1.7.8. research study;

# APPROVAL SHEET

This Project Study entitled **"THE IMPLEMENTATION OF THERMOELECTRIC SYSTEM"** prepared by **Delf Enriq Aloyon, Lord John Kevin Bangcoyo, Reiolvi Orcullo, Lowie Pejer, Hannie Bert Quinalagan** in partial fulfillment of the requirements for the degree of **Bachelor of Science in Electrical Engineering** has been examined and is recommended for acceptance and approval for ORAL EXAMINATION.

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Date: June 10, 2022

# Renewable Energy: Thermoelectric Power Generating Device

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***Abstract***

Countless households and business establishments are longing to find an alternative source of energy due to the increasing of electricity rates. Nowadays, the most popular solution for this problem are power generating devices that relies only on renewable energy. Specifically, the researchers create a study of how the waste heat from the roast chicken machine turned to be an independent source of energy for the power supply of the machinery itself. Thus, the purpose of this study is to develop a device that can generate electricity using heat energy. Additionally, experimental research is used in this study to develop the device and its scientific design, and to collect data to support the hypothesis. Also, to fully understand the device, the researchers create a project development plan which consists planning, gathering, designing, creating the system, testing, and evaluation.

***Index Terms***

Electricity, Heat Energy, Power Generating Devices, Renewable Energy, Solar Panels

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## I. INTRODUCTION

In the study of *Renewable Energy Resources* by Ellaban et al., renewable energies are sources of energy that are always being replenished by nature. They can come directly from the sun (like thermal, photo-chemical, and photo-electric energy), indirectly from the sun (like wind, hydropower, and photosynthetic energy stored in biomass), or from other natural movements and mechanisms of the environment, like wind, water, and plants.

Today's modern world is evolving and powered by technologies which lead into a massive production, those it requires enormous source of energy. According to P.K. Haldar et al. (2015), in 2013, global energy consumption was 12,730.4 million tons' oil equivalent (Mtoe), nearly double the 1980 level of 6629.8 Mtoe.

Non-renewable resources cannot be used indefinitely since they cannot be replicated or regenerated with the same capability once exhausted. Global energy demand is expected to climb to 5 times current levels by 2100, according to projections (Sadia Ali et al., 2017). Hence, the rate of electricity is also rising. Base on *Reducing Energy Poverty* (2020) by Son and Yoon, low-income countries undergo economic development like Philippines, electricity usage is continuously increasing in both the industrial and household sectors.

What's the good news? As the renewable energy sector increases and advances, a clean energy revolution is happening. The researchers chose thermoelectricity as the source of power. So how is thermoelectric power generated? According to WatElectrical (2021), it is based on the Seebeck effect, which is a type of thermoelectric effect. A temperature gradient or temperature difference is formed between two endpoints in the Seebeck effect. The electrons flow from one end to the other when a temperature gradient is produced. The electrons at the high-temperature end of the spectrum would have a lot of energy. As a result, they begin to move in the opposite direction.

The application of research output can span in different areas and industries. It puts an advantage especially for those industries that uses coals or any kind of combustion process that provides heat to generate the thermoelectric generator. They can look forward to a device that can generate renewable energy using thermoelectric because it will definitely aid the problem in power interruption for the industrial machinery like for roast chicken machine, this will allow you to make an independent source of energy for the said machinery. Furthermore, it'll also minimize the total estimated bill every month for the household or the industrial itself.

### A. PROBLEM STATEMENT OBJECTIVES

The researchers will develop a thermoelectric device that can generate a renewable energy from waste heat energy. To finish this study, the researchers desired to answer the following problems after developing the said device:

1. What amount of wasted heat energy is required to make a device generate a renewable energy?

2. What is the effect of the device on the production in a certain business?

3. What is the reduction in terms on the electric bill of the user?

### B. SPECIFIC OBJECTIVES

The general objective of this study is to develop a thermoelectric generating device; the specific objectives are the following:

1. To design a secure alternate source of energy for continuous and efficient production.
2. To identify the amount of waste heat energy and its corresponding output voltage.
3. To evaluate the owner's insight and the reduction in their electric bill.

## C. Conceptual Framework

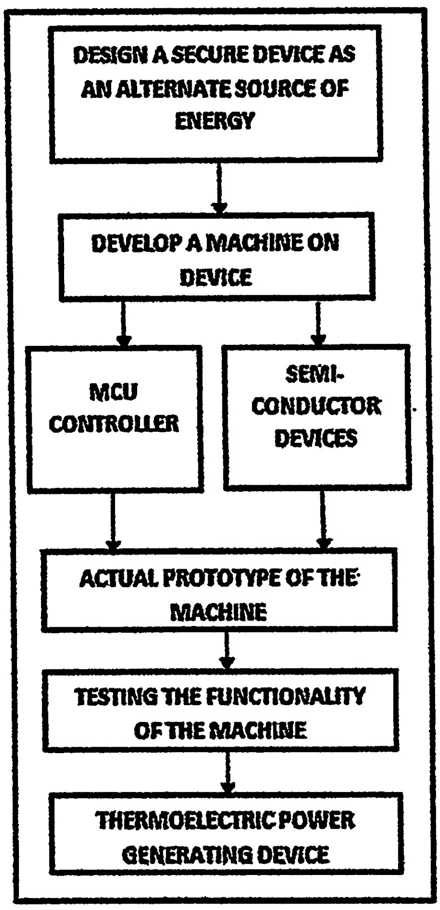



**Fig. 1.1 Conceptual Framework of the Study**

In designing a device, the researchers used an 11-plate battery as an alternative source of energy. They also used a 6000 Watts power inverter which takes on the role of inverting the power supply to provide sufficient power for the device. However, the researchers used a p-type

and n-type semiconductor which is connected in series and covered by a ceramic material which can hold a higher temperature because of its property of having a high melting point. For observing the heat index of the device, the researchers used a digital thermometer.

The current prototype of the machine uses a 0.3 HP motor and a speed controller to control the speed of the rotation of the roast chicken machine. The motor will be directly connected to the 6kW power inverter, which will provide the required power output for the 0.3 HP motor. Additionally, the researchers used p-type and n-type semiconductors for completing the design of the thermoelectric generating device, which further gives enough output power to make renewable energy that'll be stored in an 11-plate battery. Moreover, after the design of the said machinery, the researchers will directly test the functionality of the actual prototype and evaluate the level of success for the actual prototype of the Thermoelectric Generating Device.

## D. Review of Related Literature

This section presents the REVIEW LITERATURE about Renewable Energy: Thermoelectric Power Generating Device.

### 1.1 Concept of Thermoelectric Device

Based on the reaction effect, thermoelectric device materials provide a technique to transform low-quality heating energy into electrical energy. The German scientist Thomas Johann Seebeck discovered this effect in 1821, and it can be employed in a wide range of energy conversion applications. When a thermal gradient is introduced to a material, the charge carriers spread from the hot side to the cold side. An electrostatic voltage is induced as a result. A mono-electrostatic stalk's potential is very low. As a result, thermal generators often consist of tens, if not hundreds, of thermal pairs to obtain high voltage output and energy. Because their output power ranges from several watts to kilowatts, thermoelectric devices can be utilized in a wide range of energy conversion applications, from wristwatches to cars. Electrons leap from a low energy level to a higher energy level, absorbing heat from the environment and vice versa. Low to medium power and size applications benefit, whereas other conversion systems (including power plants) become less efficient when their size and power are reduced. As a result, they're interesting for low to medium power applications, particularly those that are utilized in huge numbers. The human body, for example, is a thermal source that loses heat by convection, conduction, and radiation. That's still plenty to power low-power personal devices, which typically require a power source in the W to mW range. (Fahd, Saud & Khalifa, 2016).

## 1.2 Thermoelectric Power Generator

According to (Delightus Peter et al, 2013), TEG stands for Thermoelectric Power Generator, and it is a solid-state device that converts heat energy into electrical energy. All intriguing traditional power generators transform Thermal Energy into Mechanical Energy, which is ultimately converted into Electrical Energy. As a result, there is no mechanical work here. When compared to traditional power generators, it produces less noise and no pollutants. Thermoelectric Effect (seebeck) is how TEG works. TEG produces a voltage when it is held between temperature gradients (Hot end, Cold end). This voltage is known as seebeck voltage. Modules, which are semiconductors, are available from TEG (p,n). Electrons are used as a thermoelectric power fluid here (working medium). A Module is made up of a pair of p-type and n-type semiconductors. To boost electric conductivity, these semiconductors are heavily doped with contaminants. TEG has a cover that protects modules from being damaged by high temperatures. TEG's efficiency and voltage generated are proportional to the semiconductor material and temperature gradients. As a result, semiconductors are chosen based on the material's electric conductivity, with the goal of increasing the temperature difference value. Copper electrodes connect this semiconductor. Increasing the number of modules, stages, and TEG couplings improves overall efficiency and voltage output. TEG has an exciting efficiency of 4.2 percent to 6%. When you use phases, you can enhance your efficiency by 7%.

The idea of a waste-heat thermoelectric generator has a lot of potential benefits in terms of simplicity, dependability, and safety. It appears that the successful development of new thermoelectric materials and power module designs is critical to their economic competitiveness. Reduced waste-heat thermoelectric generator costs and higher market penetration are also possibilities. In addition, the concept of a completely reversible heat engine has aided in the advancement of thermoelectric generator performance. The ideal thermoelectric generator efficiency has been considered as an upper bound for external irreversible thermoelectric generators by the engineering academic community. It is, however, a poor predictor of the efficiency of real waste-heat thermoelectric generators. Furthermore, the external reversible ideal waste-heat thermoelectric generator produces no specific power. To account for both internal and external irreversibility factors, this research proposes a true waste-heat thermoelectric generator model. This method produces a considerably more realistic forecast of generator specific power and efficiency than the ideal thermoelectric generator. (Wu, 1996).

### 1.3 The Seebeck and Peltier Effects

The thermoelectric phenomenon is the use of solid-state materials to convert heat energy into electrical energy and vice versa. A potential difference (dV) is formed between the free ends of the circuit when a temperature gradient (dT) exists between two different materials (a and b) that are in contact. The Seebeck effect is a term that describes this. The Seebeck coefficient (a) is calculated as follows:

$$(1) \qquad \alpha_{ab=}\frac{dV}{dT}$$

A current will flow if the generated dV is put across some external electrical resistance, and the Seebeck effect provides the basis for a power generation mode; the refrigeration mode is based on the reverse operation of sending a current through a thermoelectric to extract heat (Fig. 1).

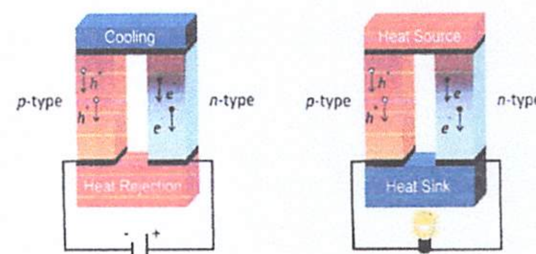
Figure 1: A illustration of the TE effect in a Peltier cooler (left) and a TE generator (right). Charge carriers flow from one end of the thermocouple to the other, carrying entropy and heat. A full device requires both n- and p-type materials.

The performance of the semiconducting materials from which a thermoelectric device is made is directly connected to its efficiency. The performance of the materials is represented by a dimensionless figure of merit, ZT, which includes the Seebeck coefficient (S), electrical conductivity (σ), and thermal conductivity (K) and can be written as:

$$(2) \qquad ZT = \frac{S^2 \sigma T}{k}$$

Charge carriers (e) and lattice vibrations (L) both contribute to heat conductivity. A significant Seebeck coefficient and low thermal conductivity, which are typical of non-metallic systems, must be paired with a high electrical conductivity, which is more commonly seen in metallic phases, to achieve good performance. As a result, S, and cannot be adjusted separately, posing a problem in the development of high-performance materials. Semiconducting materials with charge carrier densities in the range of 1019–1020 cm3 provide the optimum compromise. Device efficiency () is traditionally computed as follows (using the materials figure of merit):

**Fig. 1.3.1**




$$(3) \qquad n = \frac{T_h - T_c}{T_h}\left[\frac{\sqrt{1+ZT}-1}{\sqrt{1+ZT}+\frac{T_c}{T_h}}\right]$$

Where Th/Tc is the hot/cold junction temperature and ZT is the device's average temperature from Tc to Th. Increases in average ZT over the device's temperature range has a greater influence on efficiency than increases in maximum figure of merit of the component semiconductors. However, ZT for material and ZT for device must be distinguished (indicated by bold italic text here). They showed that for a finite temperature differential (Th Tc), the thermoelectric device ZT is given by:

$$(4) \qquad ZT = \left(\frac{T_h - T_c(1-n)}{T_h(1-n) - T_c}\right)^2 - 1$$

The temperature dependent characteristics S(T), σ(T), and K (T) between the hot and cold sides are used to compute maximum efficiency.(Freer & Powell, 2020)

### 1.4 Theory and Generic Model of a Thermoelectric Generating System.

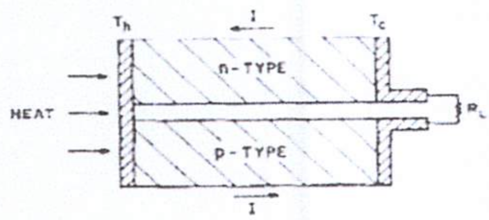



**Fig. 1.4.1 Thermocouple as power generator.**

According to (Rosi, 1968), Figure 1 graphically depicts the circuit for a basic power generating thermocouple. It involves the joining of two different materials, such as an n-type and p-type semiconductor, at their ends by a metallic conductor with higher thermal and electrical conductivities than the branch materials. The hot junction receives heat from an external source at temperature TH, while the other junction is kept at a constant lower temperature, TC. A current, I, runs through the branches as a result of the temperature differential, TH- TC, as represented by the arrows. The configuration in Fig. 1 shows a direct conversion of heat into electrical energy with conversion efficiency, Φ, by allowing current to flow through an external load resistor, RL, added into the circuit between the cold junctions, given by:

$$(5) \qquad \emptyset = \frac{power\ supplied\ to\ load}{heat\ absorbed\ at\ hot\ junction}$$

A TE (Thermoelectric) system, in general, is made up of numerous thermal masses that store and exchange heat via conduction and/or convection. Inside the TE device and/or additional elements, such as electrical heaters, heat is partially transferred to or from electricity. To ensure optimal performance, the thermal connectivity of the TE device with the rest of the system must be designed properly.

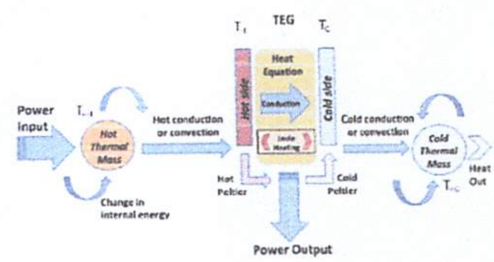



**Fig. 1.4.2 Architecture of a thermoelectric power generating system.**

The architecture of a generic TE power generating system is shown in Figure 2. On both the hot and cold sides, the TEG is usually in touch with a thermal mass. Electrical or heat power is applied to or removed from the thermal masses, resulting in changes in the thermal energy stored within the thermal masses.

A portion of this energy is transported to and from the TEG module via conduction or convection. The sides of the TEG are modelled separately from the inner half of the TEG. Inside the TEG, the heat equation (HE) deals with both heat conduction and generation (Joule heating). Additional heat is brought in from the sides where two dissimilar materials meet (Peltier effect). The process is closely related to the thermoelectric effects described by Equations 1 and 2. A portion of the energy flowing through the TEG is transformed into electrical power. (Montecucco & Knox, 2014)

$$(1) \qquad V_{OC} = \alpha \Delta T$$

$$(2) \quad P_P = \pi I = \alpha I T_j$$

## II. RESEARCH METHODS

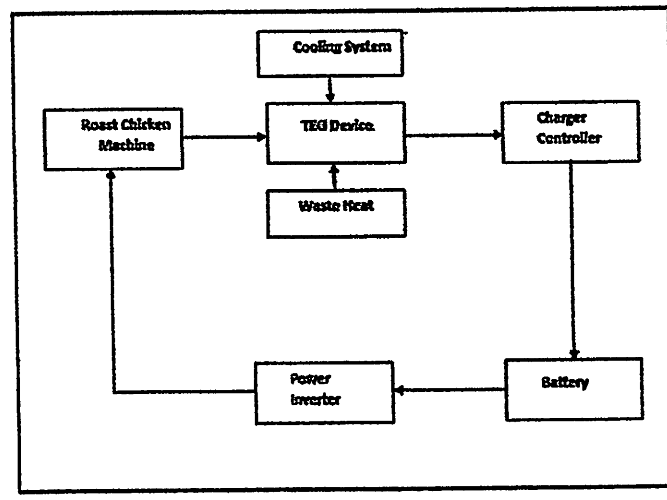
### A. RESEARCH DESIGN

In this project, the researchers are going to use an experimental research study. Experimental research is a study that strictly adheres to a scientific research design. It includes a researcher and variables that can be measured, calculated and compared. The researcher collects data and results will either support or reject the prototype.

Firstly, the researchers are going to use a p-type and n-type semiconductor pellets which is connected electrically in series and thermally in parallel and we'll covered it with a ceramics plate material for the durability of the device while absorbing the heat from the combustion in the roast chicken machine. The researchers will also use a heat sink which is place behind of the hot side of the thermoelectric generator to redirect the heat which is provided by the roast chicken machine.

Furthermore, a 6000 Watts power inverter and 11 plates rechargeable battery is also needed for the purpose of an independent power source of the roast chicken machine. The role of the thermoelectric generator device is to provide a renewable energy for the rechargeable battery for the purpose of sustaining the power that is needed for the consumption of the roast chicken machine.

### B. PROJECT DESIGN




**Project Design of the Actual Prototype**

**Fig. 2.1**

Figure 2.1 shows the diagram of how the Renewable Energy: Thermoelectric Generating Device works; while the Roast Chicken Machine is operating and while producing an efficient heat to generate the thermoelectric generating device, the diagram itself explains that heat produced will be directed into the heat sink and absorbed by the thermoelectric generator and triggers the semiconductors to create a Seebeck effect that produced an output voltage that will be stored in a rechargeable 11plates battery while at the same time, it also supplies the power needed for the roast chicken machine to operate and by using the 6kW Power Inverter, the stored power in the battery will be enough for the roast chicken machine to operate.

C. **PROJECT DEVELOPMENT**


**Fig. 2.2 ADDIE MODEL:**

ADDIE is a standard procedure and method used by instructional designers and training creators. The model's phases include analysis, design, development, implementation, and evaluation. In the present era, ADDIE is considered the most commonly implemented model for instructional design. The researchers first made a brainstorming analysis and makes an examining and articulating of the study's problem. The researchers then make a design of the proposal then further make a development, Implementation and evaluation of the actual finished prototype.

D. **PROJECT EVALUATION**

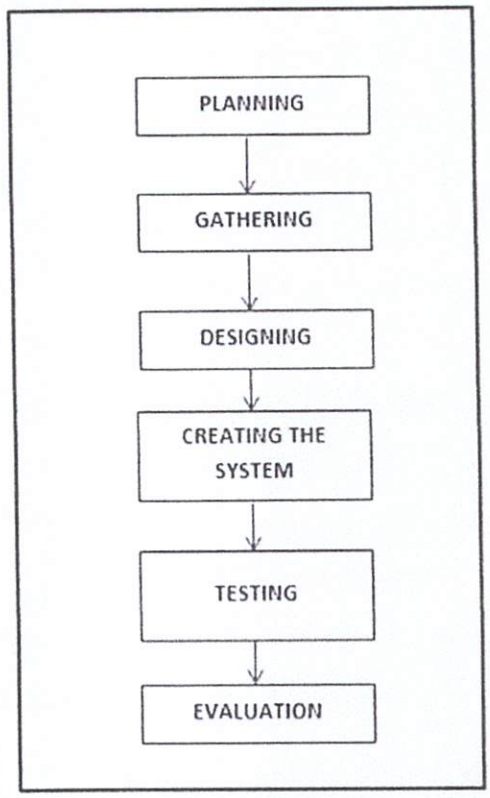



**Fig. 2.3 Project Evaluation of the Proposal**

**Fig. 2.3**

It shows the diagram flow of the general overview of the gathered data. Firstly, the researchers planned the study and gather all the needed information and designed the device that will be created by the researchers. Furthermore, when the prototype is done, the researchers will test and analyze its application. Thus, the researchers will able to evaluate the efficiency and the effectiveness of the project.

D. **PARTICIPANTS OF THE STUDY**

The researchers will present a video presentation during the testing of the mini prototype to the ten selected roast chicken machinery owners. Furthermore, the researchers will collect their insights and opinion about the proposed concept and the prototype itself. The response of the respondents will be evaluated and will be considered for the development of the project.

## E. INSTRUMENTS

1. *TEG Module* - Small and lightweight, convenient for use. Designed specifically for power generation when there is applied heat on it's hot side and cooling in it's cold side. It is a connection of p-type and n-type semiconductor connected alternately.
2. *Heat sink* - a component that increases the heat flow away from a hot device or surrounding.
3. *Cooling System* – a device that can produce cold temperature.
4. *11 Plates Battery* - Used as an alternative source for the roast chicken machine to operate. Serves as a storage device where the power generated from the TEG module is stored.
5. *Power inverter* - A device used to invert the power output of the battery to be able to run a 0.3 HP 220 V AC electric motor of the roast chicken machine.
6. *MCU Controller* – Used as a controller device to regulate the output voltage that the TEG module produced and a device used in charging the rechargeable battery.
7. *Analog Multi-tester* – A device used to monitor the output voltage that the TEG module produced.
8. *Thermometer* – A device used to monitor the temperature that the TEG module produced.

## III. RESULTS AND DISCUSSION

This chapter provides the discussion of results for this study. The researchers will use table and diagram to present the results.

### 3.1 DESIGN OF THE ACTUAL DEVICE

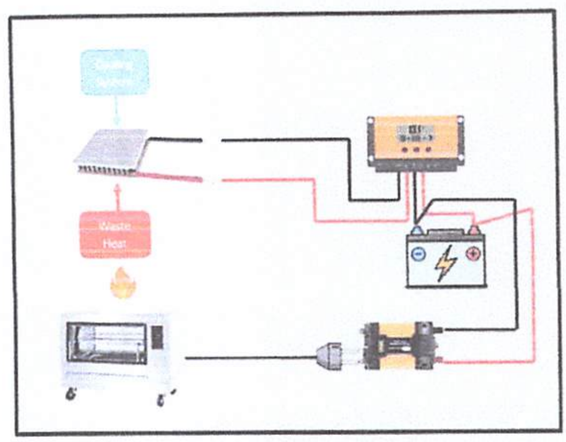


**Fig. 3.1.1: Schematic Diagram**

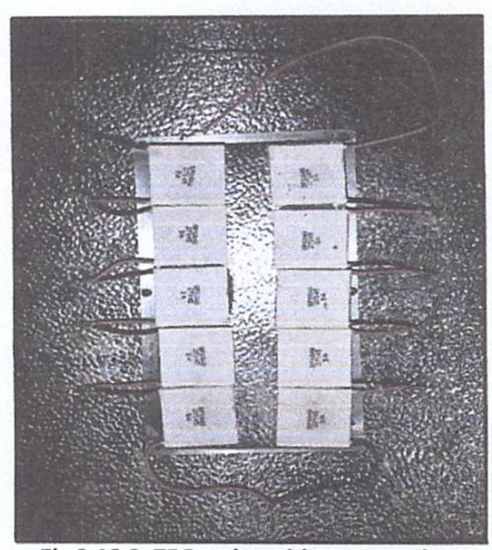


**Fig 3.12.2: TEG series wiring connection**

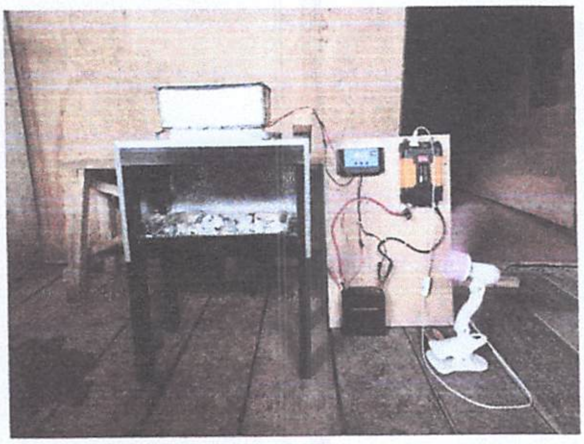


Fig. 3.1.3: Picture Diagram of the Finished Device

## 3.2 AMOUNT OF HEAT AND ITS OUPUT VOLTAGE

**Heat Index**

| No. of Trial | Heat Index | Cooling Temp. | Voltage Produced |
|---|---|---|---|
| 1 | at 50C° | at 0C° | 0.8 Volts |
| 2 | at 100C° | at 0C° | 1.4 Volts |
| 3 | at 150C° | at 0C° | 2.1 Volts |

**Table 1: Shows how much volts can be produced by a single TEG module at a specific heat index.**

| No. of Trial | Heat Index | Cooling Temp. | Voltage Produced |
|---|---|---|---|
| 1 | at 50C° | at 0C° | 6.4 Volts |
| 2 | at 100C° | at 0C° | 11.2 Volts |
| 3 | at 150C° | at 0C° | 16.8 Volts |

**Table 2. Shows how much volts can be produced by 10 TEG module (in series) at a specific heat index.**

**Operation**

| Heat Index | Cooking duration (min.) | No. of TEG module needed to supply the battery | 11 Plates Battery Capacity (32Ah), Duration of battery to supply a 1.5 A to the machine |
|---|---|---|---|
| at 50C° | 24-28 min. | A parallel connection of a series of 8 TEG module (14V) producing 1 Ampere | 21.333 hrs. |
| at 100C° | 20-24 min. | A parallel connection of a series of 8 TEG module (14V) producing 1 Ampere | 21.333 hrs. |
| at 150C° | 16-20 min. | A parallel connection of a series of 8 TEG module (14V) producing 1 Ampere | 21.333 hrs. |

**Table 3. Shows the duration of how long the battery can supply the roast chicken machine and also shows it's cooking duration as well.**

*11 plates battery charge capacity = 32Ah ; Current output for the roast chicken machine to run= 1.5A*

$Q = TA$

$Q\ (charge\ capacity)\ in\ Ah$

$A\ in\ amperes$

$T\ in\ hours$

$$T = \frac{Q}{A}$$

$$T = \frac{32}{1.5}$$

$$= 21.333\ hrs.$$

There will be an evaluation of the TEG module to determine the maximum voltage that the TEG could provide. Specifically, a single TEG can produced a peak voltage of 1.9 V at 150° C as shown in Tab. 1. However, a battery is a 12V DC supply, so a series of 8 TEG module is much needed to meet up with the voltage needed for the battery to recharge. As shown in Tab. 3, a series of 8 TEG module can produced a voltage of 16.8 V which is sufficient enough for the battery to recharge. The 11 plates battery has the capacity of 32Ah and the electric motor has a power output of 0.3 HP 220V AC 60Hz, as shown in Tab. 3. At a current supplied by the battery through inverter to run the roast chicken machine is approximately 1.5 A, so the battery can definitely supply the roast chicken machine for up to 21.333 hrs.

### 3.3 EVALUATION OF THE OWNER'S INSIGHT AND THE ELECTRIC'S BILL REDUCTION

**Owner's Rating**

| Ratings | No. of Participants (n = 10) | % of involvement |
|---|---|---|
| Satisfied | 8 | 80% |
| Dissatisfied | 2 | 20% |

**Table 4. Shows the rating of the ten selected roast chicken machinery owners.**

**Owner's Bill Reduction**

| HP | Watt | Monthly Total kWh (12 hrs. of usage) | kWh rate in PHP | Total Cost per Month |
|---|---|---|---|---|
| 0.3 | 223.71 W | 80.5356 kWh | 11 PHP | 885.89 PHP |

**Table 5. Shows the total cost of potential reduction of the owner's bill if the device will be use.**

$$\text{kWh} = \frac{watts \times time\ (hrs)}{1000}$$

$$= \frac{223.71 \times 12 \times 30}{1000}$$

$$= 80.5356\ \text{kWh}$$

$$\text{Total Cost Reduction} = 80.5356 \times 11$$

$$= 885.89\ PHP$$

Based on the provided data. It shows in table 4 that 8 out of 10 participants are satisfied and have optimistic perception that this device can give advantages in operating their business. While 2 out of 10 participants are doubted due to some concerns including high-cost, maintenance and the design may not suitable to their roast chicken machine. But overall, the satisfaction percentage of participants is above average. Meanwhile, in table 5, the researchers will able to calculate the total cost of potential reduction of the owner's bill with the used of Kwh formula.

## IV. CONCLUSIONS AND RECOMMENDATIONS

### A. CONCLUSIONS

Heat energy is a type of energy that can be transferred from one particle to another in a substance by utilizing the kinetic energy of the particles in question. In other words, according to the kinetic theory heat is transferred when particles collide with each other and bounce off. Heat is everywhere and can be transferred through three processes known as conduction, convection, and radiation. For the past decades, heat is already discovered as a source of energy or known as one of a renewable energy source. Even so, heat from the other heat sources are being neglected which will turn it into a waste heat. Specifically, heat from the roast chicken machine are one of the heat source that are being neglected so the researchers make a conclusion on how to take an action for the waste heat to be an independent source of energy for the device itself. The researchers then make a design of the actual prototype of the roast chicken machinery with a series connection of TEG module on top of it and a number of trials on it had followed after the device was finally finished. Furthermore, the researchers make simple a presentation for the roast chicken machine owners and rate their satisfaction and their perspective about the actual device. In conclusion, the thermoelectric power generating device were perceived by the participants as acceptable as more than half of the participants are satisfied with 80% of rating. To some it up, the researchers had finally make the study successfully and the device were actually functioning that corresponds with the theory that is stated in the research proposal.

### RECOMMENDATION

Based on the research's findings acquired, the following recommendations are given:

1. To use a cooling system with a monitoring system for its temperature being monitored from freezing point down to the negative degree Celsius Temperature.
2. To use more number of TEG for an efficient charging output that will be sufficient to supply the rechargeable battery and the roast chicken machine.
3. For a fast charging duration in recharging the battery, make a parallel connection of TEG modules that are connected in series and measure it using ammeter to monitor the output current that the TEG module produced.

## V. ACKNOWLEDGEMENT

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Finally, our thanks to all the people who have supported us to complete the research directly or indirectly.

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# Design and Implementation of Controllable Flood Light System in the Municipality of Sison Gymnasium

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***Abstract:*** The design of floodlight system intended to Sison Municipal Gymnasium…

***Keywords***: Current, Diode, lux, Microcontroller, Voltage

## I. INTRODUCTION

Flood light is a type of artificial luminaire that emit a broad beam of light in a designated area. As the name signifies, flood lights are used to enormously to flood a large area with light whether it is indoor or outdoor. A great quote from the Futurama TV show states that if you always do things right, people will not notice that you have done anything at all. This wisdom of words applies to the little things that people ignore. In the sporting world, lighting is one of those little things. [1]

Sports participation fulfills an important social functions among children, adolescents and adults. In a large number of countries, the number of sports facilities has grown over the last two decades, both in the public and private domain. Proper lighting system for multipurpose facilities like gymnasium is an important aspect that must be complied in order to give comfort and safety to the facility users. That there are circumstances that a gymnasium holds an event that doesn't need a high intensity used of lighting. [2]

The design and implementation of floodlight system intended to Sison Municipal Gymnasium is important to provide a standard and controllable lighting system for the gymnasium users. Thus, the researchers intend to design a flood light system that the output light intensity can be controlled. For the purpose of energy saving, long term efficiency usage, semi-automation, and better mode setting.

***Related Literature***

In this section review some existing literature concerning Design and Implementation of Controllable Flood Light System.

The lighting system in a sports facility should ensure good visual conditions for players, athletes, referees, spectators, and (if present) for TV shots. To achieve adequate lighting conditions is necessary to optimize the perception of visual information during the performance of sports events, maintaining the correct levels of visual performance and provide an acceptable level of visual comfort. The lighting requirements for indoor sports facilities are specified in Europe, in the Technical Standard EN 12193. In addition to the lighting requirements, it is important also a verification of the photobiological safety and the health effects of the lighting sources, to whose emissions the athletes can be exposed for several hours a day in accordance to what should be done for other environments intended for the permanence of people. [3]

***Conceptual Framework***

The following figure shows the input-process-output diagram of the study.

| INPUT | PROCESS | OUTPUT |
|---|---|---|
| LED flood light | Planning | Design and Implementation of |
| Microcontroller board | Development | Flood Light System in the |
| Step-up boost voltage converter | System Design | Municipality of Sison Gymnasium |
| Sensor | System Analysis | |
| | Testing | |
| | Implementation | |

The overall goal of this study is to design and build a flood light system that the output light can be controlled using buttons.

***Objectives***

The specific objective of this study is the following:

1. To design a controllable floodlight system.
2. To implement the design.
3. To solve the improper illuminance of floodlighting.
4. To come up a reliable system that would met the end-user requirements.
5. To reduce power consumption.

## II. METHODS

This chapter presents the methodology of the study. The entire timeline used for the development and designing of floodlights can be divided in five primary stages, namely; Planning, Data gathering, Research locale, Data collection, System reliability, Loading analysis, grounding system design, Designing, Assembly, and Testing.

### 2.1 Planning

The researchers will come up with the electrical floor plan including the materials to be use like brands, quality, stability, and cost efficient. The Planning process involved the exchange of ideas among the proponents. During this stage the following questions were brought up:

1) What project would best implement the fundamental concepts that Research design built on?
2) How can we maximize the proponents' limited resources? without sacrificing the quality of the final project output?

## 2.2 Designing

After the planning process came the Design of the actual project. This involved creating the layout of the gymnasium that they could accommodate. After creating the general layout of the interior, the circuits to be used were created. The systems used for the circuit included an several flood lights. The design process for installing of floodlights to satisfy a set of requirements that have multiple solutions by using any available resources. In essentially all cases, the final design must be completed at a profit or within a budget. The researchers should work sequentially from step to step but should review previous steps periodically and rework them if a new approach comes to mind during the process.

The Design and implementation of controllable floodlight system in the Municipality of Sison gymnasium is employed to serve the following purpose.

➢ Aesthetic Floodlighting

✓ For enhancing beauty of the gymnasium at night on important festive occasions, events, etc.

✓ For illuminating the Municipal gymnasium using controllable floodlights.

## 2.3. Research locale

The Design and implementation of controllable floodlight system in gymnasium is situated at the Municipality of Sison, Surigao Del Norte, Philippines. It is near the heart of the municipality as shown in figure 3.1.

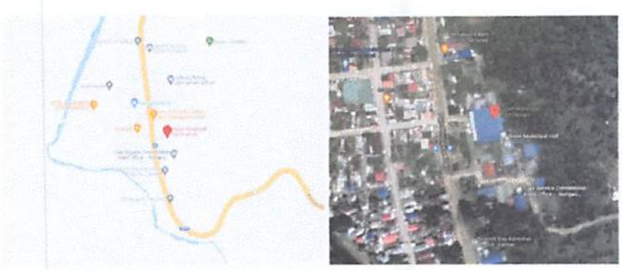


Figure 3.1 Map of Municipality gymnasium

This floodlighting designs necessary to concentrate the light from the light source into a relatively narrow beam. The particular type of reflector and its housing used for concentrating the light into narrow beam is known as floodlight projector. Since it is usually installed in remote positions, therefore, it must be robust and weatherproof in construction. The reflecting surface is the most important part in a projector. This may be made of silvered glass or chromium plate or stainless steel; the efficiency of silvered glass is about 90% while that of polished metal is only about 70%. Metal reflectors being more robust are usually preferred. The casing and its mounting are arranged so that the inclination of the beam can be varied in both a vertical and a horizontal direction on site. For permanent installations use of cast-metal cases is made to achieve robustness and protection against weather and for temporary installations or those in sheltered situations, use of sheet metal casing is made. When 500 or 1,000-watt lamps are used in projectors, ventilation may have to be provided for adequate cooling. This may be achieved by providing sufficient radiating surface. The front of the projector is usually of clear glass, often bowed outwards to protect it from the heat of the lamp; use of diffusing glass is made when a diffuse beam is required. As far as possible the projectors should not be visible to the passers-by. In some cases, the projectors may be housed in ornamental stand standards.

## 2.4. Data collection

The researchers will install a desire floodlight that can illuminate the whole gymnasium during needed time and all requirements are all in accordance to Philippine Electrical Code (PEC). Projectors are classified according to the beam spread, Location and mounting of floodlights, Floodlighting calculations, etc.

The researchers will gather data to come up with this project. After the design process has been completed, the proponents proceed to gather the data necessary for completing the project. First, the researchers gathered measurements of the gymnasium and measured the area. Interpretation of the findings of the study is limited to the data gathered through the quasiexperiment conducted, the test used and the statistical treatment employed.

The data gathering procedure is summarized in the following flowchart:

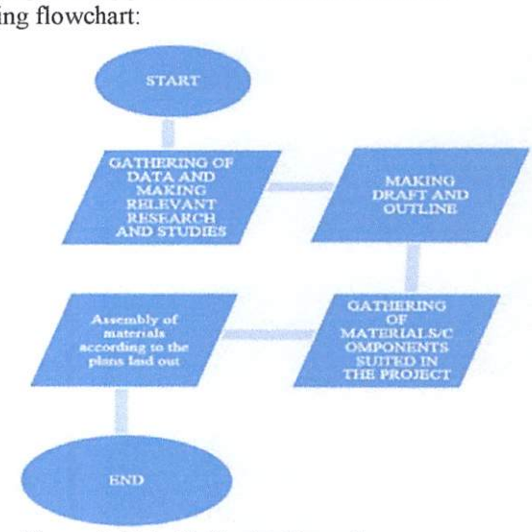
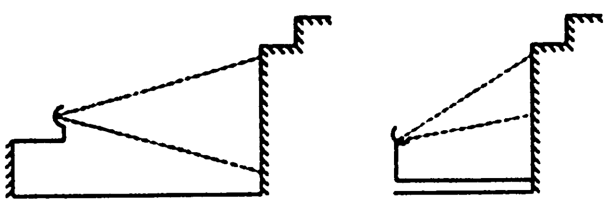



Figure 1: Data Gathering Procedure

Location and mounting of floodlights:
One of the most important factors which affects the choice of projector is the location of the projector. There are two possible locations of projectors in practice. Fig. 7.52 (a) shows symmetric projector kept 20 to 35 meters away from the surface to be floodlighted and providing approximately parallel beam having beam spread of 25° to 30°. Fig. 7.52 (b) shows the case when the projector cannot be located away from the building. In such a case, an unsymmetrical reflector mounted in a basement area or on a bracket attached to the building is used which directs more intense light towards the top of the building.



(a) (b)

Fig. 7.52

Floodlighting Calculations:
The problem of flood-lighting calculations may be roughly separated into three steps.

First Step: Illumination Level Required.
The illumination level (lumens/m) required depends upon the type of building, the purpose of the floodlighting, the amount of conflicting light in the vicinity etc.

Typical figures are given below:

| Building Surfaces | Reflection Factor | Lux Recommended For Brightness of Locality | | |
|---|---|---|---|---|
| | | Low | Medium | High |
| White terra cotta | 60—80 | 50 | 100 | 150 |
| Cream terra cotta | | | | |
| Light marble | | | | |
| Light gray lime stone | 40—60 | 70 | 120 | 200 |
| Bed Ford lime stone | | | | |
| Buff lime stone | | | | |
| Smooth buff face brick | | | | |
| Briar hill sand stone | 20—40 | 100 | 150 | 250 |
| Smooth gray brick | | | | |
| Medium gray lime stone | | | | |
| Common tan brick | | | | |
| Dark field gray brick | 10—20 | 120 | 180 | 300 |
| Common red brick | | | | |
| Brown stone | | | | |

Second Step: Type of Projector.
Two considerations enter into the choice of a projector, viz., beam size and light output. The former determines the area covered by the beam and the latter the illumination provided. Beam angle of the projector is decided keeping in view the distance of projector from the surface.

Third Step: Number of Projectors.
For any desired intensity over a definite surface the number of projectors required is obtained from the following relation:

$$N = \frac{A \times E \times \text{depreciation factor} \times \text{waste factor}}{\text{Utilization factor} \times \text{wattage of lamp} \times \text{Luminous efficiency of lamp}}$$

Where,
N = Number of projectors
A = Area of surface to be illuminated in square meters
E = Illumination level required in lumens/m2

***Calculations for Floodlighting:***
The terms used in flood lighting calculations are described below:

1. Waste Light Factor:

Whenever a surface is illuminated by a number of light sources, there is always a certain amount of waste light on account of overlapping and falling of light beyond the edges of the area to be illuminated. This effect is taken into account by multiplying the theoretical value of lumens required by 1.2 for rectangular areas and 1.5 for irregular areas and objects such as statues and monuments etc.

2. Depreciation Factor:

Dirt and dust depositing on the reflectors surface and on the source of light reduces the effectiveness of the projector and 50 to 100 percent lighter must be provided so that the illumination shall be adequate at the end of the interval between the cleaning periods. Depreciation factor is defined as the ratio of illumination under ideal conditions to the illumination under normal conditions.

3. Coefficient of Utilization:

It is also known as beam factor and is defined as the ratio of beam lumens to the lamp lumens. Its value lies between 0.3 and 0.5. This factor is due to the fact that all the light emitted by the projector is not along the direction of the beam but some of it is absorbed by the reflector and by the front glass. When the above losses are considerable the value of utilization is low. The coefficient of utilization factor goes up with deep reflectors having a good reflecting surface, such as silvered glass.

**2.5. Data collection**

One of the important tasks of the project is to accurately forecast the future demand requirement of the load. The total energy estimated where the floodlights being installed will be connected was forecasted to 3 years.

**2.6. System reliability**
Reliability assessment here is focused on the Surigao city gymnasium where the project is located.

**2.7. Loading Analysis**
It contains electrical information of electrical equipment such as transformers, instrument transformers, power circuit breakers, relays, voltage ratings, configurations, etc.

**2.8. Grounding system design**
The main purpose for this calculation is to design the appropriate grounding in the system. There are a lot of things considered in the design such as the, conductor sizing. These are all essential to secure that the grounding design is safe for the project and all the public.

**2.9. Designing**
After the planning process came the design of the actual project. This involved creating the layout of the gymnasium that they could accommodate. After creating the general layout of the area, the circuits to be used were created. The systems used for the circuit included an several flood lights. The design process for installing of floodlights with controls to satisfy a set of requirements that has multiple solutions by using any available resources. In essentially all cases, the final design must be completed at a profit or within a budget. The researchers should work sequentially from step to step but should review previous steps periodically and rework them if a new approach comes to mind during the process.

**2.9. Assembly**
The researchers will install a desire floodlight that can illuminate the whole gymnasium.

**2.10. Testing**
The researchers will test the results of the project.

***Participants of the Study***
The project beneficiaries, which includes the people of Municipality of Sison, primarily the Sison LGU is the major participant in this project research. An Electrical and Computer Engineer is required to assist the researchers in conducting this project study and ensuring that the project is properly implemented. Also needed are researchers who can study and design the product or technology.

## III. RESULTS AND RECOMMENDATIONS

**Conclusions**
**Recommendations**

## IV. ACKNOWLEDGEMENTS

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