Design and Development of Dry Waste Management System for Electricity Generation

Bhoomika K C
UG Student , Department of ECE,
BGS Institute of Technology
Adichunchanagiri University
BG Nagara, Mandya District, INDIA
bhoomikakc2003@gmail.com

Dr. Naveen K B
Professor, Department of ECE,   ,
BGS Institute of Technology
Adichunchanagiri University
BG Nagara, Mandya District, INDIA
naveenkb@bgsit.ac.in

Gaurav S
UG Student, Department of ECE,
BGS Institute of Technology
Adichunchanagiri University
BG Nagara, Mandya District, INDIA
gagangaaurav@gmail.com

Poornesh Kumar B
UG Student, Department of ECE, BGS
Institute of Technology
Adichunchanagiri University
BG Nagara, Mandya District, INDIA
poorneshappu02@gmail.com

Abstract—**The rise of the waste will be the bigger issue of all over the world. The majority of the waste will normally dump to fill the lands, this will become the major issue and creates the environmental issues in surroundings. To overcome this, we placed an idea in this project initially to segregate dry waste and wet waste automatically in view of minimizing the man power. In this project microcontroller will acts as a central unit of the system. The sensors are used to identify dry waste and wet waste. In our work, we consider dry waste like paper, wood, plastic etc., and send to the heat chamber and then after burning, heat energy is converted into electrical energy using thermos electric generator. The investigations are carried out by different finite elements to analyze the electricity generation w.r.t temperature variation in the system. The best part of this prototype system is not only reducing the waste but also generates electricity.**

Keywords— Composting, incineration, Microcontroller, Dry Waste, Wet Waste, thermoelectric generator

I. INTRODUCTION

The Global population and urbanization continue to rise, the generation of waste has reached unprecedented levels, strained existing waste management systems and posed significant threats to the environment, public health, and the overall quality of life. Waste includes a wide range of materials, from organic matter and recyclables to hazardous and non-recyclable waste. Traditional waste management practices, such as landfilling and open burning, have been insufficient in addressing the growing problem, leading to pollution, resource wastage, and an urgent need for innovative solutions.

This project is motivated by the necessity to evolve waste management strategies and find sustainable solutions to mitigate the negative impacts of waste on our environment and society. In particular, the project focuses on an integrated waste segregation and energy generation system. The primary objective is to segregate waste into two distinct categories i.e, Dry waste and Wet waste. wet waste, which is earmarked for composting, and dry waste which undergoes a moisture removal process using a specially designed heat chamber. Subsequently [1], the dried waste is incinerated, and the heat generated during incineration is harnessed by a thermoelectric generator module, converting it into electricity. This approach addresses multiple environmental challenges simultaneously, offering a more sustainable and eco-friendly approach to waste management.

Thermoelectric generators are solid-state devices with no moving parts. They are silent, reliable, and scalable, making them ideal for small, distributed power generation, and energy harvesting [2]. A sandwiched shape device which can convert heat energy into electrical energy can be the fundamental introduction of Peltier modules. Working on both the See beck effect and the Peltier effect, Peltier modules have the ability to generate voltages or to provide heating or cooling depending on the need of the user [3].

This project innovatively combines waste segregation, moisture removal, incineration, and energy generation. Using advanced technology like the ATmega328P microcontroller and sensors [4], it sorts waste into wet and dry categories. Dry waste undergoes moisture removal and sanitization in a heat chamber [5], enhancing its quality for efficient incineration. The incineration process not only disposes of waste but also generates heat, by using thermoelectric generator to produce electricity. This sustainable energy can power the system, feed into local grids, or support off-grid applications follow.

II. METHODOLOGY

The Overview of the waste segregation process is a pivotal aspect of this project. It leverages an ATmega328P microcontroller and various sensors are integrated into the system to evaluate waste's moisture content. These sensors feed data to the ATmega328P, which processes the information to classify the wet waste or dry waste [6]. Moisture removal is a crucial step for processing dry waste for incineration. To achieve this, a dedicated heat chamber is designed and implemented. Thermoelectric Generator Module is integrated into the incineration chamber. It utilizes the temperature gradient generated during the combustion process to convert heat into electricity [7]. The electricity produced is harnessed for various applications, promoting sustainable energy

generation and thus the energy generated is completely depend on heat generated in the heat chamber

A. The Framework of the waste segregationsystem

The Block diagram shows the waste segregation process, the central control unit is an ATMEGA328P microcontroller. Several sensors are used in sensor-based categorization to evaluate the colour, moisture level, and composition of the waste.
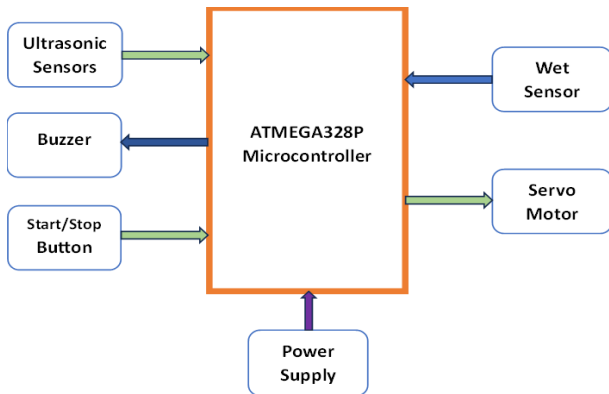
By processing sensor data, the microcontroller can discriminate between dry and moist garbage. The garbage is then separated into various groups by mechanical sorting on a conveyor belt fitted with sorting machines. By ensuring effective segregation, this integrated strategy improves waste management and recycling procedures [8]. This waste management system is important because it combines sensor technology with mechanical sorting to maximize resource usage and reduce environmental impact..
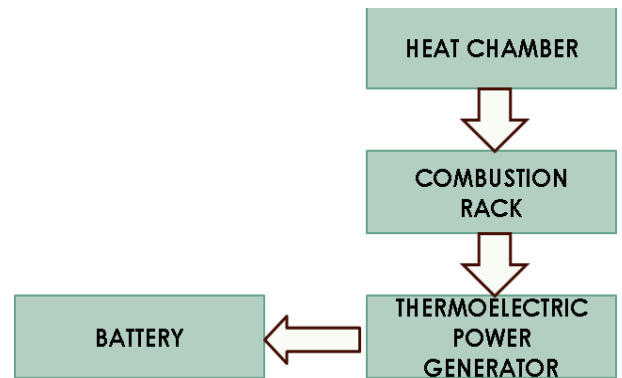

Fig. 1.   Block diagram of waste segregation

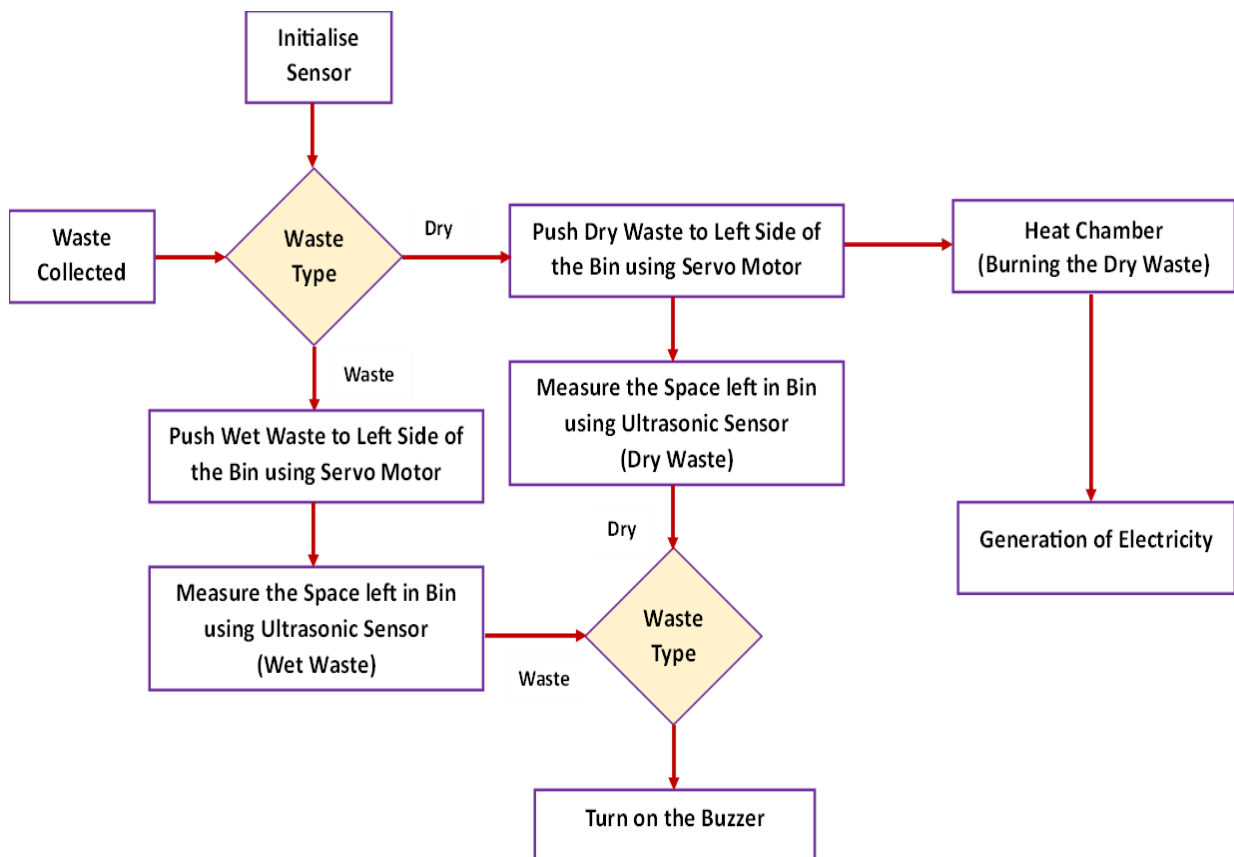Fig. 2.   Block diagram of Power Generation

Fig. 3. Flow diagram of the working system

B. Working system

Waste Segregation is the cornerstone of our project methodology, aiming to efficiently sort waste materials. Central to this process is the utilization of an ATmega328P microcontroller, which orchestrates the entire procedure. Various sensors are deployed to assess key characteristics of the waste, including moisture levels, colour, and composition. Based on the data collected, the ATmega328P autonomously classifies the waste into two primary categories: wet and dry. Once categorized, the waste is conveyed along a designated conveyor belt equipped with mechanical sorting mechanisms. These mechanisms physically separate the waste into distinct wet and dry sections, ensuring efficient segregation.

Moisture Removal is a critical step, particularly for dry waste destined for incineration. To achieve this, we've developed a specialized heat chamber equipped with advanced features. This chamber is designed with meticulous attention to detail, incorporating temperature control systems, ventilation mechanisms, and safety protocols to facilitate smooth operations. Inside the chamber, a controlled heating element and monitoring system work in tandem to maintain optimal drying conditions [9]. Dry waste is fed into this chamber, subjected to a carefully regulated temperature and time regimen. This controlled environment facilitates the removal of moisture from the waste, rendering it suitable for subsequent processing [10].

Waste Incineration and Energy Generation mark the culmination of our project's methodology. Once the waste has been effectively dried, it undergoes incineration in a specially constructed chamber [11]. This chamber is engineered to meticulously control the combustion process, ensuring complete and efficient burning of the waste materials. However, our approach doesn't stop there. We've integrated a sophisticated device known as a thermoelectric generator module into the incineration chamber. This innovative module harnesses the temperature gradient generated during combustion to convert heat energy into electricity [12]. The electricity produced can then be harnessed for a variety of applications, contributing to sustainable energy generation and utilization.

III. RESULTS AND DISCUSSIONS

This figure 4 shows the Arduino connection of Waste segregation system, all the sensors and servo motor connected to the Arduino.
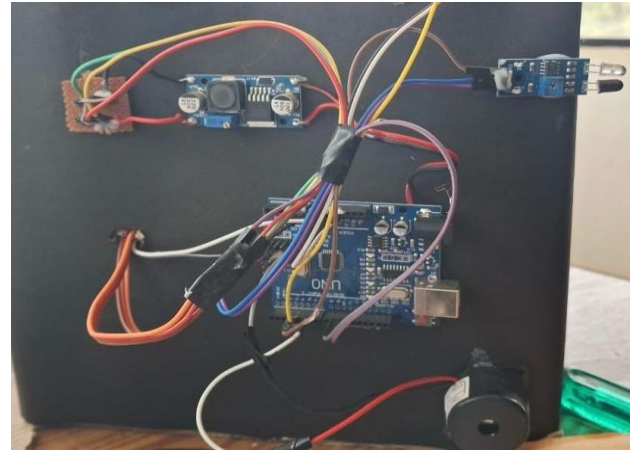

Fig. 4. Flow diagram of the working system

Fig. 4. Aduino Board Connection of the waste segregation system

In this circuit connection, the power supply of 8V is given to the Arduino through Arduino jack the bug converter step down the voltage to 5V,IR sensor is used to detect the person and it will open the dustbin IR sensor has 2 pins 5V ground and signal pin which is connected to the pin2 and pin3 of Arduino, Buzzer is used to detect the level of the dustbin which is connected to pin 4 of Arduino, then we have metal sensor which is basically Dry or wet sensor the one pin of the sensor connected to the ground and other is connected to the analog pin when we place the wet thing it will conduct pin will read it and based on that it will decide whether its dry waste or wet waste, the servo motor is connected to the pin 9 and pin 10.
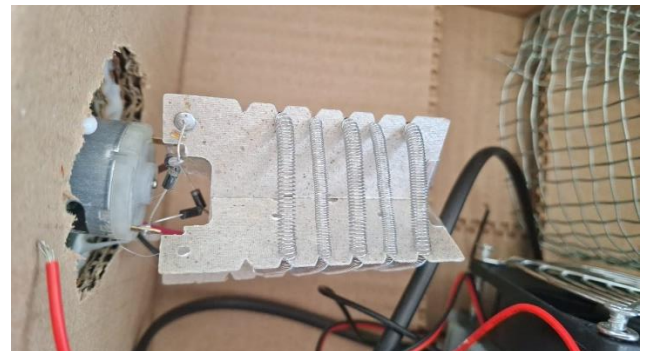

Fig. 4. Heating coil in the working system

Here it is a heater coil, this heater coil removes the extra moisture from the segregated dry waste to make it even more dryer so that it will burn easily, this heater coil produces the heat up to 140 degree Fahrenheit.
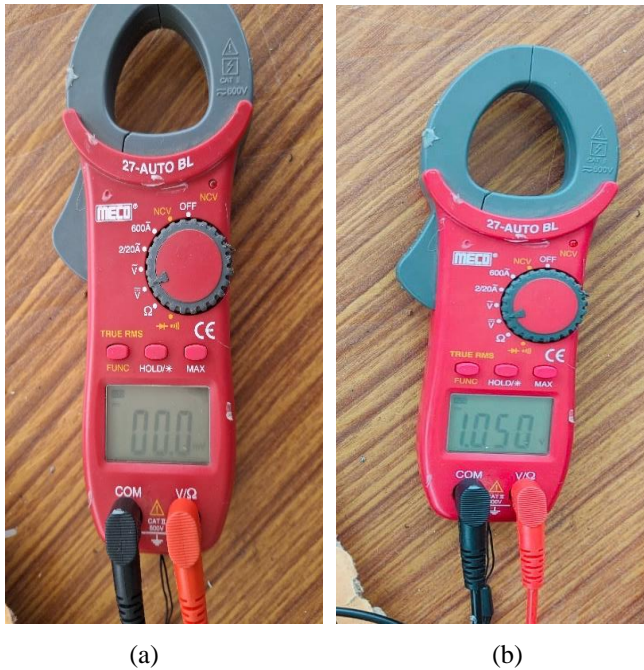
(a)   (b)

Fig.5 . This figure (a) shows before reading and figure (b) after reading of the peltier model in volts.

The amount of voltage produced by the Peltier model after burning of some waste which is 1.05volts, this is the result of single Peltier model, to generate more amount of electricity we need multiple models.

IV. CONCLUSION

The Integrated waste segregation and energy generation project presents a transformative approach to address the pressing global challenges of waste management and energy sustainability. By leveraging advanced technologies such as the ATmega328P microcontroller, sensors, and thermoelectric generator modules, the system efficiently segregates waste into wet and dry components. The specially designed heat chamber ensures optimal moisture removal from dry waste, enhancing the quality of materials for incineration. The innovative aspect lies in harnessing the heat generated during incineration to produce clean electricity. This holistic solution not only mitigates environmental pollution, health risks, and resource depletion associated with improper waste disposal but also contributes to a sustainable circular economy. The project's applications span urban areas, industrial facilities, and community initiatives, making it a versatile and scalable solution for a cleaner, more resource-efficient, and eco-friendly future. Overall, this project represents a significant stride towards redefining waste as a valuable resource and advancing the paradigm of sustainable waste management.

REFERENCES

[1] Dr.S S P M Sharma, Kaushal Barot, "Design and Development of Intelligent waste monitoring system for generation of electricity with cloud based online access control system," IEEE IAET, 2020.

[2] Kaustubh R Sonar, Trishul G. Bharsakale, "Generation of electricty using dry waste," Journal of recent trends in electrical power system, vol. 7, Issue 3,2024

[3] Rahim Zahedi, Sareh Daneshgar,Sina Golivari, "Simulation and optimization of electricity generation by waste to energy unit in tehran," Sustainable energy technologies and assessments, Elsevier, Vol.53, Oct 2022.

[4] Ivanhoe Rozo Rojas, Laura Isabel Vasquez, " Energy generation from solid waste. A literature review," IEEE International conference, 2018.

[5] V Muneeswaran, P Nagaraj, "Power generation using waste management system," IEEE International conference, 2023

[6] Natalia Vukovic, Evgenia Makogon, "Waste-to-Energy Generation: Complex efficiancy analysis of modern technologies", Sustainability, MDPI, 2022.

[7] Harshit Sharma, Aditya Jain, Dr. Sanjiv Kumar Jain, "Electricity Generation from waste materials," International Journal for Research Trends and innovation,Vol. 8, Issue 5, 2023.

[8] Rahit Patil, Rushikesh Ghate, "Generate electricity by using waste material," International Research journal of modernization in Engineering Technology and Science, Vol.4, Issue 12, Dec. 2022.

[9] Neha Rajas, Poonam Nikam, "Generating electricty from solid waste and biodiesel," ICSTCE, E3S Web of Conferences 405, 2023.

[10] Abhishek Pandey, Ashutosh Singh, "Waste to Energy: Generation of electricty using waste materials," International journal of creative research thoughts,Vol. 9, Issue7, July 2021

[11] S Alam, "Municipal solid waste based power generation: A Case study in chittagong city," IEEE International conference, 2021.

[12] Vicky Chaudhari, Ratan Mule, " Electricty generation from solid waste," Journal of emerging technologies and innovative research (JETIR), Vol. 11, Issue 4, April 2024.