

Power Generation Out of Waste Materials

P. Spandana¹, K. Umamaheswari², Y. Amulya³, K. Sai Ram⁴ and G. Chandana Malya⁵

^{1,3-5}III- B. tech Department of EIE, VR Siddhartha Engineering College, Vijayawada, India

Email: pspandana2005@gmail.com 3amulya0397@gmail.com 412sairam81@gmail.com

5chandanamalyagalannki@gmail.com

²Asst. Professor, Department of EIE, VR Siddhartha Engineering College, Vijayawada, India

Email: kunduru.uma@gmail.com

Abstract— Waste materials exert a significant influence on our daily lives, impacting various facts of our routines, surroundings, and overall well-being. Improper disposal of waste materials, particularly non-biodegradable ones, can lead to environmental pollution. Plastics, metals, and other non- degradable materials can persist in the environment for decades, releasing harmful chemicals and microplastics that contaminate soil, water bodies, and even the air. This pollution can determinately affect ecosystems, wildlife, and plant life. A transformative solution is emerging at the intersection of waste management and sustainable power generation. Through innovative technologies and creative engineering, waste materials once considered burdens are now being harnessed to generate valuable electricity.

Keywords— Solar panels, Heating sensor, waste management.

I. INTRODUCTION

In India with an increasing population from 124.06 crores in 2010 to 144.17 crores in 2024 the demands are also increasing such as food, cloths, medicine etc. and this causes an increase in waste materials. India generates around 3.4 million tons of plastic waste and only 30 percent of it is recycled. Over 350 million tons of hazardous waste was generated in 2023. As of February 2021, more than 50 million tons of hazardous waste have been thrown away globally.

The purpose of this prototype is to generate electric energy from waste materials such as plastic waste, rubber waste, etc., Normally waste is any undesirable substance which has been obtained as an outcome of all these humans and animal activities. This process of power generation is cost effective since we didn't need to use fossils, fuel, coal, or any other raw materials which costs high. It only includes all those waste materials which is been collected by municipal corporation and it also produces less harmful gases as compared to other methods which are being used. The amount of power generation is proportional to the waste material used and heating process is done in a special furnace by burning it in a controlled manor. In this process we generate electricity by burning household waste.

II. PROBLEM STATEMENT

As the global demand for electricity continues to rise and concerns about environmental sustainability increase, there is a growing need for innovative and efficient methods of electricity generation. Traditional energy sources such as fossil fuels contribute to pollution, greenhouse gas emissions, and resource depletion.

On the other hand, waste materials are often discarded without proper utilization, leading to environmental challenges. Addressing both electricity generation and waste management in a sustainable way presents an opportunity to tackle two critical issues simultaneously. The challenge is to design and develop a high-power electricity generation system that utilizes waste materials as a primary input. This prototype efficiently converts the heat energy produced by burning waste materials into electricity, while minimizing negative environmental impacts. Being conscious of the implications of waste and making efforts to reduce, reuse, and recycle can contribute to a more sustainable with clean environment for current and future generations.

III. METHODOLOGY

A. Overview

In this prototype solar panels are used as main functional unit. Here, we utilize solar panels as our main functioning unit. As the solar panels absorb the light produced from burning waste, they convert the light energy into electrical energy.

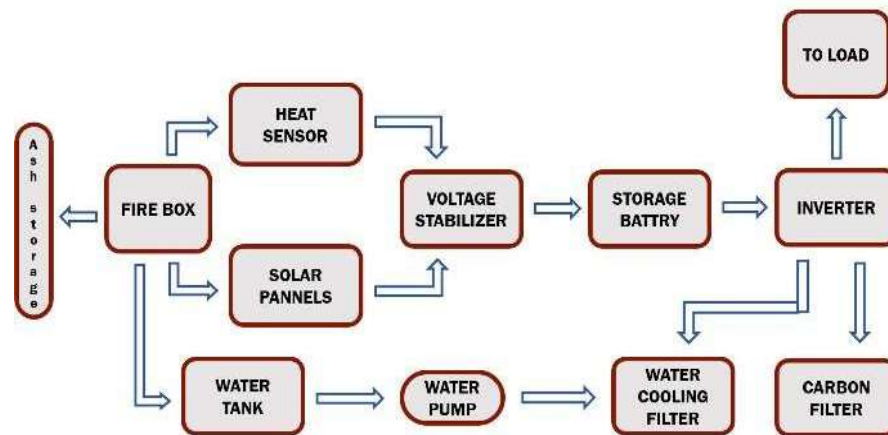


Fig.1 Block diagram for power generation out of wastematerials

Fig.1 shows the block diagram for power generation out of waste materials. solar panels will absorb the heat energy begin gathering the heat energy produced in the burning box by waste materials such as rubber, plastic, and other materials. As soon as we initiate the burning process, the heating panel will convert the captured heat energy into electrical energy. The circuit box's glowing LEDs will indicate the electrical energy generated. The electrical energy generated will be transported to the batteries by means of power boosters. Additionally, a diode is connected to the batteries prevents energy loss back into the system. The heat sensor and LED lights are connected via batteries, which allow energy to flow whenever the heat sensor is activated, causing the LED lights to glow.

Initially we are collecting undesirable or waste materials such as plastic, rubber, paper, and wood and burn the waste materials in a metallic jar box. When we burn waste materials light energy and heat energy are produced. The light energy is absorbed by the solar panels and convert it into electrical energy. The process by which photons, or heat- or light-producing particles, break free electrons from atoms to produce an electrical current is how a heating panel works. Heating panels are composed of many smaller parts called photovoltaic cells. A p-n junction diode is made up of adjacent P-type and N-type semiconductors. In order to stabilize itself, the p-type takes the extra electrons from the n-type since it has one fewer electron. The electron is shifted as a result, and electricity is generated.

The electrical energy which was produced from solar panels will be stored in 4V rechargeable battery. Rechargeable batteries are connected to inverter circuit to convert DC current to AC current. The AC current from the inverter circuit will be given to the DC light bulbs. We use 3V LED bulbs to indicate current flow in the inverter circuit. PN junction diodes are used in the circuit for passing the current in one direction. These diodes help to prevent the current to flow in the reverse direction. The Heating sensor will sense the heat produced from burning of waste materials and initiate the current through capacitors to inverter circuit and then flows to DC light bulbs. Hence DC bulbs will glow. The produced electricity is used in street lights and household appliances, etc. To control the heat and pollution caused by burning the waste we use cooling filter and carbon

filter. The cooling filter is used to cool the hot air with the help of fans and cold water. We use carbon filter to collect the carbon pollutants to the carbon collecting plate.

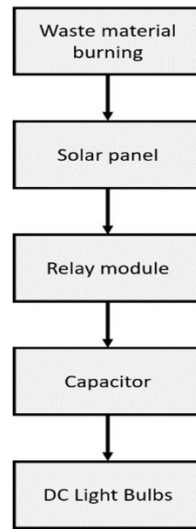


Fig.2 Flow Chart of Overall Prototype

A heating panel uses photons to dislodge electrons from atoms, resulting in a flow of electricity. Heating panels use solar cells to convert light and heat into power. A p-n junction is made by placing p-type and n-type semiconductors next to each other. The p-type semiconductor pulls excess electrons from the n-type semiconductor, resulting in stability. As a result, electrons are displaced, producing an electric current. When heat strikes the semiconductor, an electron is energized and travels towards the n-type semiconductor, resulting in the accumulation of negative charges in the n-type semiconductors and positive charges in the p-type, increasing the flow of current. This process is referred to as the photovoltaic effect.

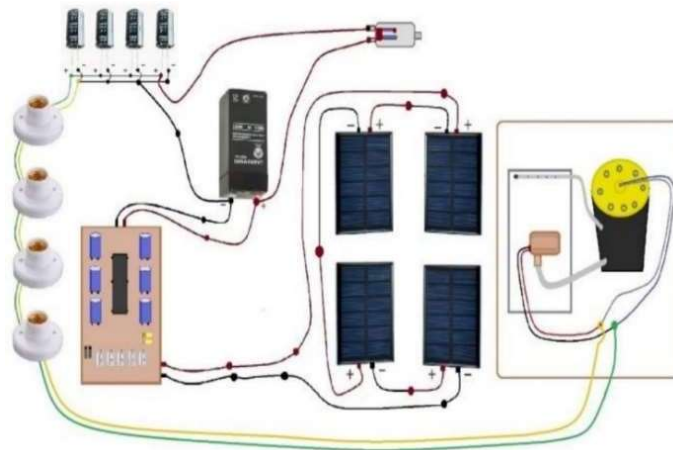


Fig.3 connectional diagram

Fig.3 Shows overall connections involved in the prototype.

B. Hardware

Electric Jar or Fire box

The metallic Jar box serves as the container for burning the waste materials, enabling the efficient conversion of their energy content into light and heat energy. Garbage is collected into the jar box where the combustion takes place, producing heat energy that can be converted into electrical energy.

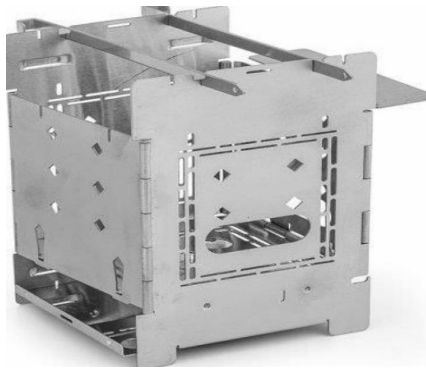


Fig.4 Fire Box

Heating Sensor

A heat sensor detects heat from burning waste products. The heating sensor is designed to detect the temperature rise resulting from the combustion process within the metallic jar box. It serves as a monitoring device to ensure that sufficient heat is being produced for energy conversion. Once the heating sensor detects a predetermined threshold temperature indicative of successful combustion, it sends a signal to initiate the flow of current through capacitors to the inverter circuit.



Fig.5 Temperature Heating Sensor

Solar panel (6v)

A unique type of device known as a solar panel receives heat input and converts it into electricity. Solar panels are composed of photovoltaic cells, which are semiconductor devices capable of generating electricity when exposed to light. These cells are typically silicon-based, with p-type and n-type layers producing a p-n junction. Photons excite electrons on a photovoltaic cell surface, generating an electric current. This phenomenon is called the photovoltaic effect.



Fig.6 Solar panel

Rechargeable Battery (4V, 1.5A)

A device used to store the electrical energy generated from the conversion of light energy produced by burning waste materials. These batteries act as energy reservoirs. In this project, a 4V rechargeable battery is used to

store the electrical energy produced by the solar panels. Rechargeable batteries use reversible electrochemical reactions to store and release electrical energy. They are designed to be charged and discharged multiple times, making them suitable for renewable energy storage applications.



Fig.7 Electric Battery

LED Bulb (9v)

LEDs (Light-emitting diodes) are semiconductor light sources with two leads. In this project LED is used to indicate current flow in the inverter circuit and also as sources of illumination for street lights and household appliances. LED bulbs illuminate instantly when power is applied, unlike some other types of bulbs that may require a warm-up period. This feature provides immediate lighting when needed.



Fig.8 LED Bulb

Capacitor (4700uf/25v)

The capacitor functions similarly to a miniature rechargeable battery. Capacitors store energy as an electrical field between two conductive plates separated by a dielectric substance. They can store and release electrical energy quickly. These are used to initiate the flow of current to the inverter circuit when the heating sensor detects sufficient heat from burning waste materials. Once the heat sensor triggers the capacitors, they discharge the stored energy, initiating the flow of current to the inverter circuit, which then powers the DC light bulbs.



Fig.9 capacitor

Water pump motor

The water pump motor (DC 2.5-6v, 80~120L/H) is an essential component that facilitates the cooling process to control the heat generated from burning waste materials. The water pump motor functions by drawing cold water from a source, such as a reservoir or water supply, and circulating it through a cooling filter system. As the hot

air generated from burning waste materials passes through the cooling filter system, the water pump motor pumps cold water through the filter. The cold water absorbs heat from the hot air, helping to lower its temperature. This cooled air is then circulated back into the environment, contributing to the overall cooling process.



Fig.10 Water pump motor

DC Motor

In cooling filter system the DC motor of 775 ball bearing type, maximum voltage of DC 36v, with 3500~9000 RPM drives the fans that are part of the cooling filter system. As the hot air generated from burning waste materials passes through the system, the fans, powered by the DC motor, help to circulate cold water from a source such as a reservoir or water supply through the cooling filter. This process assists in cooling down the hot air by transferring heat to the cold water, thus aiding in the overall cooling of the system. In carbon filter system the DC motor may also be utilized to drive pumps or other mechanisms that circulate water through the carbon filter system. The carbon filter helps to collect carbon pollutants from the air generated during the waste burning process. By circulating water through the carbon filter, the DC motor ensures efficient trapping of carbon pollutants, contributing to the system's effectiveness.



Fig11 DC motor

IV. RESULT



Fig.12 Proposed model

Fig.12 shows the overall prototype of the “Power generation out of waste materials.

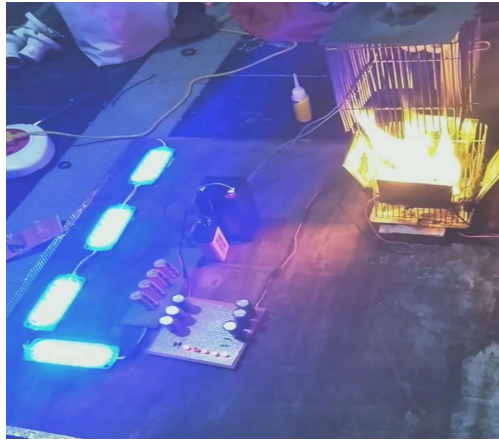


Fig.13 Final output

Fig.13 shows the final output of the prototype

TABLE I. AMOUNT OF POWER GENERATED FOR 1KG OF WASTE

S.NO	Types of Waste	Amount of Waste (Kg)	Power Generated (MJ)
1.	Paper	1	16-18
2.	Wood	1	15-20
3.	Organic Waste	1	14-18
4.	Biodegradable Waste	1	12-20
5.	Plastic	1	30-40
6.	Municipal Solid Waste	1	8-15

Table I. shows the amount of power generated for different types of waste materials. A sustainable energy system is devised to harness heat and light energy from waste materials through solar panels and heating panels. The converted electrical energy is stored in rechargeable batteries and supplied to DC light bulbs via an inverter circuit, indicated by LED bulbs. Controlled by a heating sensor, the system efficiently powers street lights and household appliances while mitigating heat and pollution through cooling and carbon filters.

V. CONCLUSION

The "Power Generation out of Waste Materials" prototype introduces an innovative and sustainable approach to waste management and energy production. By harnessing light energy emitted from burning waste materials through solar panels and heating panels, it showcases the potential for utilizing renewable resources effectively. The project's integrates rechargeable batteries, an inverter circuit, and LED bulbs which ensures efficient storage. The utilization of the generated electricity, catering to various applications such as street lighting and household appliances. Furthermore, the incorporation of heating sensors and filtration systems addresses environmental concerns by effectively managing heat and pollution emissions during waste incineration. Overall, this methodology showcases a promising solution to both energy needs and environmental sustainability challenges.

FUTURE SCOPE

Power generation from waste materials offers numerous opportunities for both environmental sustainability and energy production. Continued research and development in waste-to-energy technologies can lead to more efficient and cost-effective methods of converting various types of waste into usable energy. Integrating waste-to-energy facilities with smart grid systems improves energy management across generation, distribution, and consumption. Smart grid technologies allow for real-time monitoring, optimization, and control of energy flows,

improving grid stability and resilience. This will optimize the distribution and utilization of the generated electricity, paving the way for a more sustainable energy future.

REFERENCES

- [1] Rabou, L. P. L. M. et al., "Micro Gas Turbine Operation with Biomass Producer Gas", 15th European Biomass Conference and Exhibition., ETA Renewable Energies, Florence: Berlin, Germany, pp. 935- 937, 2007.
- [2] R. Widmer, H.O Krapf, D.S Khetriwal, M. Schnellmann and H. Boni, "Global Perspectives on E-waste" Environmental Impact Assessment Review, Elsevier, pp. 436-458, 2005.
- [3] Zhu, J., & Chow, M. Y. "A review of emerging techniques on generation expansion planning". IEEE Transactions on Power Systems, 12(4), 1722-1728, 1997.
- [4] Wiser, R., & Bolinger, M. "An overview of alternative fossil fuel price and carbon regulation scenarios", J. Marine. Sci. Appl, vol. 19, pp. 72-82, 2004.
- [5] H.Y. Xu, "Summarization of 2017 development of municipal solid waste treatment industry", China Environmental Protection Industry, vol. 7, pp. 5-9, 2018.
- [6] H.A. Arafat, K. Jijakli and A. Ahsan, "Environmental performance and energy recovery potential of five processes for municipal solid waste treatment", Journal of Cleaner Production, vol. 105, pp. 233-240, 2015.
- [7] M. A. Salam, "A High-Efficiency Step-Down DC-DC Converter with Dual Active Bridge LLC Resonant Converter and Capacitor Voltage Balancing", IEEE Transactions on Power Electronics, vol. 33, no. 2, pp. 1371-1385, Feb. 2018.
- [8] Spyridon Tompros et. al., "Enabling Applicability of Energy saving applications on the appliances of the Home Environment", IEEE Network, November/December, page 8-16, 2009
- [9] O. Cherednichenko and V. Mitienkova, "Analysis of the Impact of Thermochemical Recuperation of Waste Heat on the Energy Efficiency of Gas Carriers", J. Marine. Sci. Appl, vol. 19, pp. 72-82, 2020.
- [10] J. W. Lu, S. Zhang, J. Hai and M. Lei, "Status and perspectives of municipal solid waste incineration in China: A comparison with developed regions", Waste Management, vol. 69, pp. 170-186, Apr. 2017.
- [11] O. S. Nikiforova and A. E. Primak, "public Awareness in the field of selective waste collection" in the collection: Ecology of Russia: on the way to innovation interuniversity collection of scientific works, Astrakhan, pp. 90-94, 2017.