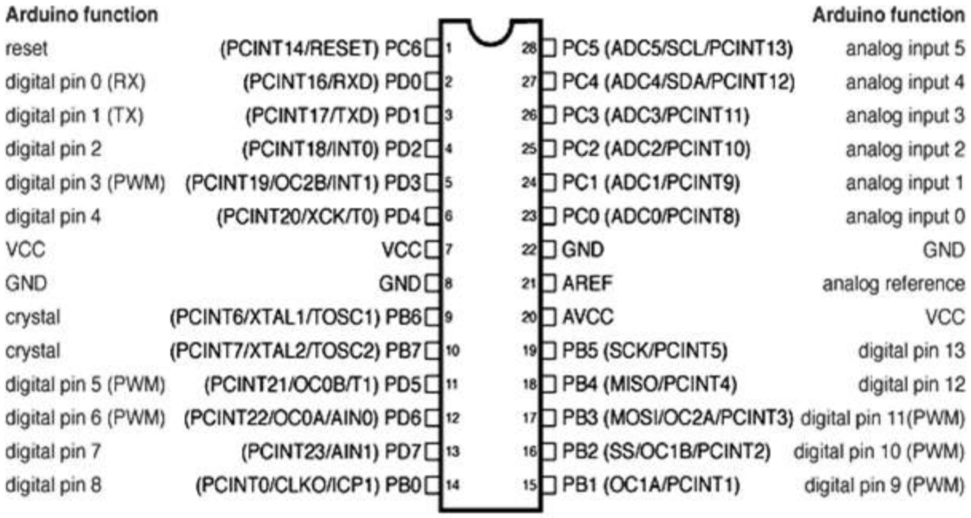
Arduino Uno Technical Specifications

Microcontroller	ATmega328P – 8-bit AVR family microcontroller
Operating Voltage	5V
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	6 (A0 – A5)
Digital I/O Pins	14 (Out of which 6 provide PWM output)
DC Current on I/O Pins	40 Ma
DC Current on 3.3V Pin	50 Ma
Flash Memory	32 KB (0.5 KB is used for Bootloader)
SRAM	2 KB
EEPROM	1 KB
Frequency (Clock Speed)	16 MHz

Arduino Uno to ATmega328 Pin Mapping



Digital Pins 11,12 & 13 are used by the ICSP header for MOSI, MISO, SCK connections (Atmega168 pins 17,18 & 19). Avoid low-impedance loads on these pins when using the ICSP header.

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G) Temperature sensor (LM35)

The LM35 is a precision IC temperature sensor that measures object temperatures directly in Celsius. The LM35 is more accurate and stable than typical thermistors. Self-heating is negligible, raising still air temperature by less than 0.1°C. Its -55°C to 150°C range meets power supply, battery management, and domestic appliance temperature measuring demands.

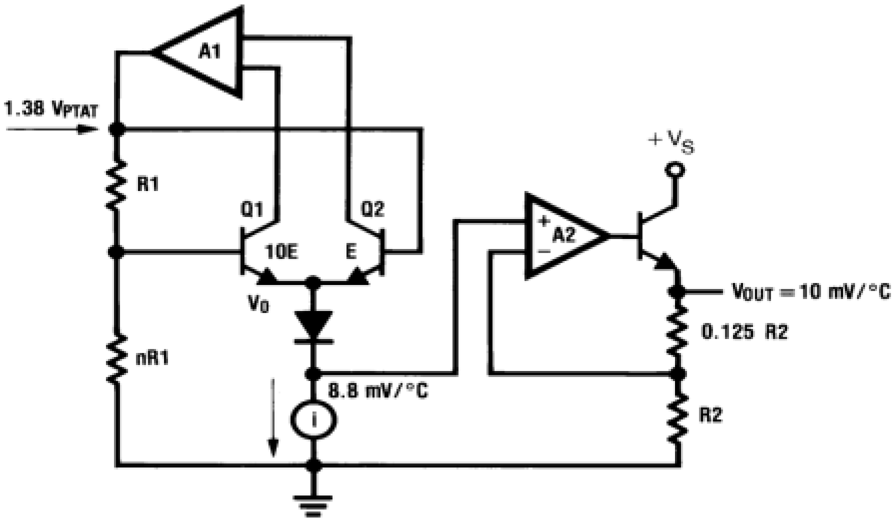

Figure 4. Functional description of LM35

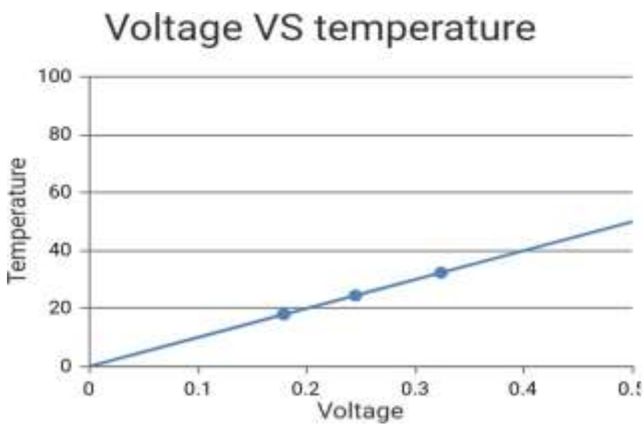

Figure5. Graphical representation of Output Voltage VS Temperature

One transistor has 10 times the emitter area of the other at the schematic's centre. The emitter area discrepancy causes different current densities in each transistors, yet this design provides continuous current flow. This generates a voltage across resistor R1 that is proportional to absolute temperature and roughly linear over the temperature range. A unique circuit straightens the voltage-temperature curve to correct modest departures from linearity.By comparing outputs from both transistors, an amplifier at the top keeps the voltage at the base of the left transistor (Q1) proportional to absolute temperature (PTAT). The amplifier on the right transforms Kelvin absolute temperature into Fahrenheit or Celsius, depending on the component (LM34 or LM35). A constant current source circuit is represented by the "i" circle, and the two resistors are factory-calibrated to provide a precise temperature sensor.Two power supply pins and one analogue output pin make up the LM35 IC. It outputs a linearly linked analogue voltage with Celsius temperature at +5VDC. Pin 2 outputs 1

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millivolt per °C (10mV per degree), therefore dividing by 10 simplifies Celsius temperature measurement.

H) Liquid Crystal Diode (LCD)

LCD modules are often interfaced with microcontrollers in embedded systems. LCDs can show letters, numbers, and rudimentary drawings, making them better than seven-segment displays. Many electronic systems show information using them.Before connecting an LCD to a microcontroller, you must grasp its operating modes and how to programme it in assembly language or C. The LCD receives instruction commands from the microprocessor. These LCD command codes clean the display, move the pointer, and flash the cursor.

The LCD has two main registers: command and data. The LCD's RS pin indicates whether the microcontroller is providing data or instructions. By selecting the command register while RS is low (0), the microcontroller may clear the display. RS high (1) selects the data register, allowing the microcontroller to deliver data to the LCD panel.A busy flag is usually on the D7 pin of the LCD. This indicator shows whether the LCD is executing internal activities or receiving fresh data. To ensure the LCD is ready to receive data, check the busy indicator before writing data.

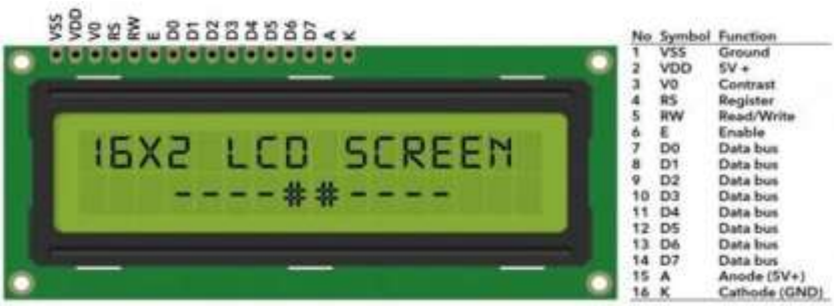

Figure 6. LCD

4. RESULTS

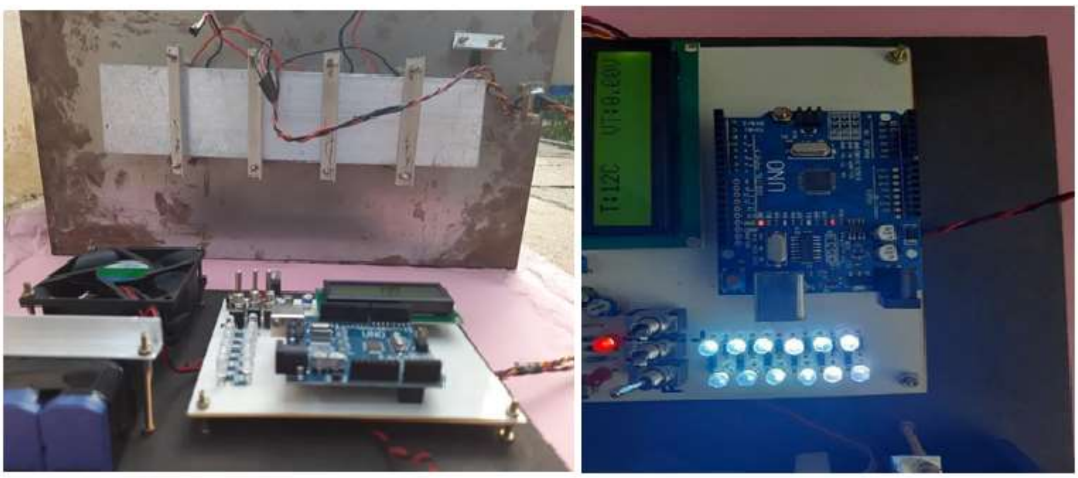

Figure 7. Hardware model of TEG module insustainable building design

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CONCLUSION

In summary, waste management and energy creation are two urgent problems that the suggested heating device creatively addresses. Through the use of thermo-electric generators (TEGs), the gadget efficiently transforms otherwise lost energy into useable power by capturing the heat generated by burning wood fuel or dry trash. The electricity produced may subsequently be used to power a variety of low-energy equipment, such as mobile phone chargers, tiny DC fans, and LED lights, providing usefulness in a variety of situations. Specialised mechanical parts including TEG modules and aluminium heat sink water cooling devices are included, showing a careful engineering approach to optimise energy conversion efficiency.

Additionally, the device's mobility increases its adaptability, making it appropriate for emergency scenarios, off-grid living, or use as a backup power source in areas with unstable electrical infrastructure.All things considered, this idea not only offers a viable way to produce power in areas with limited resources, but it also offers a sustainable solution for waste management by repurposing garbage as a source of energy. The suggested heating equipment has the ability to solve energy and environmental issues, which might lead to a more robust and sustainable future.

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