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Waste to Wattage: Revolutionizing Camping with Sustainable Energy

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Abstract

This project sets out on a multifaceted journey to deal with the growing problem caused by the increasing volume of non-biodegradable garbage. In this paper, a proposal and result were made to create a wattage from the non-biodegradable waste by converting the waste to energy using burning process. This project aims to examine and assess sustainable energy alternatives from waste material for camping in response to the limitations and environmental challenges posed by conventional camping energy sources, to develop a portable waste-to-energy system for camping with a focus on achieving notable improvements in energy efficiency sources and to assess the capability of converting material to energy by using multimeter test. This prototype requires coal that is obtained from non-biodegradable trash as the main resource. Next, the goal of a diligently planned process that includes in-depth research, continuous prototype development, and extensive trial and error to create a solution that not only reduces the negative effects of non-biodegradable waste but also exhibits resilience and adaptability in a variety of camping situations.

1. Introduction

Camping is a popular outdoor activity that allows people to experience the beauty of nature for a short while. Usually, tents or customized vehicles are used for this kind of activity. However, irresponsible human behavior endangers the area's recreational resources in areas like Taman Negara Pahang [1]. Research reveals continuous degradation of the land, vegetation, wildlife, and waterways, compromising ecological stability and the visitor experience. These problems are made worse by widespread urban trash disposal and a lack of environmental knowledge, which makes it urgently necessary to promote sustainability, especially among younger generations [2]. Regardless of usage, a recent study conducted across ten dry zone park campsites revealed serious environmental degradation marked by soil compaction, erosion, litter accumulation, and tree damage that puts both tourism and natural ecosystems at risk.

The project endeavor has the potential to provide campers with several advantages that will enhance their convenience. By using these project commodities instead of generators, it is possible to avoid using generators to generate power. In addition, campers can save money and simplify their holiday as it is no longer needed to purchase the generator and carry it around. Even though they need to bring a lot of gear, some people are too

inefficient to go camping since they might save space in their van by not utilizing a generator. The generator at the campground is not likely to produce any noise pollution. It's common knowledge that spending time in a peaceful, distraction-free environment is one of the benefits of camping.

The objectives are to examine and assess sustainable energy alternatives from waste material for camping in response to the limitations and environmental challenges posed by conventional camping energy sources. This helps to develop a portable waste-to-energy system for camping with a focus on achieving notable improvements in energy efficiency resource utilization. Finally, to assess the capability of converting material to energy by using multimeter test.

2. Material and Method

This project requires different materials that have been tested, such as coal and leaves. Next, the method used in this project is multimeter and durability tests.

2.1 Material

The material that has been listed is flammable material. Coal and Fuel are non-biodegradable items that have been chosen. However, coal is the best material from non-biodegradable to be burned and converted into electricity. Coal also will combine with other material such as dried leaves and boxes to enhance the flame and make a higher voltage lamp during the camping.

2.1.1 Coal

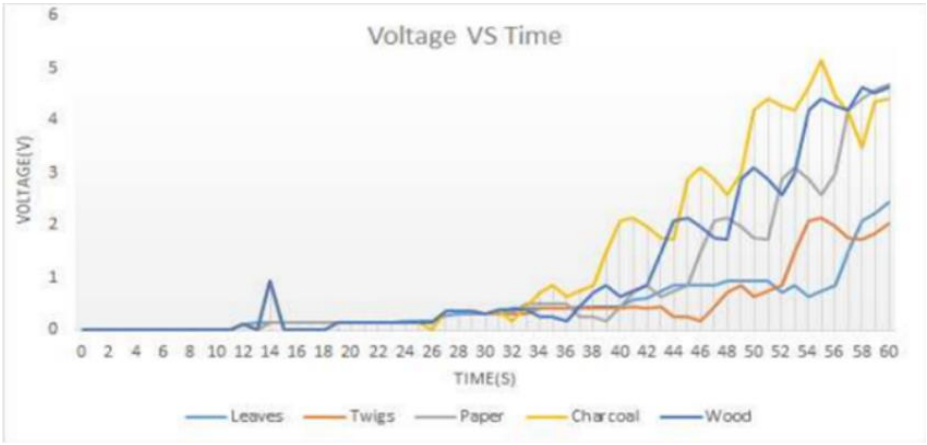
Several interesting technologies for producing power from waste materials have been identified through research. "Carbon: Energy for the Future" emphasises the importance of coal as a transitional energy source as the economy shifts from one based on petroleum and natural gas to one based on limitless or renewable energy sources [3]. Coal's capacity to provide energy at a cheap cost has made it a popular choice for power production and industrial use. Its ubiquitous availability and the comparatively cheap cost of producing electricity in massive coal-burning power plants, which benefit from coal's low price and high energy content, have fueled its widespread use. Coal has several applications, including electricity generation, steel and cement manufacture, and industrial process heating. Despite the growing importance of oil and gas, coal is anticipated to remain a critical component of global energy production. However, it is critical to recognise the significant environmental effect of coal use. Burning coal emits greenhouse gases and air pollutants, which contribute to climate change and have a detrimental impact on human health. A greater understanding of coal quality characteristics can help in addressing some of these health concerns.

Boqiang [4] has conducted more research on power generating technologies, including the coal-to-electricity (CtE) effort. This programme tries to minimise SO2 and NO emissions from CO2. While energy substitution in the CtE project does not immediately result in energy savings, it does have a limited impact on CO2 reduction. The CtE project, when paired with other energy-saving methods, can improve air quality by lowering NO and SO2 emissions while also contributing to decrease CO2 emissions and a higher quality of life. During the shift from coal to shale gas, it was discovered that gas can be a more efficient energy source for combating global warming. Comparisons of the environmental implications of electricity generation from the co-incineration of different biofuels against coal alone have revealed that biofuels are more ecologically friendly. Energy replacement remains a significant topic in energy policy and economics, spanning transitions from coal to petroleum, coal to biotechnology, and adjustments in car usage from petrol to electric.

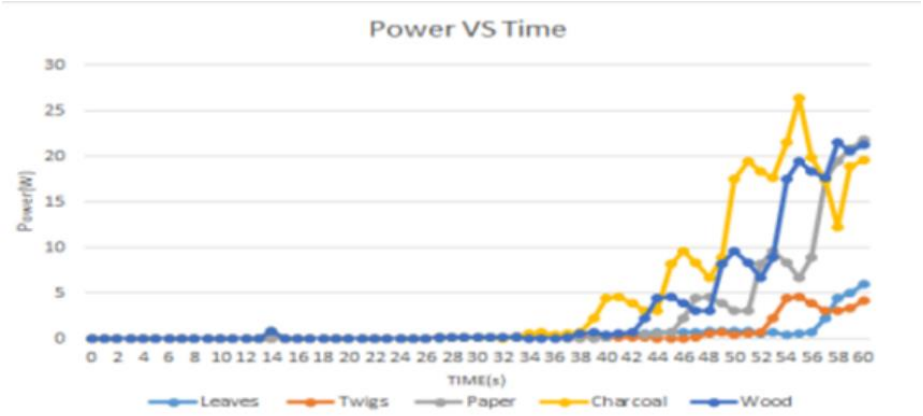
Furthermore, Said et al. [5] investigates a novel approach for supplying free electricity, which might be extremely advantageous in developing nations. This technology is far less costly than other current harvesting devices, such as solar panels or water turbines. Based on test data collected via an IoT platform, charcoal emerged as the top material in terms of output power generation. This technique has enormous promise not just for supplying electricity during emergencies like natural disasters or power outages, but also for charging electronic devices during outdoor activities like camping, where standard electrical sources are unavailable. Using petrol gasoline to power generators while camping poses considerable concerns owing to potential leaks and fire threats, and it may be costly in the long run. This system can power phones, radios, and lights as long as there is a source of biomass around, such as leaves, twigs, wood, paper, or charcoal. This system collects several variables, including voltage, current, temperature, weight, and smoke.

A linear regression graph, as illustrated in Fig. 1 (a), shows that various materials create variable voltages over a one-minute period. Fig. 1 (a) and (b) show that burning charcoal produces the most voltage and power when compared to other materials, making it the most efficient energy source. Wood comes second in heat emissivity because it contains less fixed carbon than charcoal. The power output steadily increases, and the material maintains the necessary voltage level for energy generation. Leaves create less power because of their

low emissivity, however burning them on a bigger scale can provide more voltage to compensate for this constraint. These observations are logged and analysed according to the material burnt, which includes leaves, twigs, wood, paper, and charcoal.



(a)



(b)

Fig. 1 *(a) Voltage versus Time graph for five different materials; (b) Power obtained versus Time graph for five different materials*

2.1.2 Leaves

Leaves are biomass material that is easily available and has potential as an alternative energy source. Sugarcane is an important agricultural commodity in the Philippines, and the harvesting process produces large volumes of sugarcane leaves or straw (SCL). Preliminary study of sugarcane trash as a possible resource for bioenergy generation, with an emphasis on assessing local availability and bioenergy generation potential to serve as a baseline and reference. SCL has several advantages that make it a promising renewable resource: it can be used to produce biofuels such as bioethanol and biomethane; it can help displace a significant fraction of coal used for electricity and meet mandates for biofuel blending; and it can reduce greenhouse gas emissions associated with allowing residues to decay. SCL has the potential to generate 40.2 ± 2.4 PJ/year of recoverable bioenergy, with the Visayas region having the highest potential. It can be used for direct combustion or processed to produce bioethanol/biomethane for electricity generation, making it an avenue worth further exploration for renewable power in the country [6]. Techno-economic study of second-generation bioethanol production from sugar cane bagasse and leaves, which was integrated with the sugar-based ethanol process. The capacity to generate eco-friendly bioelectricity from sugarcane leaves has the potential to lessen reliance on fossil fuels. Sugarcane leaves are also considered a sustainable fuel since they may be replenished year after year. Furthermore, using sugarcane leaves to generate energy can help minimize agricultural waste and make better use of crop wastes that were previously discarded. However, there are certain limitations to creating power from sugarcane leaves. One of them is the manufacturing cost, which may be greater than utilizing fossil fuels in the near run. Furthermore, the bioelectricity production process from sugarcane leaves necessitates specialized equipment and infrastructure, which may demand a significant initial investment. Furthermore, there are issues in production efficiency and

waste management that must be addressed in order to maintain the long-term viability of using sugarcane leaves as an energy source [7].

2.1.3 Fuel

Fuels have been the basis of energy production since the Industrial Revolution, providing a primary source of energy for a variety of important uses. Each form of fuel has different properties, advantages, and environmental impacts [8]. Fuel of golden berry wastes were utilized to generate electricity in low-cost microbial fuel cells, achieving maximum current and voltage values of 4.945 0.150 mA and 1.03 0.02 V, respectively, over 35 days monitoring period. In this regard, the primary purpose of this study was to create bioenergy from GB waste (substrate) in a low-cost single-chamber microbial fuel cell that was monitored over 35 days. This study acquired substrates (fuel) from Golden Berry waste collected at Trujillo's La Hermelinda market. To eliminate pollutants, the waste was properly cleansed with distilled water and dried. 4 kg of Golden Berry rubbish was crushed to produce around 1.5 L of waste extract. This extract was sterile before being used as a substrate in microbial fuel cells (MFCs). During the monitoring period, no more substrate was added to each MFC, which contained 400 mL of Golden Berry waste. To create anaerobic conditions, the MFC chambers were sealed with caps. The produced voltage, current, pH, conductivity, degrees Brix, and conductivity were all measured depicts the output power (Ps) of MFCs at various external resistance levels. In this way, the waste of this type of fruit can be provided extra value by producing a good, like electricity, for the benefit of businesses or farms committed to the gathering and sale of GB in an ecologically responsible manner. The study then proposes the use of this sort of waste for bioelectricity generation, which would benefit farmers, exporters, and importers by allowing them to generate their own energy in the future while saving money in an ecologically friendly way [9].

2.2 Method

2.2.1 Durability

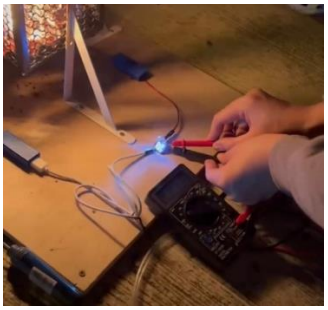
Electrical equipment undergoes durability tests to assess its ability to withstand various weather conditions, mechanical stress, and electrical loads over a long period of time. This test involves exposing the equipment to extreme temperatures, humidity, vibration, impact, and electrical waves. Table 1 shows the degranation time of non-biodegradable wastes. The durability testing determines the longevity and reliability of equipment under actual operating conditions. These tests help manufacturers identify weaknesses or defects in devices and make necessary design changes to improve performance and durability. Various situations are used to evaluate the equipment's ability to withstand mechanical stress, electrical load, and environmental conditions without experiencing damage or failure. Durability testing ensures that equipment can handle power safely and effectively without potential problems or risks [10].

Table 1 *Degrenation time*

Category	Type of Waste	Approximate time taken to degenerate
Non-biodegradable	Tin, aluminium, and other metal items	100-500 years
	Plastic bags	One million years
	Glass bottles	Undetermined
	Coal	Few decades to several centuries

2.2.2 Multimeter

The multimeter is the most useful instrument for precisely measuring steady electrical values. Fig. 2 shows the multimeter test. The avometer is the most prevalent type of multimeter available. Its distinguishing characteristic is the ability to detect voltage, resistance, or amperage based on the position of the rotary switches on the front face. The avometer's versatility makes it an indispensable tool for engineers, electricians, and enthusiasts alike. Its capacity to measure volts, amperes, and ohms illustrates its adaptability in a wide range of electrical applications, giving users a full grasp of electrical circuit parameters. The avometer's design provides a customisable measuring approach, allowing users to accurately alter the rotary switches to suit diverse electrical engineering and diagnostic applications. This versatility increases the instrument's usefulness in a variety of applications, from basic circuit examination to complicated troubleshooting.



(a)

Fig. 2 *Multimeter test*

A multimeter uses a variety of modes and settings to detect the existence and strength of electrical impulses in a circuit. For example, to measure voltage, connect the multimeter in parallel with the component or circuit and show the voltage result on the LCD. To measure current, connect the multimeter in series with the circuit, which allows it to detect the passage of electric current. A multimeter may also measure resistance by measuring the voltage drop across a component when a tiny, known current is applied to it. This feature is critical for testing circuit operation, identifying electrical problems, and assuring proper electrical safety. By providing accurate measurements of voltage, current, and resistance, the multimeter, especially the avometer, becomes an essential tool in the toolkit of anyone working with electrical systems [11].

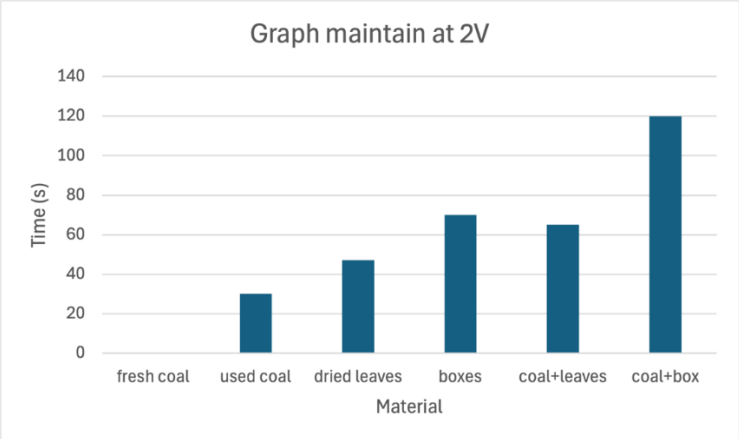
3. Result

Results will be elaborate with the formula for each material by using multimeter test and durability test. It shows different types of material and some combinations of coal. Table 2 below shows the summary of material tested data with weight (g), voltage(V) and Time (s).

Table 2 *Material Tested Data*

Material	Fresh Coal	Used Coal	Leaves	Boxes	Coal + Leaves	Coal + Boxes
Weight (g)	5	5	1.7	2.1	5 + 1.3	5 + 1.7
Voltage (V)	0	0.82	2.82	2.61	2.78	2.93
Time (s)	0	30	47	70	65	120

From the data obtained at Table 3, we conclude with Fig. 3 (a) and (b).



(a)

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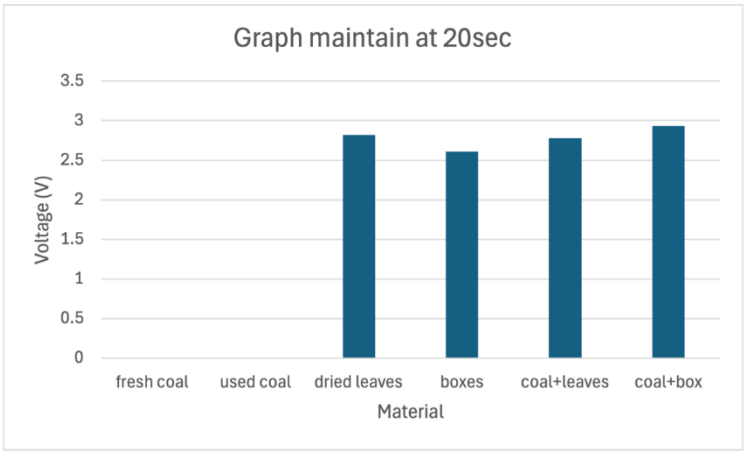

(b)

Fig. 3 *(a) Graph Time (s) vs Material; (b) Graph Voltage (V) vs Material*

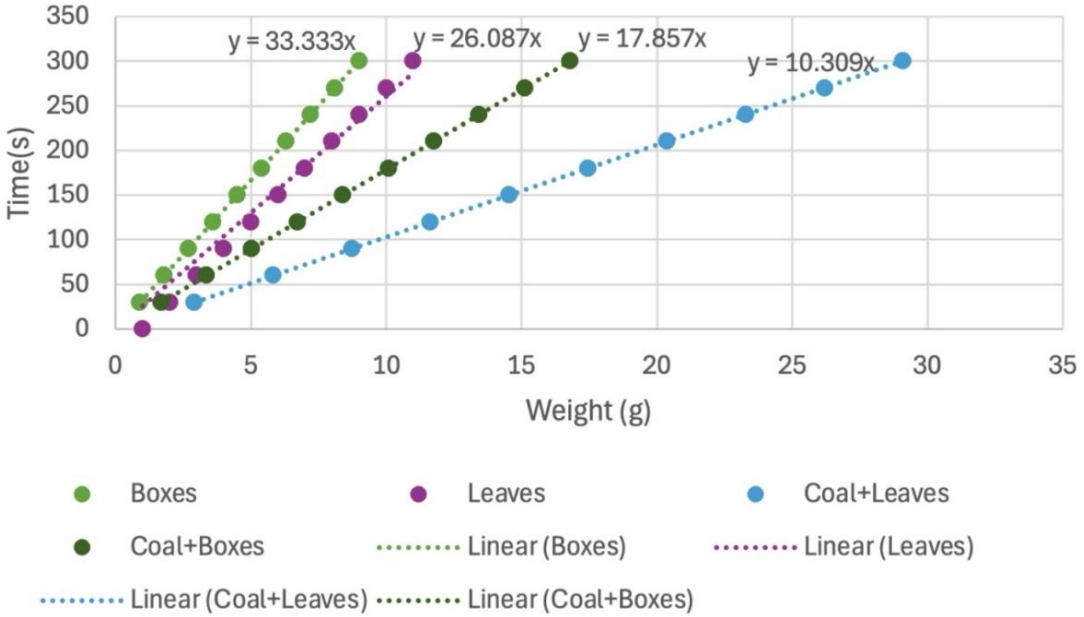

Fig. 4 *Result Data of Simulation Graph Time (s) vs Weight (g)*

Through the data obtained from Fig. 3, it shows different equations for simulation at Fig. 4 for each material. This project tested 4 types of material such as boxes, dried leaves, combination of coal and dried leaves and combination of coal and boxes. Table 4 shows the simulation equation for each materials.

Table 4 *Simulation equation*

Material	Boxes	Leaves	Coal + Boxes	Coal + Leaves
Equation	33.333x	26.087x	17.857x	10.309x
Solution 2V at 300s	300s= 33.333x x= 9.0	300s= 26.087x x= 11.50	coal= 74.63% box= 25.37% 300s= 17.857x x= 16.80	coal= 79.37% leaves= 20.63% 300s= 10.309x x= 29.10
Weight (g)	9.0	11.50	coal= 12.54 box= 4.26	coal= 23.10 box= 6.0

4. Conclusion

The "Waste to Wattage: Revolutionising Camping with Sustainable Energy" initiative is a ground-breaking endeavour to solve the combined concerns of energy generation and environmental sustainability. It cleverly combines coal, high-quality wiring, energy-saving lighting, and a BBQ grill to provide a versatile energy solution for camping. This revolutionary technology effectively generates electricity from coal while also providing practical cooking capabilities, increasing convenience, and fostering environmental stewardship. The prototype has been rigorously tested, including multimeter evaluations and durability tests under various climatic conditions, to demonstrate dependability and mobility, making it appropriate for outdoor use at beaches and campgrounds.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design, data collection, analysis and interpretation of results, draft manuscript preparation:*** *Khairina Ameera Kamarul Ariffin, Muhammad Aiman Kamal, Nurul Darwisyah Zakirah Noor-Al-Anuar, Mardiha Mokhtar. All authors reviewed the results and approved the final version of the manuscript.*

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