Design of Alternative Energy Using Thermoelectricity by Utilizing a Dispenser Heat Tank Using IOT

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***Abstract*— Energy is an object that can move through essential reactions; increasing population growth is one of the factors for increasing energy needs. One of the initiatives initiated was the creation of a Thermal Electric Generator (TEG). The formulation of the problem in this study is to determine the output voltage, current, and power generated by the thermoelectric as an alternative energy and to determine the effect of temperature on the thermoelectric. The goal is to determine the amount of output the thermoelectric generates when it gets a heat source from the dispenser. The data source in this study was obtained from testing the tools made. The test results show the effect of temperature on the thermoelectric tested for 120th minutes test of max 5.96 Volts with a water temperature in the dispenser tank of 73°C without using a step up using six pieces of thermoelectric arranged in series.**

Keywords— ***Thermal Electric Generator, Alternative Energy , Micro Power Plant, Micro Energy Harvester.***

1. INTRODUCTION

Energy is an object that can move through essential reactions due to fundamental reactions. Increasing population growth is one of the factors for increasing energy demand. Now, energy availability worldwide, especially in Indonesia, is decreasing[1]. One of them is conventional energy, namely energy whose availability is limited. Currently, the conventional energy use is fossil energy. Fossil energy comes from natural resources which cannot be renewable. Fossil energy is currently the most widely used energy source [2]. To overcome this problem, along with the development of technology, many emerging alternative and renewable energy sources are used to reduce the impact of global warming. One of the initiatives initiated was the creation of a Thermal Electric Generator (TEG) [3] as an alternative energy source. Thermal Electric Generators can directly convert temperature differences into electrical quantities, even though the efficiency value is as low as 10% [4]. Factors that can reduce efficiency are heat converted to the thermoelectric generator that is not absorbed entirely and an imperfect cooling system that causes the thermoelectric generator to work less optimally [5]. Thermoelectric generators can be alternative energy generators that produce electrical energy to charge batteries [6].

In 2022, the [7] researched thermoelectric, "Performance investigation of a thermoelectric generator system applied in automobile exhaust waste heat recovery, "using heat from sunlight and 16 thermoelectric. The references obtained are related to the use of thermoelectric. One of the studies conducted [8] entitled "Output voltage characteristic of heat pipe sink thermoelectric generator with exhaust heat utilization of motorcycles." However, the consequences cannot be explained when it rains. The research, which is also one of the references, is the research conducted [9] entitled " Design of Fire Heat Energy Conversion System". The research aims to produce heat from a campfire to convert it into electrical energy by thermoelectric. In this study, the heat generated using firewood to make a campfire reached 151^{0}C. The temperature is good enough to be converted to electrical energy, but it is less environmentally friendly because it produces smoke from burning bonfires.

Based on a similar problem, this research was carried out by designing builds and measuring the size of the alternative energy potential for lamps using thermoelectric by utilizing a heat dispenser tank. This research aims to develop and utilize thermoelectric heat energy by using a hot water dispenser tank in electrical energy to determine the effect of the heat generated by the dispenser. The hope is that it can be helpful as a source of information about the results of the analysis of the energy output produced by the thermoelectric generator and provide information about the effect of hot temperatures on the thermoelectric generator as an alternative energy. Researchers are trying to make a device that generates electrical energy for lamps by utilizing a heat dispenser tank as a source of heat or heat to be converted into electrical energy using thermoelectric. This technology is a future alternative energy that has several advantages. It has a reliable service life, is not noisy during operation due to the absence of moving mechanical parts, is maintenance-free, simple, and is very small in size, light, and environmentally friendly by utilizing a heat source from the water dispenser tank as one of the electronic equipment that there is a household. The author is trying to build a power plant using a thermoelectric generator. They combine with the NodeMCU ESP8266 control system component for turning on and off lights and manual controlling monitoring

2. METHOD

Before embarking on further research, below is an overview of a suggested flow of research to illustrate the research process.

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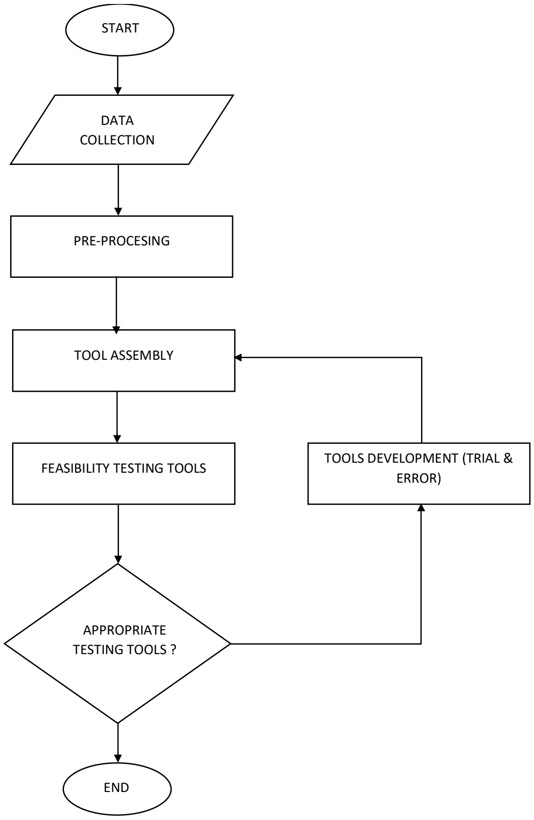

Figure 1. Research Flowchart

A. *Thermoelectric Generator*

A thermoelectric generator is a technological device that can convert heat energy (temperature difference) into electrical energy directly or vice versa electrical energy into temperature changes (temperature differential) [10]. When the metal rod is heated or cooled at the two poles of the metal rod material, electrons from the hot to the cold part will cause an electric field [11]. The *Seebeck effect* [12] is the working principle of the thermoelectric used in this study. That is, "*when two dissimilar copper metals connect to one end, and then different temperatures are applied to the connection, there is a difference in voltage between one end and the other*."

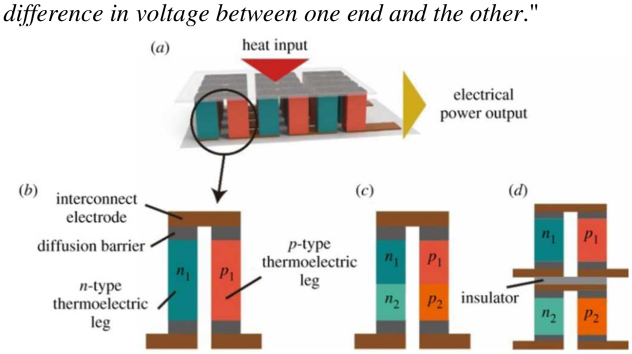

Figure 2. Thermal Electric Generator Principle

This technology can be an excellent alternative to power generation because it has several advantages. Some of the advantages of a thermoelectric generator are reliable use (usually exceeding 100,000 hours of steady state operation) [13], does not produce noise when used because it has no moving mechanical parts, does not require more maintenance, is safe, simple, has a reasonably small size and is light, friendly environment and flexible energy sources [14]. The thermoelectric used to manufacture this tool is the TEG SP184827145 SA series module.

Figure 3. TEG SP184827145 SA Type

The specifications for the thermoelectric type TEG SP184827145 SA are as follows [15]:

Table 1. Thermoelectric Specifications

Dimensions (mm)	Weight (gr)	Temperature (^{0}C)	Voltage (V)	Current (mA)
40x40x3.5	26	20	0.97	225
		40	1.8	368
		60	2.4	469
		80	3.6	558
		100	4.8	669

B. *NodeMCU*

NodeMCU is an IoT platform that is open source and a board that encapsulates ESP8266 into a single board with various options, such as microcontrollers with access capacity to Wi-Fi and communication chips such as USB to serial ports [16].

C. *Relay*

A relay is an electronic component in the form of an electronic switch driven by an electric current. Relay is an electrical component based on electromagnetic field induction to move the switch contacts so that significant voltage electricity can flow with a low electric current (low power) [17]. If an electric current flows through a conductor, a magnetic field arises around the conductor.

The following are the specifications of the 2-channel relay module used:

1. This relay uses a low voltage of 5V, so it can directly connect to the microcontroller system.
2. The type of relay is SPDT (Single Pole Double Throw): 1 common, 1 NC (Normally Close), and 1 NO (Normally Open).
3. It has a resistance of up to 10A.
4. The control pin can be connected to any microcontroller port so programmers can freely determine which microcontroller pin to use as a controller.

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5. It is equipped with a relay driver circuit with a TTL voltage level so that the microcontroller can directly control it.
6. Driver type "active high" or relay coil will be active when the controller pin gives logic "1".
7. The driver is equipped with an induction emf damper circuit so that it will not reset the microcontroller system. Connection: VCC connects to 5 V, GND connects to GND dan 1N 1 - 1N two relay control interface connected to MCU's IO port.

D. Heat Sink

A heat sink is a device for effectively absorbing or dissipating heat (thermal energy) from the surrounding environment (air) using an expanded surface such as fins or spines. A heat sink is a passive heat control device that absorbs heat emitted or generated by electronic components and then transfers it to the heat sink function to control or cool the thermoelectric installed in the hot water dispenser tank for maximum thermoelectric performance. The surrounding fluid media can be air or liquid [18]:

- Dimensions size: 40mm x 40mm x 1 mm
- Material : Aluminum

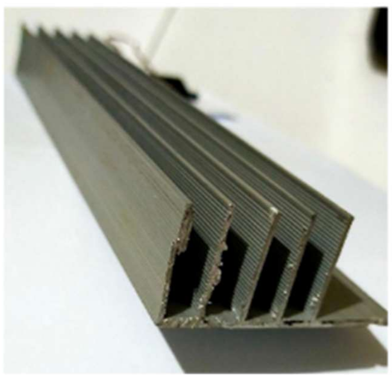
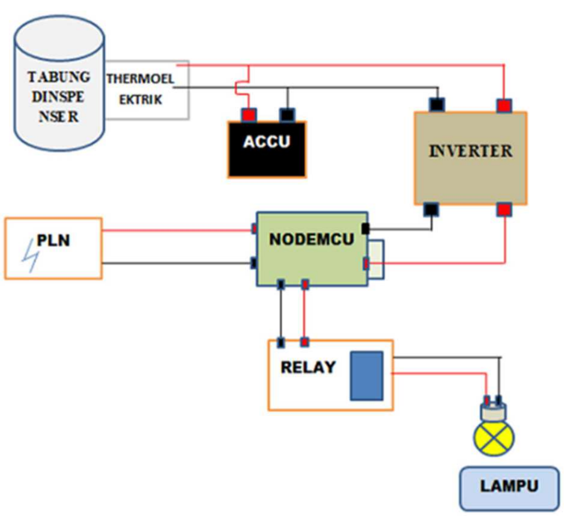


Figure 4. Heat sink

E. System Design



Picture 5. Circuit Thermoelectric System

In system design, the main thing made is a complete overview of the design, a statement of a device's or other component's sequential relationship. The main components are the hot water tube in the dispenser, thermoelectric TEG SP184827145 SA series, step-up block, Accu/battery block, inverter block, NodeMCU block, relay block, energy source block from PLN, and lamp block. Below is a picture of the Thermoelectric working system circuit.

The figure explains the tooling made, namely the design of alternative energy for lamps using thermoelectric by utilizing a water dispenser tank containing a dispenser, inverter, NodeMCU, relay, and battery. It arranges to produce the desired output.

The steps for testing the tools are in the image on the block diagram:

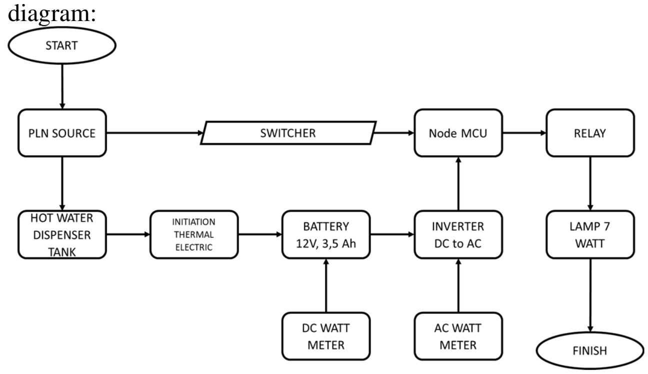


Figure 6. Block Diagram System

Testing the tool can be done in the following way: First, make sure the thermoelectric is installed on the hot water tank in the dispenser with a series circuit for data collection, and prepare writing tools to write down the test data. The dispenser turns on to start the water heating process, then measures the temperature of the heat generated by the dispenser tank and the thermoelectric and the amount of voltage released by the thermoelectric; a heatsink and DC fan are installed on the thermoelectric section to absorb the heat released by the thermoelectric for maximum thermoelectric performance. The heat generated by the tube section of the dispenser will affect the change in output generated by the thermoelectric. The thermoelectric assists by a step up to stabilize the output voltage and will be connected to the battery to store the voltage generated.

After the battery enters the inverter, which functions to change the electric current from direct (DC) to alternating electric current (AC), which will enter the relay, the NodeMCU will be programmed to regulate the on and off of the switch replacement lamp if it happens electricity cut by PLN. the use of electrical energy generated from thermoelectric using relays as separators and lights will be with energy sources generated from thermoelectric and from sources of electrical energy directly from PLN.

F. NodeMCU ESP8266 Wiring Circuit and Relay

In the NodeMCU ESP8266 and Relay wiring circuit, the first thing to do is prepare and assemble using special jumper cables for nodeMCU and relay. Then, the USB port data cable on the

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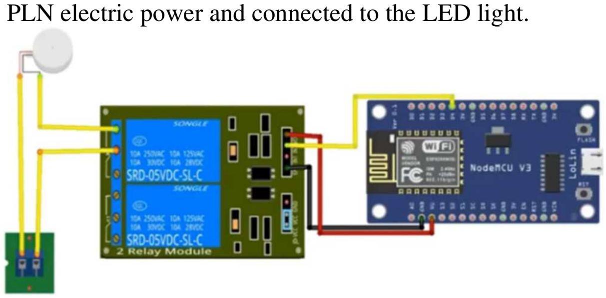
NodeMCU connects to the inverter. The relay is connected to the PLN electric power and connected to the LED light.

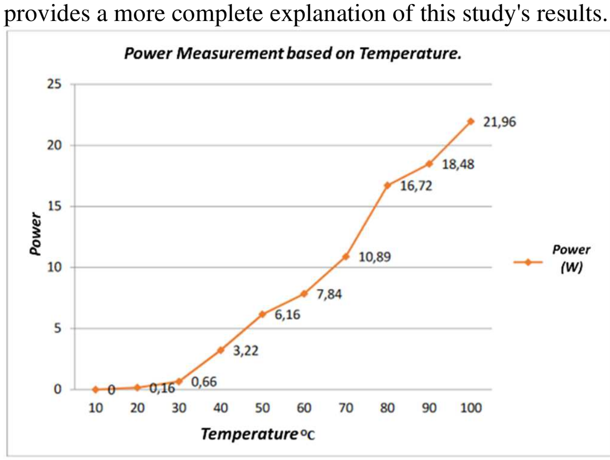


Picture 7. NodeMCU and Relay Control Circuits

Description: NodeMCU on the right and relay two channels on the left, and one plug cable will connect to the socket or PLN power. The yellow cable from NodeMCU to the relay is the voltage connected to VCC or D5 NodeMCU, and the IN2 relay connects. Then, the red cable from NodeMCU connects to the ground relay, and the black cable Vin from nodeMCU connects to the VCC relay output from the relay for lights and PLN power and power from the inverter.

3. RESULTS AND DISCUSSION

These tools are active when there is a power source from PLN or a power outage from PLN. The following step below provides a more complete explanation of this study's results.



Picture 8. Graph of Thermoelectric Power based on temperature

Table 2. Thermoelectric Measurement Based on Temperature

Temperature (ºC)	Voltage (V)	Current (A)	Power (W)
10	0	0	0
20	0,81	0,23	0,16
30	1,13	0,61	0,66
40	4,64	0,72	3,22
50	7,71	0,81	6,16
60	9,85	0,83	7,84
70	12,15	0,94	10,89
80	15,26	1,11	16,72
90	16,87	1,12	18,48
100	18,38	1,23	21,96

These working measurements are when the dispenser turns on to know the temperature of the water produced by the dispenser at home, which will be used by the thermoelectric to generate voltage data obtained by using several data retrieval methods at a predetermined time. Data collection shows that every 10^0C temperature increase, the resulting voltage increases.

Measurement of Dispenser Usage and Thermoelectricity

The thermoelectric output voltage is measured when the dispenser is turned on by dividing the time by a 10-minutes difference. The time needed for the dispenser to reach a temperature of 60^0C is ± 17 minutes, and then the dispenser will stop heating the water. The data collection determines the time needed for the dispenser to reach the maximum temperature that can be absorbed by the thermoelectric to produce electrical energy.

Tabel 3. Dispenser Power Consumption and Thermoelectric Power Consumption

Time (Minute)	Temp ºC	Thermoelectric Power (W)	Dispenser Power (W)
10	45	0,203	288,2
20	60	3,45	288,7
30	64	4,14	290,7
40	69	4,93	295,1
50	68	4,55	294,5
60	66	4,22	292,0
70	64	3,95	301,5
80	71	5,25	298,0
90	73	5,96	308,1
100	71	5,50	300,5
110	69	4,86	292,2
120	68	4,53	291,5

From the results of data collection on the use of the dispenser for 120^{th} minutes and the power generated by the thermoelectric without using a DC step up to determine the power that the dispenser emits and determine the power generated by the thermoelectric, during this data collection the dispenser works to heat water an average of 1 time per 10 minutes. From the experimental results, the dispenser temperature will stand at 64^0C. Detailed results do not check every minute or outside the dispenser specifications set by the company. When the dispenser heats the water, it consumes the highest electrical power in the 90^{th} minutes at 308,1 watts with a water temperature in the dispenser tank of 73^0C and thermoelectric produces the highest voltage of 5.96 Volts in the 120 minutes test. When the dispenser stops heating the water, the power released is 3,95 – 4.14Watts.

Testing turning on the Lights Using NodeMCU

Testing the application of the tool was carried out using two pcs of 5-watt LED lights attached to the tool. The lighting test uses a switch as a breaker from the PLN power source and the Blynk application for energy sourced from a thermoelectric generator. During the test, the tool uses a switch to disconnect the electricity source from PLN and uses the Blynk application, which has been set to a mobile phone, to disconnect and connect from nodeMCU, which comes from thermoelectric. Tests for lighting lamps with a backup power source have been successful; when the dispenser reaches the thermoelectric heat temperature, it can issue a voltage and electric current according to the data that it has obtained so that the battery

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connected to the thermoelectric can store the electricity generated and can turn on the lights that are connecting to the battery.

Picture 9. Measurement of Dispenser and Thermoelectric Usage


Picture 10. Tool Application Testing

4. CONCLUSIONS AND RECOMMENDATIONS

After conducting research and discussing the design analysis of alternative energy for lamps using thermoelectric by utilizing a heat dispenser tank, it concludes as follows:

1. Making an alternative source of electricity using thermoelectric has been successfully carried out and can be used properly. The success of this tool is that it can utilize the heat source generated by the dispenser tube and convert it into electrical energy by storing power in the battery using thermoelectricity to provide electrical energy for home lighting use.
2. It can be seen that the generating power uses a thermoelectric of 6 pcs arranged in series by utilizing heat from the dispenser tank.
3. The water temperature in the dispenser tank significantly affects the voltage generated by the thermoelectric, which could used to turn on the lights. The lowest temperature of 45^{0}C can produce a voltage of 0.203 W and the highest temperature of 73^{0}C can produce a voltage of 5.96 W.

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