AN EMPIRICAL ANALYSIS OF SUSTAINABLE EARTH-BATTERY

An Undergraduate CAPSTONE Project
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Fall Semester 2020-2021
January, 2021

Faculty of Engineering

American International University - Bangladesh

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A CAPSTONE Project submitted to the Faculty of Engineering, American International University-Bangladesh (AIUB) in partial fulfillment of the Bachelor of Science requirements in their mentioned respective programs.

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DECLARATION

It is to certify that this project is our original work. None of this work has been submitted elsewhere partially or fully to award any other degree or diploma. Any material reproduced in this project has been appropriately acknowledged.

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APPROVAL

The CAPSTONE Project titled **An Empirical Analysis of Sustainable Earth-Battery** has been submitted to the following respected members of the Board of Examiners of the Faculty of Engineering in partial fulfillment of the requirements for the degree of Bachelor of Science in the respective programs mentioned below on **September 2020** by the following students and has been accepted as satisfactory.

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ACKNOWLEDGEMENT

We thank **Prof. Dr. Md. Abdur Rahman** for supervising our project and continuous support of capstone project study and research, for his patience, motivation, enthusiasm, and immense knowledge. His guidance helped us in all the time of research and writing of this thesis. We would like to thank our external supervisor **Prof. Dr. Md. Kabiruzzaman** for giving us technical guidelines and **Dr. Mohammad Mahbub Rabbani** Sir for his continuous motivation and guidance. We also thank our EEE department for helping us to betterment our project.

Finally, we would like to thank our family, our parents, for supporting us spiritually throughout life. This research project was conducted as a part of the Undergraduate Capstone Project and Thesis (Fall 2020-2021) from the Department of Electrical and Electronics Engineering (EEE), Faculty of Engineering, American International University-Bangladesh (AIUB). We also thank the Ministry of Power Energy and Mineral Resources (MPEMR)-Bangladesh for taking the research project as a part of the BICCHURON-19 funded research project of Power Cell on Renewable Energy.

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ABSTRACT

Fossil fuel-based energy sources are severely damaging the environment and becoming a threat to the future generation. According to the theory of potential energy, this prototype has been designed for soil power generation by implementing a prototype as a source of soil-based renewable energy. As a green source of energy from the soil, we successfully implemented a prototype. The purpose of the research is to supply different home appliances with power and serve various low-powered devices. Different soil samples, influential reactors, and electrodes were investigated for the maximum potential difference and electron flow. The priority was to select the raw material concerning its price and availability. In the presence of water, the power generation system from soil demonstrated better performance. So, it is also called a water-activated battery. In soil cells, aluminum and carbon electrodes for skipping voltage and current level fluctuation have been used as dipole electrodes. This book explains the design, operations, and features of soil power generation systems in which each cell can produce approximately 1 Volt DC. Soil, Water, and electrodes were used as raw materials for this project. Different types of raw material were investigated. Here, we use four types of soils (sticky, Clay, Sandy, silt). Among them, Sticky type soils show better performance due to their low intermolecular distances. For water three types of water (Natural water, Wastewater, saltwater) were used. But natural water was reported as the best combination. Electrodes Aluminum, Copper, and Carbon were investigated. But Aluminum and Carbon combination had better performance. This book reports a detailed explanation of the soil's design, operations, and electricity generation systems characteristics.

CHAPTER 1

INTRODUCTION

1.1. Introduction to the Project

Soil is a capacitive element so that the charge can be stored [1]. In this project, the soil's potential energy in a limited area is used to convert it into electrical energy. The potential difference is 0 on the ground, as a result of this vast amount of electron remaining stable under the ground and generating electricity from the soil, the creation of the Artificial Electromagnetic Field, and the use of the component as easily obtainable elements such as Soil, cell container, connecting wire, Anode, Cathode, water, saltwater, sugar, honey, multimeter [2]. To create this initial force for moving electrons using Anode and Cathode as a dipole electrode and the co-operative elements are working here as an electron reactor. Here Copper was used as an anode and Aluminum as a cathode under a soil container where the Anode attracts electrons instead of the Cathode repulsing the electrons triggering cathode transport (-ve) for its Attract-Repel condition of charge. As we know, saltwater is a very conducive element, so by using soil here, we increase the electron flow and generate more electricity from this project. Before the salt was added individually, each container could produce approximately 0.5V, but the output rate increased after salt. Sucrose and fructose are both proven conductive and function as reactive elements and improve their conductivity by adding them [3]. Honey is also an aspect of correction. So, we can also note a shift in the production rate by adding sweetness. Finally, we can get much electricity from this project that will aid in the future as a power plant that can provide electricity to the national grid. It is a straightforward, cost-effective, and easy-to-use process for generating soil electricity.

Everyone knows that very soon, people will suffer from the power crisis and that everyone needs to resolve this issue, so it will be the best way to use the world's renewable and affordable source. This project aims both for now and forever to generate more electricity by gradually solving electricity problems. More significantly, this process is environmentally friendly and generates green energy for nature development. Since the soil is readily accessible and used for providing power to the national grid throughout the project, it reduces government purchasing costs of electricity [4]. Again, electricity distribution would be more flexible than before as this project would provide mass power generation. In developing nations like Bangladesh, electricity is traditionally very high. Our project will also open up a new horizon at the electricity price, which will help the government progressively fulfill the Digital Bangladesh Vision.

Earth soil chemical reactions and electron affinity-based earth batteries may explore low to high voltage DC Potential to drive small-scale [5]. White emission LED for Lighting loads in rural hilly areas or small-scale electrical appliances. Like this project, sea and air batteries could consider for similar applications, but elements of earth batteries are easily accessible. Therefore, these batteries would be less desirable than most other batteries since uranium and coal will continue to exist for many decades and could not substitute oil and gas despite the risks of radioactivity hazards (plutonium) and greenhouse gasses (CO2). However, few countries use uranium and coal as the primary source of electricity. However, these processes harm nature. These forms of electricity generation mechanisms are growing problems such as the greenhouse effect. Here we use the elements that have genuinely collected from the heart, and we also do not burn anything so that there will be no Co2 or other factors that are not contributing to nature. However, this project is very eco-friendly and, in the event of an incident, this project would not have cost much by nature. It would also be known to replace low-current high-voltage charging or ionization power supplies. Earth soil chemical reactions and electron affinity focused on soil cell batteries will be examined for low to high voltage DC. Capacity to drive with some average loads in small hilly areas or small-scale electrical appliances. As this project is a straightforward method, it will also be the easiest way to produce electricity.

1.2.Motivation

Our country is a developing country dependent on agriculture. So many of our people live in rural areas where there is no electricity available. Some of the remotest places do not even think they are going to get the electricity facility. Some sites use solar, but they face a major energy crisis in the rainy season and winter. So, we think we will fix this issue and, as a result, we plan to undertake this project in a rural area where the electrical transmission line is unthinkable. It is going to generate electricity continuously there. Often there is a firm or light storm in rural areas where people are suffering from electricity. We are speaking about figuring out the dilemma of these solutions. This thinking drives us to ensure electricity for rural and remote areas and make the project readily accessible to people everywhere [6]. The electricity bill is also high in our country, as a result of which the middle class and the lower class are not making any effort to make electricity bills. Then we are thinking about introducing society with our initiative that can quickly solve the energy crisis. For the proper use of this project, we also add the current produced in the national grid due to load shedding. On the other side, the soil is readily accessible, and we use it as a crucial aspect of our project. We can quickly generate energy for both rural and urban areas by using the soil and other components. Then one day, load shedding and the crisis of power would be lifted from our society.

1.3. Complex Engineering Problem Statement

To tackle this project's complex engineering issue, we first know that energy cannot create or destroy but only changes from one form to another. Our project uses the soil's potential power to turn it into electricity in a small sphere. Practically all know that any energy is waste for the process or other electrical equipment if we turn some energy into another. However, there is no risk of wasting any resources in this soil-based project. The battery system for soil earth consists of the soil's electrical energy and is a useful way of converting them from the fossil-fuel energy system. Based on the Ohms rule, we get more current from this project since the voltage source provided enough voltage, and we get a vast amount of voltage quickly from the ground source. If we apply Kirchhoff's law, we combine every cell's current and get a significant electricity amount. We also use the OHM law here when we get production [7]. However, anything applicable to both current and voltage rules is indeed the best project for the future and will be considered in all complex engineering and theory matters.

1.4. The goal of this project

Providing a low-cost alternative power solution is the main objective of this project.

- Study on different electrodes and soil types for earth battery
- Performance analysis of earth battery with different dielectric materials
- Designing a soil lamp

1.5. Comparison to the Traditional Method

In today's world, power consumption is increasing by a minute. The latest technology, power equipment, and systems need in every aspect of our lives.

1.5.1. Traditional sources and their limitations

Fossil fuels have been popular for many years. Three primary fossil fuels supply a vast amount of electricity from coal, oil, and natural gases. Worldwide 38.37 percent of electricity is produced from coal and peat, 23.1 percent from natural gas, and 3.7 percent from oil [8]. Producing electricity from natural gas is a low-cost system. It needs to burn to produce electricity from fossil fuels. Emissions and pollution are the keys to traditional sources of energy. The burning of coal produces carbon dioxide, sulfur dioxide. Nitrogen oxide is produced by natural gas nitrogen. Fossil fuels a power plant that pollutes water and harms wildlife. If proper management practices have not observed, the harm to nature can be high. To find fossil fuels, people are destroying the ground. It is tough to find, and mineral resources on Earth are limited. Fossil fuels, coal, gas, oil need to be lifted off the ground, and lifting costs are very high. Lifting materials from the ground is also dangerous. The lead-acid batteries found on the market are costly and harmful to humans and nature.

1.5.2. Renewable sources and limitations

Nowadays, these traditional sources of energy are more significant because of renewable resources. Renewable energy sources are sustainable, green, and will not run out. In most cases, renewable power plants require less overall maintenance than generators using traditional fuel sources [9]. Renewable energy sources, such as solar power plant first installation, are costly. The solar power plant is less efficient than other plants. There were troubles on rainy days. Nuclear power sustainability has been discussed as a result of the generation of nuclear waste. Biomass has ash; it has hazardous materials. It is a very expensive wind turbine. The supply of energy is not constant, which is a threat to natural and noisy life. The wind turbine creates visual pollution. Hydroelectric power has few reservoirs, environmental consequences, and droughts. The cost of distribution is also expensive.

1.5.3. Earth-Battery

Overcoming all of this 'Earth Battery' limitation is the best solution. The raw materials of this project are elementary to find at low cost.

Advantage of the Earth's battery:

- The raw materials are available.
- Cost-free collection of soil.
- Cost-effective power source.
- Green and Renewable Energy.
- Eco-friendly.
- Do not harm nature.
- Low cost of installation.
- Safe for children.
- Affordable to all.

1.6. The novelty of the project

The idea is to generate energy from the soil—a unique design for the production of electricity. There are an innovative solution and an excellent opportunity for society to solve the electricity crisis. We have unlimited raw materials to make this battery. Renewable and Green Energy with low installation costs and affordable for all people. Eco friendly with zero emissions. Rural and urban people are the primary users of this product. The cost of production of this battery is meager with better efficiency and can reduce the power crisis. Everyone can afford it. Poor people have the opportunity to get cheap power. In remote hilly areas, this is the best solution. A power plant can stand by the Earth's battery and run a customer-friendly business in the future.

1.7. Impact on Society

The goal of a project is to find a sustainable solution to the issue being targeted. It has to be economical, environmentally friendly, and socially acceptable. It is essential to consider the social, economic, and environmental costs of an engineering project. There was a proper understanding of how the project could impact the day-to-day lives of the targeted community. It is also essential to consider the future dimensions, the project's impact, and further changes. We made a survey form for our research and examined most of the preferences, Feedback, proposals, and consumers' arguments for this project. They will help us to improve the plan and make it more user-friendly for individuals.

- 90.9% of people face a constant power crisis. 98.2% think our project will solve the power crisis, which is a good sign for our project.
- A maximum number of people assume that this project will be beneficial to society.
- 69.1% of the overall population want to use this battery for its low-cost productivity.
- 85.5% responded that our earth battery's price, amplification, and efficiency considerations are essential considerations for their choice.

CHAPTER 2

LITERATURE REVIEW WITH IN-DEPTH INVESTIGATION

2.1. Introduction

In our project, we use some specific sticky soil types and some readily available elements. Here we use a simple method that can be used anywhere globally, a widespread, cost-effective, and easily usable mechanism for generating electricity from the soil [10]. If we implement this project in an area where people are suffering from a power crisis, it will be the best solution for future power shortages. It can be used as an alternative source of power generation and the best way to eliminate load shedding. It is also suitable for every critical condition of the weather. Previously, many renowned institutes and organizations have worked with the soil. As if we're going through the IEEE and other institutes, we will find different types of paper or working publications and usually work with mud and other hazardous or non-obtainable elements. One of them used the soil and the Phragmites Australis, which is generally harmful to our body. There is another literature in which plants such as Chlorophytum comosum, Chasmanthe floribunda, and Papyrus diffuses had used in microbial fuel cells (MFCs). However, they are not so harmful, but they are not readily available. Again, in one piece of literature, they talked about Himalayan Mud Soil using Microbial Fuel Cell. But they are not readily available.

On the other hand, we are trying to find a readily available and environmentally friendly source by making the most of the soil's efficiency. After that, we set the goal of producing electricity without any pollutants, and then we tried to solve the electricity crisis, so we took the step to plan the project. We finally created a blueprint for our project and started work on it. After that, we usually took the help of different types of physics and mathematics formulas. We applied Ohm's law to make the project successful; then, we took the help of Kristof's law. It is an electromagnetic field-based system, so here we are using relativity theory and the idea of inertia. We then ensured that our project would work in a manner that would be appropriate to all the views and laws of electricity and physics.

2.2. Historical Background

From the start of this project, our main concern is to increase the current output. Therefore, we need to apply different types of elements based on different types of theory and applications. Because there are different types of applications that are the reason to increase efficiency, they're bellowing:

2.2.1. Impact of PH on Conductivity

Since different types of elements have an increasing impact on conductivity, first we said about PH, it's crucial to increase or decrease the conductivity level. When the PH had increased, the conductivity decreases, and when the PH level drops, the conductivity level begins to rise and grows in a certain way [11].

2.2.2. Electron velocity

The velocity of the electrons affects the resulting current rate. When the velocity increases, the resulting current will also increase. When we give extra force to the electron, the electron's movement increases, then the resulting current also increases.

2.2.3. Cell size

The size of the cell is related to the gravitational force that has an impact on conductivity. When we use a small cell size, the mass is short and gives a small output, but the outcome was higher than before when we use a large cell size.

2.2.4. Adding saltwater

The conductivity also increases with the use of fluids as saltwater. When we use salt water, the electron's movement has often grown, the conductivity has also increased.

2.2.5. Changing connections

We get better performance by changing the relation to the sequence. And we also get better current rates from the previous connections by using series-parallel.

2.2.6. Electrode Selection

The selection of electrodes is rather impactful in our experiment. We use the electrode as an anode and Aluminum as a cathode in our project. But for better performance, we change the electrode. As a result, we replace magnesium with Aluminum and graphene, Carbon with Copper. We further increase the electrode's reaction by rubbing Silicon Dioxide in place of magnesium with flannel paper. By using this change feature, the result of the output current has improved.

2.2.7. Potential Energy

We also apply here the Potential Energy, Ep= mgh,

Potential Energy, $\Delta V = \Delta IR$ [R is a constant] and $\Delta V \propto \Delta I$

So here we can make them more of the potential energy, the more we get output current.

Here we also apply Kirchhoff's law and get the equation.

$I1 + I2 + I3 - I4 - I5 = 0$

$V1 + V2 + V3 + V4 = 0$

So, we can easily apply Kirchhoff's law in this project [12].

Now we can apply

$V=IR$

And also, from the OHM's law, $P=VI$.

Finally, we can say that our project has faced every relatable theory and law of the particle and current.

2.2.8. Cells and electrode distance

Expanding cell distance also increases the energy potential. Furthermore, decreasing the cell gap decreases the potential difference. According to the coulomb theorem, the electric force between our cells is directly proportional to the charge's product. The cathode charging is inverse to the distance between the two electrodes—possible voltage increases as electrode distance increases and electrode distance decreases.

2.3. Earlier Research

Seeing the recent earlier study, we can see the Electrical, Energy & Power, Petroleum and Energy Studies Department, Dehradun-248 007, India, where Himalayan mud and microbial fuel cells have used. Bacterium and better performance to our cells and the response were faster than before. The cell, therefore, provided us with a great deal of current. In another research bio-electricity generation using a living soil plant, the concept of plant photosynthesis has been accomplished by converting solar power into electricity. In microbial fuel cells (MFCs), Chlorophytum comosum, Chasmanthe floribunda, and Papyrus diffuse used and provided a maximum current of 25, 31, and 19 mA/m2, respectively, without the use of nutrients or membrane [13]. So, we can implement the plants in our prototype, and by using them in the cell, we can get a good performance. So, the reality of production is also preferable for nature. Microbial fuel cells (MFCs) have been designed in other water research plants to develop bioelectricity. Freshwater and seawater plants used organic soil and marine sediments, respectively. Sea plants are more useful for producing bio-electricity than freshwater plants [14]. As Phragmites australis had used, the highest voltage was 520 mV. This paper uses both the salt water and the marine plant in our project and achieves the best results. Where saltwater increases the conductivity, and the plant also affects the cell.

2.4. Related research/ published works:

Nnebedum, B. et. Al [15] invented the Earth's Earth Battery from Earth's surface at The second International Conference on Electrical Engineering 25-26 March 2008 at the University of Engineering and Technology, Lahore, The electrodes had arranged on Earth's surface in an open-air environment—combinations of magnesium anode and coke cathode. Again, zinc anode and graphite cathode; aluminium anode and carbon cathode; zinc anode and copper cathode 2.05, 1.40, 1.10, and 0.9 volts per cell. The single Zn-Cu cell has estimated to be a few tens of microamperes. Earth's battery cells are also made up of zinc and copper electrodes. The 0.92V electrode soil reaction voltage is used to drive small-scale lighting and electronic loads. Outside bare Earth, currents and voltages were observed higher at smaller distances and lower at greater distances between cathodes and anodes.

Yang, Wulin, et. al [16] of University Park, Pennsylvania 16802 A team from the Department of Civil and Environmental Engineering, the H2E Center, and the Department of Chemical Engineering, Penn State University, released a paper on Graphite Fiber Anodes for Improved Power Generation in Air-Cathode Microbial Fuel Cells. The technology used to generate electricity from bacteria using individual reactors—anode brush made of Carbon (Graphite).

Professor **A.G. Sveshnikov et. al [17]** of the Chuvash State Agricultural Academy, Russia, published a work entitled Earth Battery as a renewable energy source. A collection of copper and aluminium plates with a paper separator placed in the air and buried in the soil produced free energy. In the summer, tension measurements had taken between the plates at random times when the air temperature was between 22 and 30°C. Voltage difference during the initial phase increased to 0.5 V. Often, the voltage increased more than 0.5 V, and sometimes the voltage often decreased was unpredictable.

Logan, Bruce E. et. al [18] with A team from the Department of Civil and Environmental Engineering, Pennsylvania State University, 212 Sackett Bldg. University Park, PA 16802, USA worked on cysteine in a microbial fuel cell. Anodyne bacteria and cathode oxygen reduction drive the oxidation of organic matter. The energy produced is proportional to the organic content of the sediment.

Bose et. al [19] of the Department of Electrical, Power & Energy, University of Petroleum & Energy Studies, Dehradun-248 007, India another research was carried out using Himalayan mud and microbial fuel cells to obtain a small amount of energy.

2.4.1. Other Research:

Battery based on available glucose. The presence of glucose, oxygen, and other enzymes produces electrons and protons—glucose has broken down at the Anode side. Mediators are helping to generate electricity through this mechanism. Potassium ferricyanide used in Cathode and vitamins enzyme has used in the Cathode. Electron Affinity is the energy emitted when an electron is bound to another atom or molecule. Reactivity sequences have been used to assess the results of single-displacement reactions. Saltwater contains an electron that can improve conductivity. Daniel's cell used the slatted bridge, and the sugar battery received a lot of electrons raising the current flow [20].

2.5. Critical Engineering Specialist Knowledge:

The basic principle for the conversion of energy is that energy cannot be produced or destroyed. In our project, the soil is the primary raw material with a big energy capacity.

The soil is a source of infinite electrons. The potential difference of the Earth is zero as electromagnetic force never reaches the other side. Electricity consumed by Free Earth Large quantities of electrons remains stable on the ground. No electricity will, therefore, pass through the soil. Start the movement by producing an electron from AEMF. The initial power for moving electrons is the Anode and Cathode, like dipole electrodes. Since the charges have been carried out by Anode, (+ve) electrons are attracted, and the cathode, on the other hand, carries charges (-ve) that repel the electron. Anode electrons and cathode electrons absorb electrons. There are more electrons in saltwater, and soil cell conductivity has improved. The current between the two points is directly proportional to the two-point voltage. Each cell has a voltage, and a series of added cells simultaneously increase the voltage and increase the current rating. The electrical force between the anode and cathode charges of our cells is directly proportional to the charge and inversely proportional to the square distance between the two electrodes. Integrate and obtain colossal electricity from each cell.

For this project, we must have a prior understanding of practices such as Voltage, power rating, temperature, and humidity measurement, metals height, breadth, weighing, and good MATLAB software knowledge to simulate our results and the drawing of a plot by MS Excel.

2.6. Engineering in the latest technology

Energy demand is rising day by day. From the past to the present, human energy has derived from fossil fuels, coal, gas, minerals, and renewable energy sources. One day, mineral resources will come to an end, and other renewable energy generation technologies will be very costly. Our project is an alternative solution to prevent a low-cost energy crisis.

Our project is power generation from the soil with a few readily available elements such as salt, sugar, and honey. Soil is a capacitive part so that the charge can retain. We have built a model with better performance. Positive and negative electrodes have used in each cell. The AEMF effects cause the electron to pass the Anode to the Cathode. Saltwater increases the electron rating in soil cells. Adding cells in series increases the voltage and increases the current at the same time. It is a unique model with a range of advantages. Usable raw materials at a low cost. Eco-friendly, no adverse effects on nature. Don't have any radiation. Portable, easy-to-use. Low-cost installation with battery efficiency [21].

The project also opened up a business opportunity. A new history could have developed after the completion of this project. Most rural countries suffer from the crisis of power and the Cost of Energy. They can easily use our product at a low price. It saves money, keeps the air safe, and saves natural resources**.**

2.7. Summary

In the future, people will face a power crisis. To overcome the power crisis problem, we find out a solution. We use the sticky type of soil with a little salt, sugar, honey. It is a simple, cost-effective model and can easily install any place. It's a sustainable and green power source. We can use this project to ensure electricity in a rural area. And can make in large amount to add to the power grid. It has a better opportunity in the business field can serve a better service to people at a cheap cost. It has no harmful effect on the Earth's nature.

CHAPTER 3

Project Management

3.1. Introduction

Electricity is essential in every sector of our life. From the beginning to the end of the day, we depend on it. For the massive use of electricity, we are facing a power crisis nowadays. Our earth battery can participate in reducing the power lacking problem [22]. We have followed some way and procedure for producing electricity from our project. We ensured few things to achieve our goals. We have done proper project management and appropriate forecasting. Our team also followed the process of managing, initiating, preparing, closing, and leading. We are also concern about proper time management.

This chapter briefly described our project management process: SWOT analysis, Schedule management, Cost Analysis, PEST analysis, Etc. They will help to gain a suitable outcome for the project. The cost analysis of this project will assist us in setting the price of this project. Critical analysis of this project will show the external factors. Those factors can affect the project.

3.2. S.W.O.T Analysis of the Project

Swot Analysis is a useful planning technology to recognize project and market competitor assets, weavings, opportunities, and challenges. For the improvement of the project, we evaluated these four sections. Swot Analysis is a useful planning technology to recognize project and market competitor assets, weavings, opportunities, and challenges. For the improvement of the project, we surveyed for our project where 55 consumers joined. We examined most of the feedback, preference, proposal, and consumers' arguments. we evaluated these four sections.

3.2.1. Strengths

- **Efficiency of costs**

  All peoples want more with less cost. We produce electricity from the soil and some other raw materials which are available at a low price. Therefore, we can buy materials at a low cost and create a low-cost project. Our project will provide electricity for poor people in rural and remote hilly areas at a cheap rate.

- **Helpful to the consumer**

  All consumers said our project is user-friendly; no exemplary method for running this project. So, everyone can use it. It is safe for Kids and General peoples. So, this project can potentially beneficial for society.

- **Good Nature Effect**

  This project has no negative and no radiation effect on the atmosphere, such as C02, CO, and other harmful gasses. This project meets the demand for green energy for SDG-7. It is a zero-emission energy source.

- **Portability**

  Maximum Consumer's first choice portable battery, Our Earth Battery t is a lightweight unit that is conveniently applicable to all environmental conditions.

- **Sustainable**

  A vast amount of people facing a power crisis. This Earth Battery can overcome power crisis by providing renewable energy sources with long battery life, increased performance, lower prices, economical and multiple uses of source recycling, and no adverse effects.

3.2.2. Weaknesses

Everyone faces various types of vulnerabilities in the initial phase of their project. By concentrating on weakness and improving, it can be the secret to perfect performance. Here too, we are faced with some weakness, and they are:

- **Current flow rate**

  In this project, the electron speed is low, and as a result, we have a small amount of current. The new rating is between 50 mA and 100 mA.

- **The size of the battery**

  A large number of clients prefer portable Battery. In our Battery increasing the cells to increase the current flow and strength. By growing the cells, our battery is going to be large and not attractive and lose portability.

- **Forthcoming**

  It is a profound science project. People cannot easily grasp their processes. We need to make more effort to embrace the public.

● **Public Demand**

Nowadays, several types of batteries can find on the market. All people want to have is more power with fewer resources. It is also a matter of concern to produce enough energy at a cheap rate.

3.2.3. Opportunities

Our project has many opportunities.

● **Market for Battery**

The project opened an opportunity for us to do business. There are several types of batteries in the battery industry. However, with improved performance, our Earth battery is sustainable and cost-effective. It reduces the cost of supplying electricity.

● **Strong investment**

Unlike other batteries on the market, it is a powerful battery. Besides, further updates will add every day. There is an ample opportunity for investors to earn money here.

● **Source of power generation**

Our Earth Battery generates electricity all the time. It will reduce the crisis of power in our nation and serve people with authority. We can also expand our jurisdiction to the national grid. Soon, by using our initiative, we will also take the opportunity to build a power plant and support the people of our country by providing electricity.

3.2.4. Threats

Our 'Earth Battery' is capable of producing power at a low price. So, this is a cost-effective project. There is a significant business opportunity for this project in the battery industry. Other batteries are still influential on the market, but they are shorter than our battery life. So as a competitor, it could pose a challenge to battery companies in the market. So, it is going to be a challenge to our productivity from other battery firms.

3.3. Schedule Management

The project management schedule contains a list of tasks, outcomes, and achievements in a project. The scheduled start and finish date, duration, and resources allocated to each operation have usually included in a schedule [23]. So, we had a long-term plan for effectively completing the entire project work. We have been operating according to our well-planned program since the beginning of the semester. We had to make a Gantt table and complete the tasks, which has shown in Table.3.1.

Table. 3.1. Gantt Chart of Our Project

	July 11	July 23	July 23-31	Aug 1-15	Aug 16-31	Sep 1-10	Sep 11-22	Sep 23-30	Oct 1-15	Oct 15-31	Nov 1-15	Nov 16-31	Dec 15	Dec 30
Orientation														
Topic Selection & online proposal submission														
Background Study & Survey														
Simulation & Sourcing Equipment														
Preliminary Hardware Implementation														
Experimental Analysis														
Thesis Book writing														
Project Testing & optimization														
Progress Report & Thesis Book (Partial) Submission, and Progress defense														
Features Addition & Implementation														
Project testing & System up-gradation & Survey														
Thesis Book submission to external & Feedback from the external														
Finalizing the Project and Poster, Book, Summary & CD Submission														
Final Defense														

3.4. Cost Analysis

In financial aspects, the Cost Analysis relates to the cost-creation relationship calculation; for example, market analysts are concerned with surveying the cost of using information sources and how they can be re-orchestrated productively to maximize the effectiveness of the association. All in all, the cost examination is concerned with assessing the cash measure of products (work, crude material), called the general cost of production, which helps to determine the ideal degree of yield. Table.3.2. shows the Equipment Cost List of our project.

Table 3.2: Equipment Costing List

Equipment Name	Quantity	Expected Cost (BDT.)	Buying Cost (BDT.)
Carbon (Anode)	24	2400	1920
Aluminum (Cathode)	24	360	480
Plastic Container	24	120	96
Cement, Sand	120g*24	144	120
Patch Wire	24m	600	480
Switching circuit	1	180	200
Secondary battery	1	330	300
others		200	150
Total		**4334**	**3,746**

Cost Analysis Equation:

The Cost Effect from the table can be expressed from the given equation

$$\mathbf{X} = \sum(\mathbf{Ec} - \mathbf{Bc}) \times \mathbf{N}$$

Here,

X = cost Effect

Ec = Expected Cost

Bc = Buying cost

N = Number of Device Made/sell

If, **N=**1

Then, **X** = $\sum(\mathbf{Ec} - \mathbf{Bc}) \times \mathbf{N}$

$= \sum(\mathbf{4334} - \mathbf{3746}) \times \mathbf{1}$

= 588 TK.

If, **N=**10

Then, **X** = $\sum(\mathbf{Ec} - \mathbf{Bc}) \times \mathbf{N}$

$= \sum(\mathbf{2510} - \mathbf{2285}) \times \mathbf{10}$

= 5880 Tk.

When **X** is positive, the project is cost-effective.

3.5. P.E.S.T Analysis

Typically, a project impacts society with the political location, Economic site, effects on the Social Atmosphere, and Technological conditions. So, we were worried about these sectors' impact. Companies must follow these analytical factors to make the correct identifications on the national or international market. Various types of organizations should be worried about these variables. As we build a market, we will follow the factors that are, by the way, bellowed:

- **Factors in Politics**

  We follow unique variables that can be politically motivated in our business. As our political conditions policy governs the corruption, public supply, and controlling the sector and foreign market policy, we are also worried about the tax and copyright policy: consumers security and environmental balance.

- **Factors in the economy**

  If we discuss the economic impacts, we should be concerned about the total GDP received from the countries' sector. In 2019, almost 50.3 percent of the Bureau of Ministry of Administrations joined the country's GDP based on electricity and power plants' contributions. According to ILO 2020 calculations, roughly 21.65 percent of labor sources have used various power plans, and the power sectors function directly or indirectly. The use of the new power plan expands the reach of work and the large population's working sectors. We are working with raw materials that are readily available and do not need to import, and are economic support for our country.

- **Social Factors**

  To fulfill society's demand, we need to give attention to the consumers' assertions. We use here efficiently and available methods used for any consumers and stakeholders. As we generate electricity at a low cost, people will get a huge opportunity to use electricity cheaply if we supply electricity socially. The ultimate goal of the Sustainable Earth Battery is to make the nation self-sufficient in generating electricity for home appliances and provide electricity in all critical circumstances. It ensures a profitable and sustainable electricity production system and increases purchasing power by raising all industries and individual's real savings income.

- **Technical Factors**

  Technical factors provide the physically immersive qualities of an experience. Generally, they are the parameters that lead us to label an understanding belonging to a particular medium, and within that medium, the degree of sensory details. We use different technological equipment types: multimeter, ampere meter, different kinds of sensors as humidity sensors, and temperature sensors in our projects. We are working with these technical elements so that these technical factors can improve our current production methods.

3.6. Individual Accountabilities

As this is the work of a capstone project, we do the job as a team. We split the whole job into sections, and the entire task will eventually accomplish by completing each part. We are a team of four members, and we primarily concentrate individually on any particular point. Though we are working in a team, we have done the work with some phases and separately by the four group members, shown in Table.3.3.

Table.3.3. Individual Accountabilities

Name: Borno, MD. Samiul Islam **<u>Work of Space</u>** By Almighty Allah's grace, I have completed the project with my fellow members of the group. Firstly, to have teamwork, I split the work between each member. I mainly did the hardware implementation. As a team leader, I have helped other group members achieve their goals by giving experimental data and ideas and managing the work to be completed right on time. Lastly, I also get help from our respected supervisor, external, and my fellow group members.	**Name:** Elme, Khan MD. **<u>Work of Space</u>** With a group and with group work, it's a pride to complete such a project. We split the work between each participant first to provide a team job. I mostly did the literature review, the formulation of the theory, and paper writing. I wrote a chapter called Implementation of Hardware, which is chapter five. As a team co-leader for their objectives, such as chapter writing, theory research, I assisted the group mates with appropriate guidance and guidelines. I reviewed their behaviors and made the necessary corrections. To keep him updated on our progress and further modifications, I maintain proper contact with our supervisor. Also, I was responsible for hardware improvements.
Name: : Hridoy, Iftakhar Ahmed **<u>Work of Space</u>** By Almighty Allah's grace, I completed the project with my fellow members of the party. I have been doing research and research as a group member and researching ways to increase efficiency. Primarily buy the equipment and supply the hardware required to implement to the leader. I also wrote the chapter on the individual sections. I wrote, Partly half of the chapter, 'Introduction.' I wrote, 'In-depth literature review,' 'Project Management,' chapter partially. I wrote a full chapter, 'Methodology and Modeling.' And 'Conclusion.'	**Name**: Abdullah Arafat **<u>Work of Space</u>** By Almighty Allah's grace, I completed the project with my fellow members of the party. It's all about the appreciation of teamwork and the contribution of all respondents. I tried to find a way to improve the current production rating on our project. I have been trying to figure out how to use the reactors, electrodes, and other experiment components. For writing the paper, I gather the data and write my parts. With proper graphs, tables, and figures, I also wrote the Result & Analysis section.

3.7. Multidisciplinary Components Management

We are trying to eradicate the issue of insufficient electricity and make our project an environmentally friendly device. Researchers from various scientific fields for the generation of soil electricity have used Anode, Cathode, and soil cells as glass pots for a long time now. We have also used various equipment forms to produce electricity, such as soil cells, containers, Copper, Aluminium, wire connectors, and water. We are researching better equipment for a better result, and we have found magnesium, graphite, a polymer of every hydrocarbon, and saltwater as functional equipment. We used the sticky soil forms that filled in an isolated individual jar. The height of the cell container is 10 cm, while the diameter is 8 cm. Copper is used as Anode, and Aluminium as Cathode had mounted within the soil container below the depth of 6 cm. The number of turns is 10 for electrodes with copper wires. We used 7.5 cm long and 0.9 cm electrodes in diameter, while the distance between the Anode and the Cathode is 4.5 cm.

It is now well understood that achieving sustainable electricity production demands a special effort to transcend the sector-based viewpoint and provide real-world solutions. The descending suggests a polite approach to the concept of resolutions, capable of capitalizing and incorporating sectoral information and various epistemic and normative positions and methodologies.

For that reason, the use of world-class equipment and tools in electrical development is so critical in our country. Ours was an underdeveloped nation trying to be a developing country, but using high-tech equipment like the other developing countries, we do not have too much financial situation. We use the readily available equipment gathered from nature and other sources that can be accessed.

In our project, we applied a natural and eco-friendly approach to the electricity production system. We stated that we used natural water to provide more output-the water mechanism and other equipment to provide low-cost usable electricity. So, in the future, we will use this prototype as a source of power generation and a power strategy by connecting it to the national grid.

3.8. Project Lifecycle

We have invented an exceptional design for the production of electricity. It is an alternative approach to reduce the power crisis at a low cost.

- **Initial stage**
  During the initial process, we established the purpose of the project; our objectives are to generate soil electricity with a positive effect on nature. Run low power appliances and provide electricity at a low

cost. Provide electricity to poor people in rural areas at a low price. Save nature creates poor impacts such as CO_2, CO, and other toxic gases, zero-emission radiation. Save the Earth's mineral wealth and build a power plant in the future. We are already running a start-up company under the BICCHURON-19 research project Power Cell, Ministry of Energy and Mineral Resources (MPEMR)-Bangladesh, Young-Bangla (CRI) and funded by Green-Delta Insurance.

- **Process of preparation**

  We have made a plan to complete our work for a better result in our project. It had expected to take the required measures to fulfill the purpose of the project. Our team has built an outline of operations, roles, dependencies, and timeframes. Prepare a project budget by presenting cost estimates for the cost of equipment and materials. The fund is used to track and control spending during the execution of our project.

  We are also investigating other publications to gather more information and help to better our design. Finally, we are beginning our work to set our goal. List the conditions to be met to achieve consumer attractiveness. We have done tasks individually to save more time. We have identified and developed a contact plan with all project stakeholders.

- **Implementation phase (execution phase)**

  During the implementation process, we set up and implemented a more effective battery. In the first stage of the prototype, we used 37 cells and got the battery's output. A 5-watt bulb can lighten. Can charge a cell phone. We are doing more tests and collecting more info. Our team is working on the process of adding more functionality and development. So, we reviewed the data at every meeting of the day.

- **Closing of process**

  Finally, we will develop the project as we aim it. After successful implementation, our final version of the battery will ship to the customer. We are going to hand over project papers to companies. Communicate to stakeholders. We are going to connect our generated power to the national grid. Provide electricity to the people of our country at a low rate.

Chapter 4

Methodology and Modeling

4.1. Introduction

The idea of sustainable earth battery contains the applications of supplying the electricity from the soil. The soil equipped the project's primary steps, electrodes as Copper and Aluminum, water for capacity, stable the systems voltage, copper wires for connecting the device, and isolated containers for restricted the soil charges. As we got a small amount of current, we researched different types of books and chapters. Then we decide to use some applications on our projects to get better output. We experiment with added influential reactors and water to improve the output result. For a sustainable earth battery, we create a potential difference. We create electron flow freely from Anode to Cathode. We make two compartments in one container between Anode and Cathode to get more efficient output. We designed a safe prototype for using the water in the cell. All of the equipment and system does not negatively impact using those elements for our better output and get an accurate result.

4.2. Design and Modeling

Here, Earth Battery is a DC power source designed for low power dc devices. We use soil, electrodes, and available servitors in this battery.

4.2.1. 3D Model of the prototype

Fig.4.1. 3D Model of the prototype

4.2.2. Block Diagram

The proposed system is recognized using sticky soil, positive and negative electrodes, saltwater.

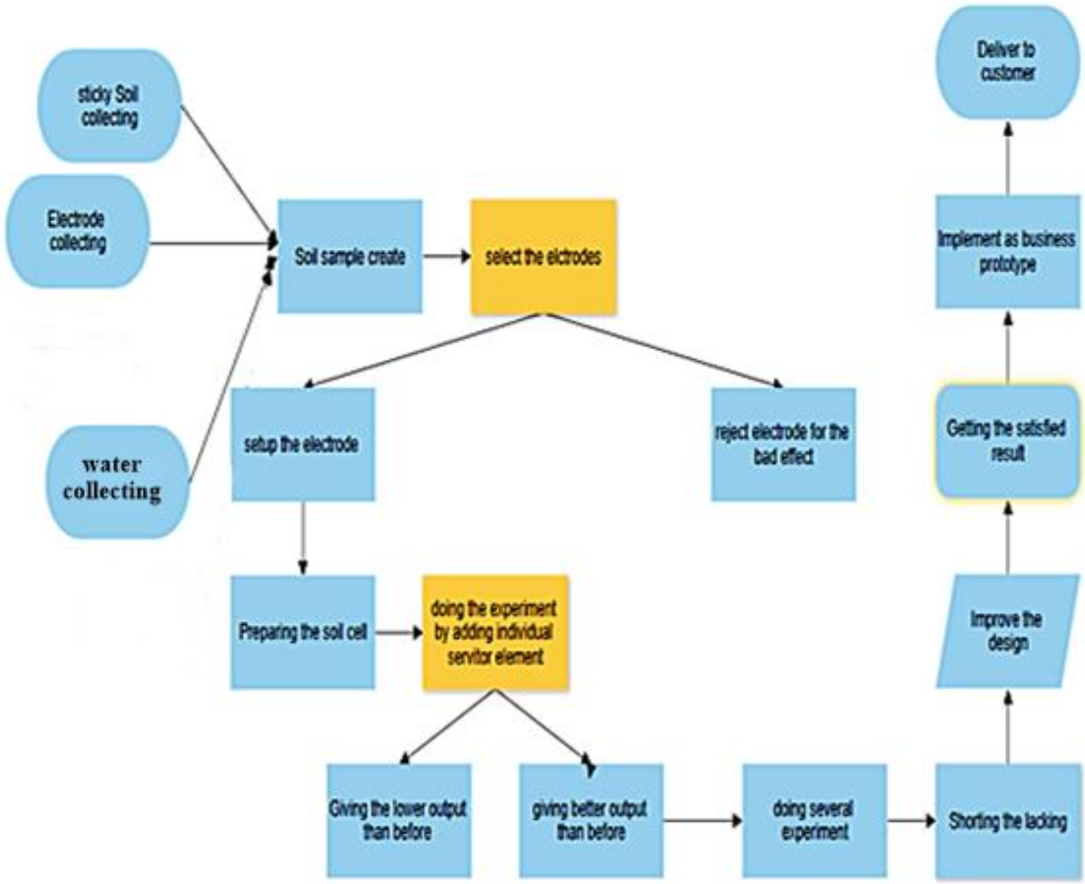


Fig.4.2. Block Diagram of an Earth Battery

4.2.3. Prototype

Soil is a capacitive element [24]. The Potential Energy of the Earth had used to convert into electrical energy in a restricted sphere. As a result, this enormous number of electrons remains stable under the ground. Batteries used in this research are Earth battery while wet batteries and air batteries may also be considered. Still, Earth Batteries' elements are easily accessible such as Soil, cell container, connecting wire, Anode, Cathode, water, analog voltmeter**,** and ammeter had used in this prototype. Anode and Cathode were used as dipole electrodes to generate this initial force for moving electrons. Copper and carbon rod were used under a soil container as Anode and Aluminum as a cathode. Compared with the Cathode, anode attraction attracts electrons that repel the electrons that allow the Cathode to carry (-ve) charges for its Attraction/Repetition status. A sample prototype-diagram has shown in Fig.4.2.

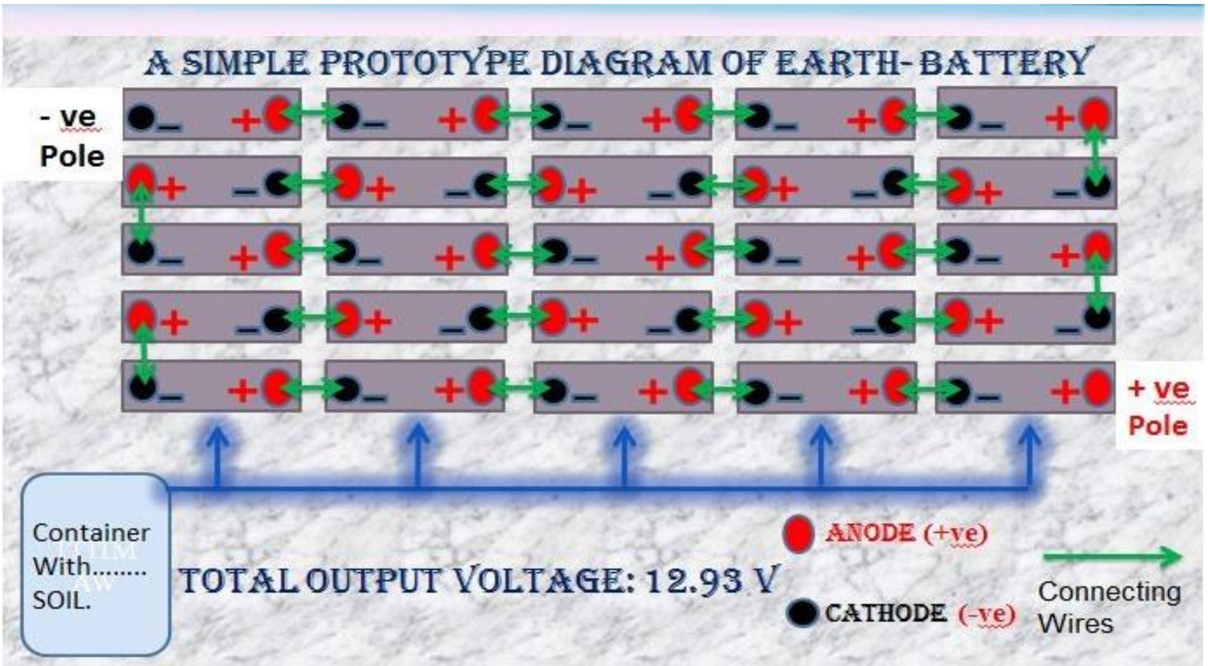


Fig.4.3. A Sample Prototype Diagram of an Earth-Battery

4.2.4. Basic Components

The necessary components that we have used in our project had briefly discussed below:

- **Soil**

From various locations, we collect soil. Collect different soil types. We gather mud from a river, pond, and agricultural field from each division and every spot. Both soil types had tested. However, due to their closer inter-molecular distance and higher ion density, red sticky type soil, and decomposed soil showed better output.

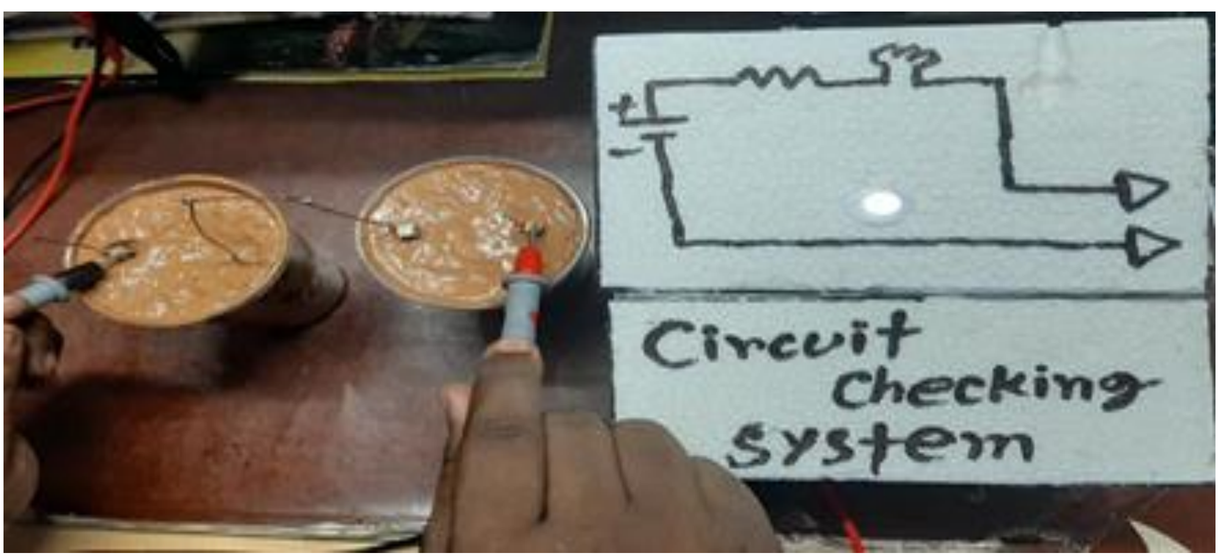


Figure 4.4. Soil conducting current

- **Water**

Water had used to produce mobile ions as a noteworthy feature. It will boost conductivity and create a convenient path for the movement of electrons. Various forms of water are stored, such as regular water, drain water, pond water, river water, saltwater.

- **Electrodes**

Due to its mobility and conductivity, Copper and Aluminum had chosen for the Anode and Cathode. Copper's conductivity with electron affinity is 58.14×10^6 s/m (-119.2 kJ/mole), and the conductivity of Aluminum is 3.8×10^7 s/m with electron affinity (-41.8 kJ/mole) [25]. Copper and Aluminum also have a lower cost and weight than other electrodes.

- **Non-Conductive Container**

An isolated insulator container had used to hold the materials connected. It had used during the same time for the restriction between the cell and the ground. The container was estimated to be 8 cm in length and 7 cm wide.

- **Cork Sheet**

The cork sheet was used as a pocket to hold all the cells.

- **LED. Bulb**

For testing purposes, 12-volt, 5-watt LED. Bulbs were used.

- **Connecting Wire**

1 mm of neutral copper wire had used to connect the system.

- **Analog Voltmeter**

The analog voltmeter is used to calculate the single-cell output voltage and the total battery voltage.

- **Analog Ammeter**

We used an analog ammeter for the measured output current rating.

4.3. Working Process

Soil, Water, and Electrodes were used to make a single cell, and after that, by increasing the cell number, we created a prototype of Earth-Battery. The Earth-Battery is connected with a switching circuit and a Secondary battery. When the switching circuit is off, the secondary battery continuously charges from the Earth battery to the secondary battery's limit. When the switching circuit is on, The Earth battery and The Secondary battery gets parallelly connected to turn on the load.

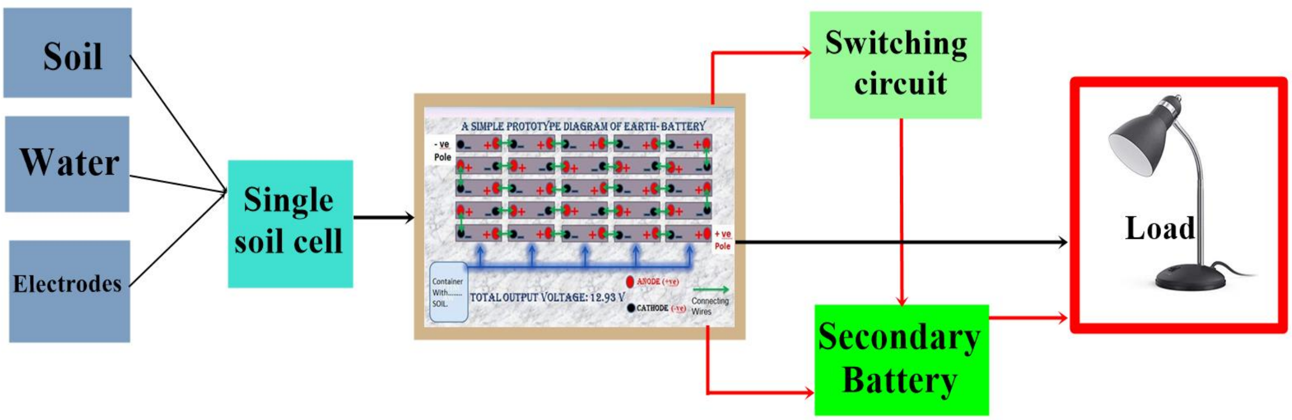


Fig.4.5. Working Process Diagram of the Prototype

4.3.1. Systematical Mechanism

The prototype has designed to produce soil-based electricity. Complex engineering was the focus of the process, such as making potential differences in restricted ground areas. Firstly, by making individual cells in an insulated container, the soil is restricted from the soil cell. Anode (Cu, Carbon) and Cathode (Al) had implemented dipole in cells to measure the separation of positive and negative electrical charges within a cell to measure the soil cell's overall polarity. The first cell's Anode has connected to the second cell's Cathode, and the second cell's Anode to the third cells' Cathode, and thus the whole system is designed. After that, a series circuit operation had carried out to increase voltage and series-parallel operation to increase the power-generation. The charges of Anode (+ ve) attract electrons, and the charges are carried by the Cathode (-ve)

on the other hand, and the cathodic electron had repelled. The average voltage of 0.5V (DC) had measured in every soil cell; water had used for soil wetting for soil storage loads. Each cell container's total weight is 450 gm on average, and the atmospheric temperature is 24.2° C per day. Because of the soil properties, researchers have a variable voltage. Fluctuating voltage had obtained due to the soil characteristics. When 0.779V (DC) is found in higher soil cell values (in wet conditions) and 0.328V (DC), in dry conditions, in soil cell values are found. By using different circuit connections, the output could vary.
The output can control a limited quantity according to user requests. For a series-parallel connection, the resulting power for 50 cells has displayed as P = VI. The prototype was divided into two compartments: cell-A and the other is cell-B. As a result, 12 V (DC) and 30 mA with 25 series cells. Again, the cell-B series contains 25 series cells, 12 V (DC), and 30 mA current. In this prototype, the total voltage of 12V (DC) from the overall cell-A series and cell-B series operated with parallel, and the ampere rating has increased to 60 mA. A 12V sustainable earth battery prototype has shown in Fig.4.6.

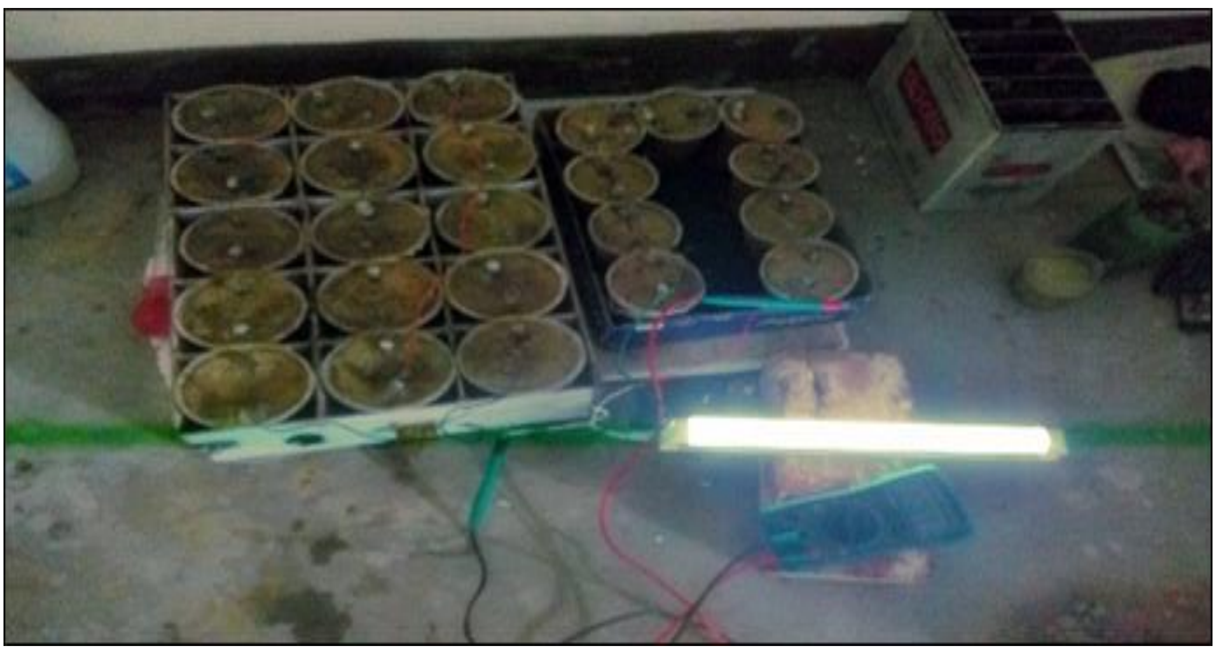


Fig.4.6. A 12V working prototype of a sustainable earth-battery

4.3.2. Theoretical Equations

By position, every material on the planet has potential energy. It can be expressed as to potential energy theorem, $E_p = mgh$ (equation 1)
The difference of potential energy of two materials can be expressed as ΔE_p, which is known as a potential difference or voltage.
From equation 1, $E_p = mgh = Fh$ $[F = mg]$

The "Coulomb's Law," $F = \frac{\mathrm{K}q_1 q_2}{r^2}$ It is consistently applied for a prototype because the voltage will be maximized when the distance between the electrodes is higher [26]. The voltage will be reduced when the distance is lower, which has shown in Fig. 4.7.

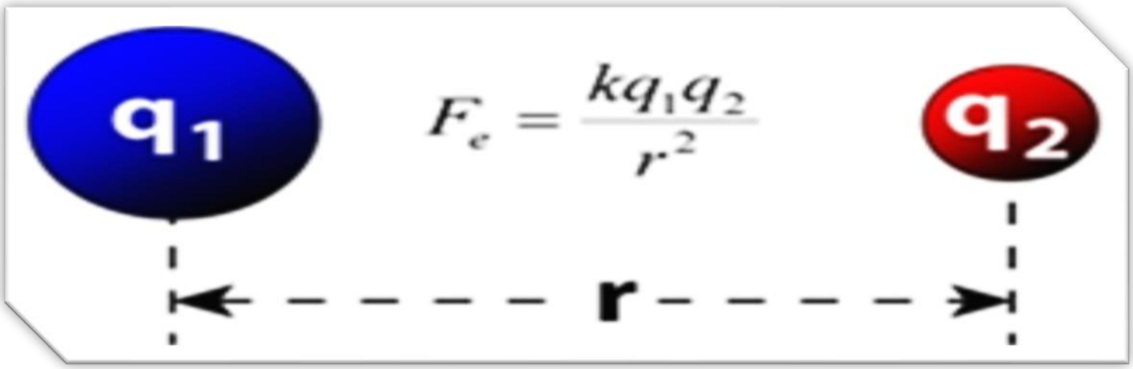


Fig.4.7. Coulombs Law's expression diagram with equation

So, $E_p = V = \frac{\mathrm{K}q_1 q_2}{r^2} \times h$;

here, h= distance of electrodes from the ground.

That is how coulombs law and potential energy theorem have been applied in this project. If h and q increases, the voltage will increase [27].

The electron flow of this earth-battery has shown in fig.4.8.

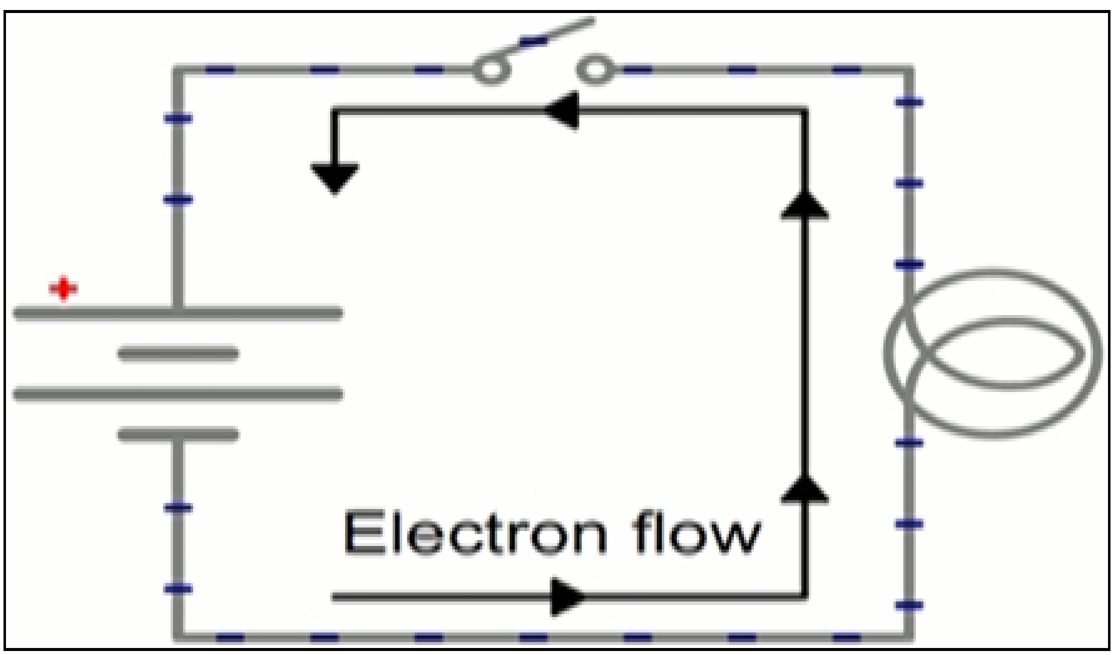


Fig.4.8. Electron flow diagram of a sustainable Earth-Battery

A single soil cell of a sustainable battery can produce 0.5V (DC), shown in Fig. 4.9.

Fig.4.9. Single soil cell of a sustainable earth-battery

Multiple earth-battery cells can supply 17.75 V(DC) and 30 mA with 36 series-connected cells have shown in Fig.4.10. and it may vary with demand.

Fig.4.10. Multiple soil cell of a sustainable earth battery

4.4.Summary

The critical project work process had written in detail in this chapter. We focused on sustainable earth battery methodology and modeling. The facts and procedures reported were written in this chapter at the time. We also mentioned the materials used in our project in this chapter. Here we showed how the cell had been designed. The output of the single-cell had calculated.

Chapter 5

Project Implementation

5.1. Introduction

Sustainable Earth Battery is a clean and renewable energy source that can meet low power demand and demand in remote areas. Without the application of the collected data, a reliable attention value cannot be achieved. The project's final implementation had done after completing all segments, i.e., theory generation, modeling, and design. Fig.5.1 demonstrates the methods of implementation of this project. A Sustainable Earth-Battery is a combination of these two compartments Anode and Cathode.

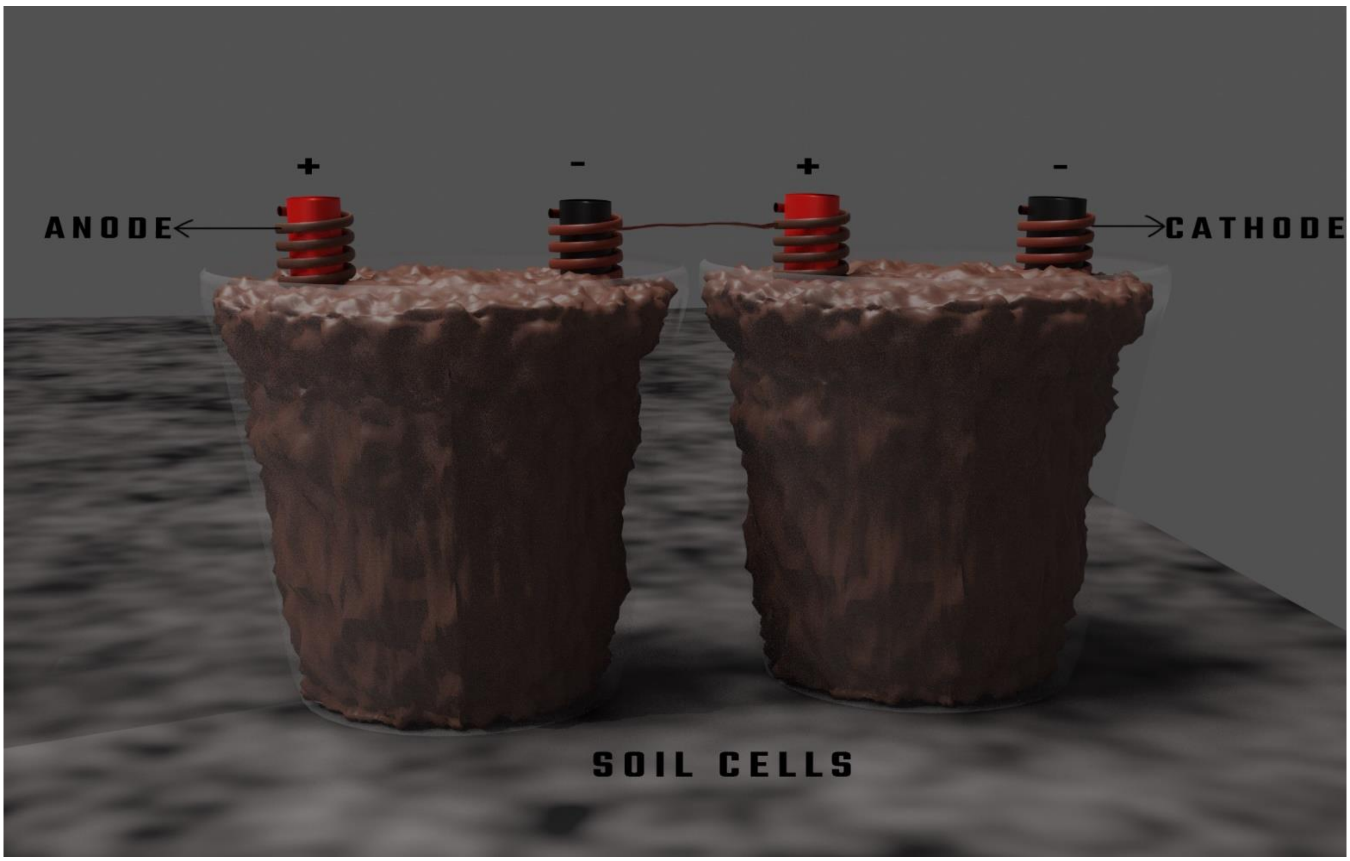


Fig.5.1. Cell designing

5.2. Implementation of the project

This project demonstrates the Sustainable Earth Battery concept of low-energy electrical capacity. The main objective of this project is to produce electricity at a low cost. The project is carried out in individual experiments that include a single cell design and 12V prototype design.

- Single-cell designing:

After selecting soil, water, electrodes, introducing a single cell was made. In two compartments, one is the cathode compartment, and the other is the anode compartment, a single cell was added. Finally, two compartments that make a single cell are electrically connected. Below, there will be a detailed review of the theory of how a single cell has been applied.

5.3. Materials Processing

5.3.1. Soil Processing

Different types of soil collected from different location have been examined for this project. However, due to its low intermolecular distances and higher water absorption capacity, sticky type soil was selected. Sticky type of soil collected and tested from different places has shown in Fig 5.2.

Fig.5.2. Sticky type of soil collected and tested from different places

Red sticky soil has more potential for water absorption. It was dried with the sun's heat for one week after the soil was collected. When it was scorched, the soil was powdered. For an individual compartment, 500 gm of soil was taken.

5.3.2. Soil with Water

Water was used to create contact between all soil materials. Due to its lower PH level, industrial wastewater was chosen. It was necessary to have the PH level in question since conductivity depends on the level of PH. In this initiative, industrial wastewater has served as an influencer and will increase soil compounds conductivity. In an individual compartment, 200g of water was added after water selection. Fig.5.3. reflects a visible cell scenario after water is applied.

Fig.5.3. Water added Soil cells

5.3.3. Electrodes Implementation

Carbon and Aluminum have been chosen for this project as electrodes. Carbon acted like Anode, and Aluminum worked like a cathode. So, a Carbon rod was delivered into the natural soil compartment was provided with an Aluminum rod. The height of the electrode was 7.5 cm, and the width was 0.5 cm. We made 18 turns to take readings with copper wire and attach them to other cells shown in Fig.5.5.

Fig.5.4. Electrodes implementation in soil cells

5.3.4. Supporting tools used in the project

- Cork Sheet
- LED. Bulb
- Connecting Wire
- Analog Voltmeter
- Analog Ammeter

5.4. Experimental Process

- **Single-cell prototype**

A container of 8 cm of plastic in height has filled with soil up to 7 cm. Electrodes were dug into the soil up to 4 cm in depth. The remaining 3 cm of the electrodes is above the soil refill. There were 20 turns of the electrode with copper wire. Fifteen of which were above the soil, and five were below the soil. A small amount of water was provided to activate the cell.

- **Single-cell measurement operation**

For measuring the single-cell output, a multimeter has been used. If the distance between the electrodes is high, the voltage will be maximized, and the voltage will be reduced if the distance is low. The voltage varies between 0.4 V-0.7 V(DC) because of the cell's electrode placement and humidity distance. So, 0.5 V(DC) has taken as a standard voltage for making the cell measurement operation stable.

- **Series operation**

Single-cell output with an analog multimeter has been measured in a series connection; 36 cells were connected. 17.75 V(DC) 30 mA has been calculated as output. Environment temperature and moisture also affected the setup prototype. Experimental results were taken at room temperature (22.5˚C to 31.1˚C), and humidity was between 51%-65%. This prototype produced a low current flow, so the intensity of the LED was low. The current can be increased by adding parallel connections. A figure of a series operated prototype of a sustainable earth battery has shown in Fig.5.5.

Fig.5.5. Thirty-six cells in series connected sustainable earth-battery with and without load.

- **Series-Parallel Operation**

In the series-parallel operation, each set of 18 cells were connected in series, and two sets of that cell prototype with a total of 36 cells were connected parallelly. The Ampere rating has been noticed to be doubled, and 8.87 V(DC) and 60 mA have been obtained. Temperature and cell conditions varied in voltage and current. In wet conditions, in the presence of water, the voltage and ampere rating has increased, and in the dry state, it has reduced. As soluble ions in the soil are indicated with electric conductivity, measuring the electrical resistance of a 1:5 soil: water suspension, the electrical conductivity (EC) determination is made with a conductivity cell [28]. A figure of a parallel operated prototype of a sustainable earth battery has shown in Fig.5.6.

Fig.5.6. Two sets of 18 series cells connected in parallel for sustainable earth-battery with and without load

5.5. Standard Prototypes

5.5.1. Single-cell prototype

- **Cell processing with soil**

A container of 11 cm of plastic in height and 8 cm in width has filled up with red sticky soil up to 6.5 cm, shown in Fig.6.7. The electrodes remain stable in their position as 3.5 cm of the cup is clustered with cement to adjust the Electrodes.

Fig.5.7. Soil processing

- **Electrodes implementation**

In the container, the electrodes are clustered in the bottom with cement. Here Carbon had used as Anode and Aluminum as Cathode. Both have the same height, which is 15 cm, and the diameter for Anode is 1.2 cm, and for Cathode, it is 0.7 cm. Electrodes were dug up to 10 cm inside the soil, and the remaining 5cm was outside the soil. The distance between the two electrodes is 5 cm. There were 30 turns of the electrode with copper wire. Twenty of which were above the soil, and ten were below the soil. A small amount of water was provided to activate the cell.

Fig.5.8. Electrodes Implementation

- **Cell weight**

Cell weight= Electrodes weight+ Soil weight+ Cement weight

= (65+450+150) gm

= 665 gm

- **Cell prototype**

For measuring the single-cell output, a multimeter has been used. If the distance between the electrodes is high, the voltage will be maximized, and the voltage will be reduced if the distance is low. The voltage varies between (1 – 1.2) V DC because of the cell's electrode placement and distance. So, 1 V(DC) has taken as a standard voltage for making the cell measurement operation stable.

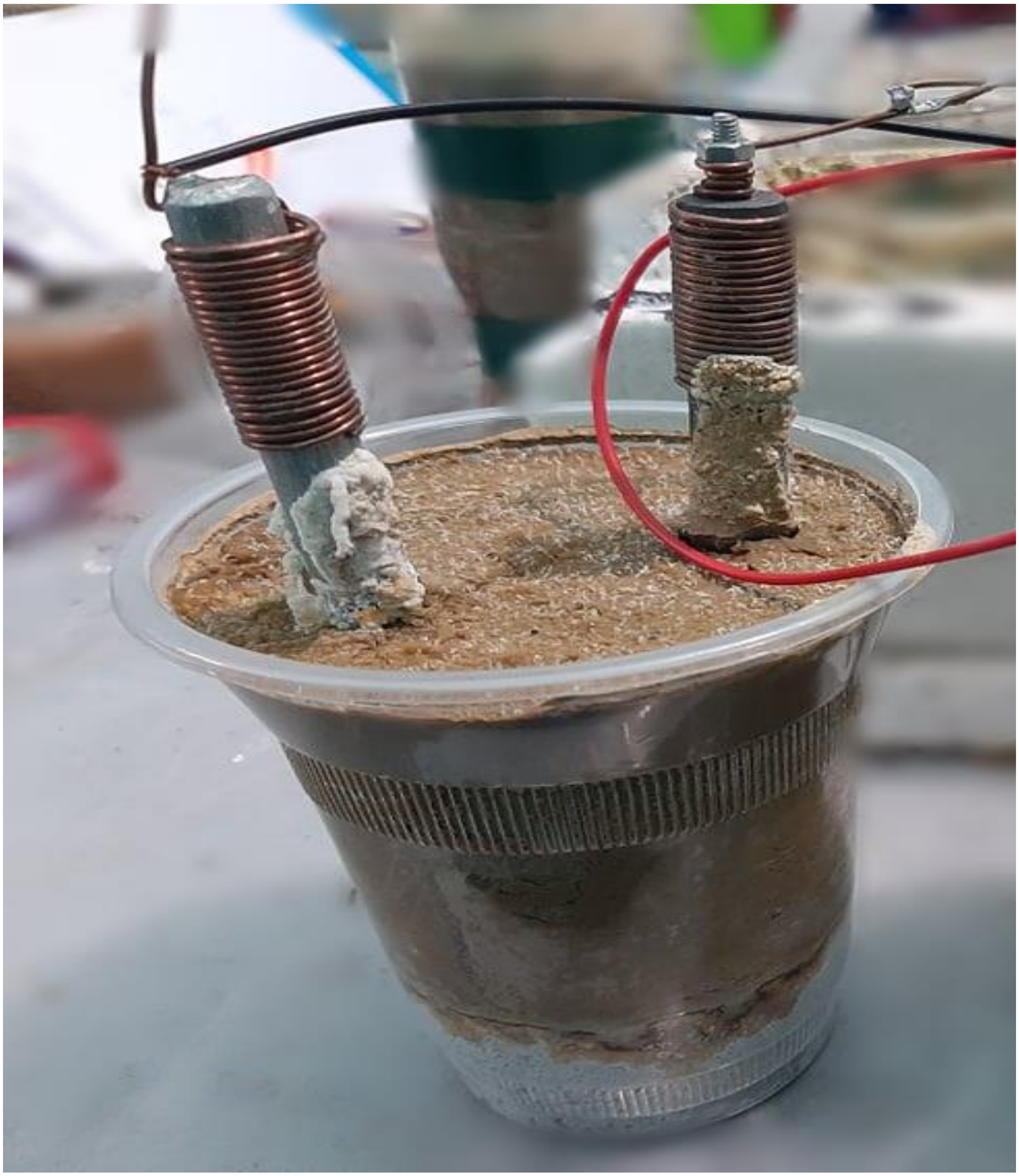


Fig.5.9. Single Cell Prototype

5.5.2. Standard Prototype with Double cell

We were able to lighten the simple LED. Light with a double cell and the intensity was very decent and was linked in series with around 2.5 V (DC) output voltage as shown in Fig6.10.

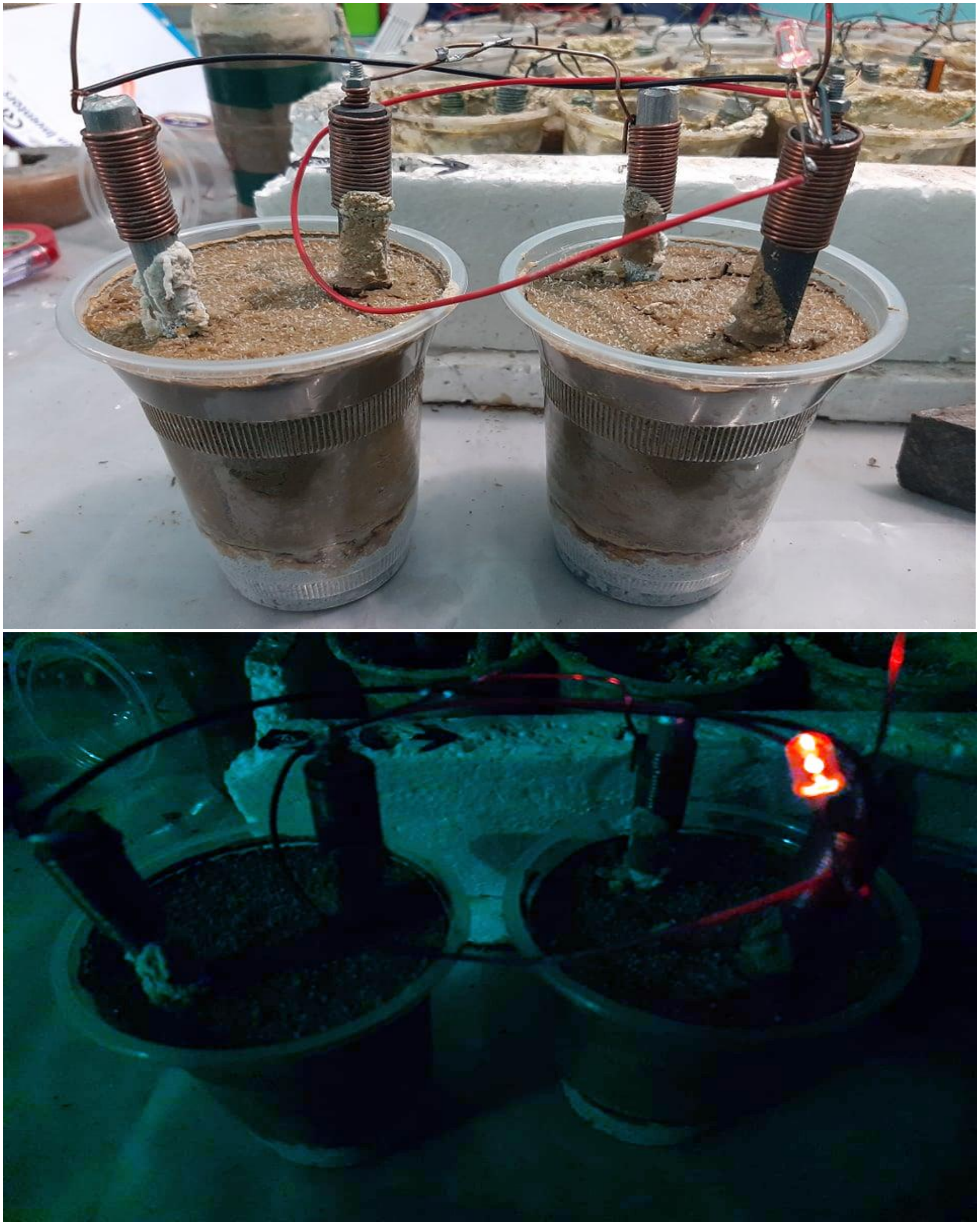


Fig.5.10. Working prototype with double cell

5.5.3. Series Connected Standard Prototype

There are 25 cells connected in series, where each cell has a voltage around 1 V DC. Cell no.25 had used as a power backup cell. With the 24 cells, we get the voltage approximately around 24 V DC, and the current rating was 25 mA. The working series-connected standard prototype has shown in Fig.5.11.

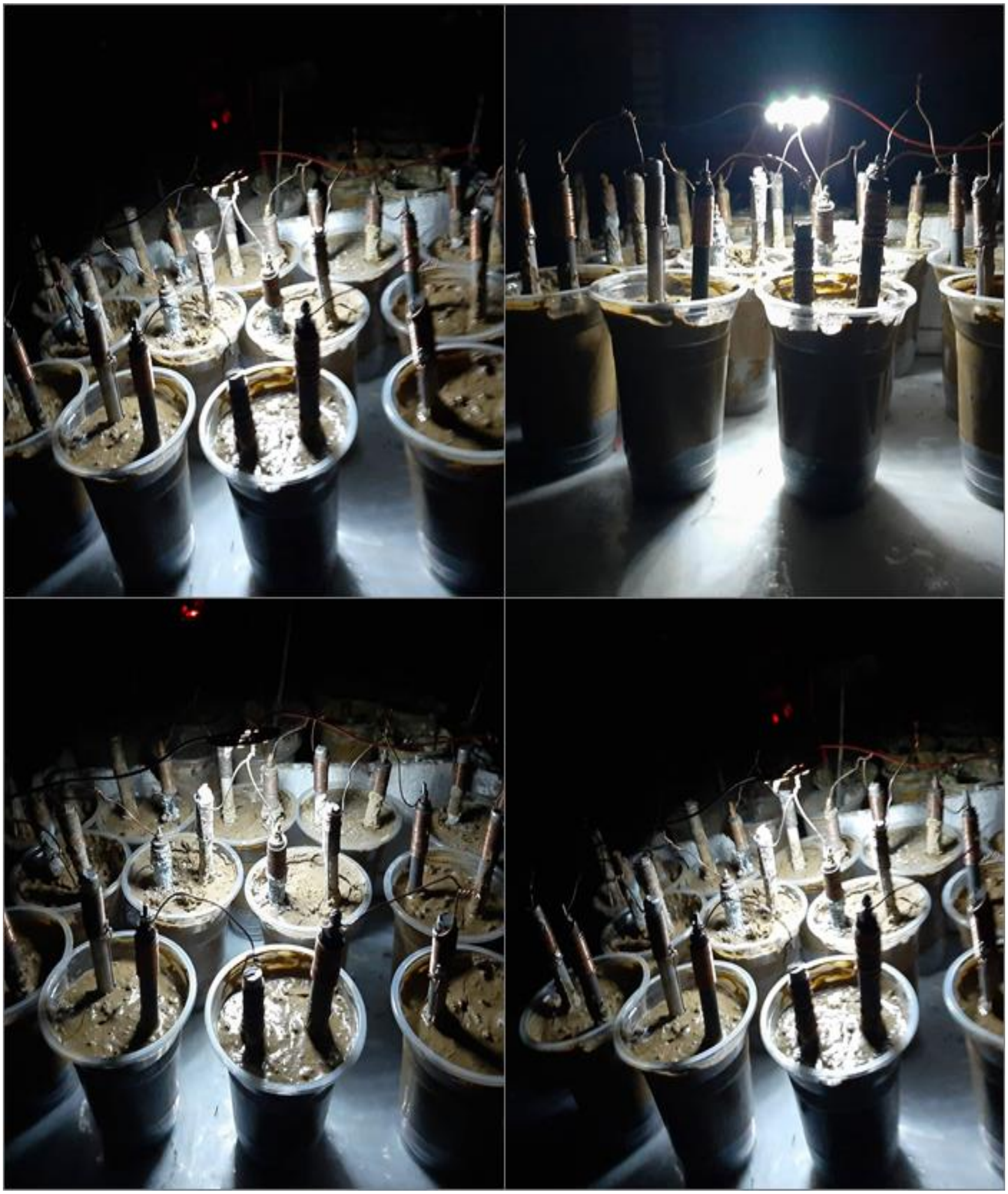


Fig.5.11. Series Connected working Standard Prototype

5.5.4. Series-parallel Connected Standard Prototype

There are 25 cells in total, where each cell contains 1 V DC. 24 cells are connected in a series-parallel connection and splitting them into four compartments. Each compartment has six cells connected in series. They are then parallelly connected with each compartment, and therefore we get a standard 6V prototype with a current rating of 100 mA or 0.1 A, which has shown in Fig.5.12.

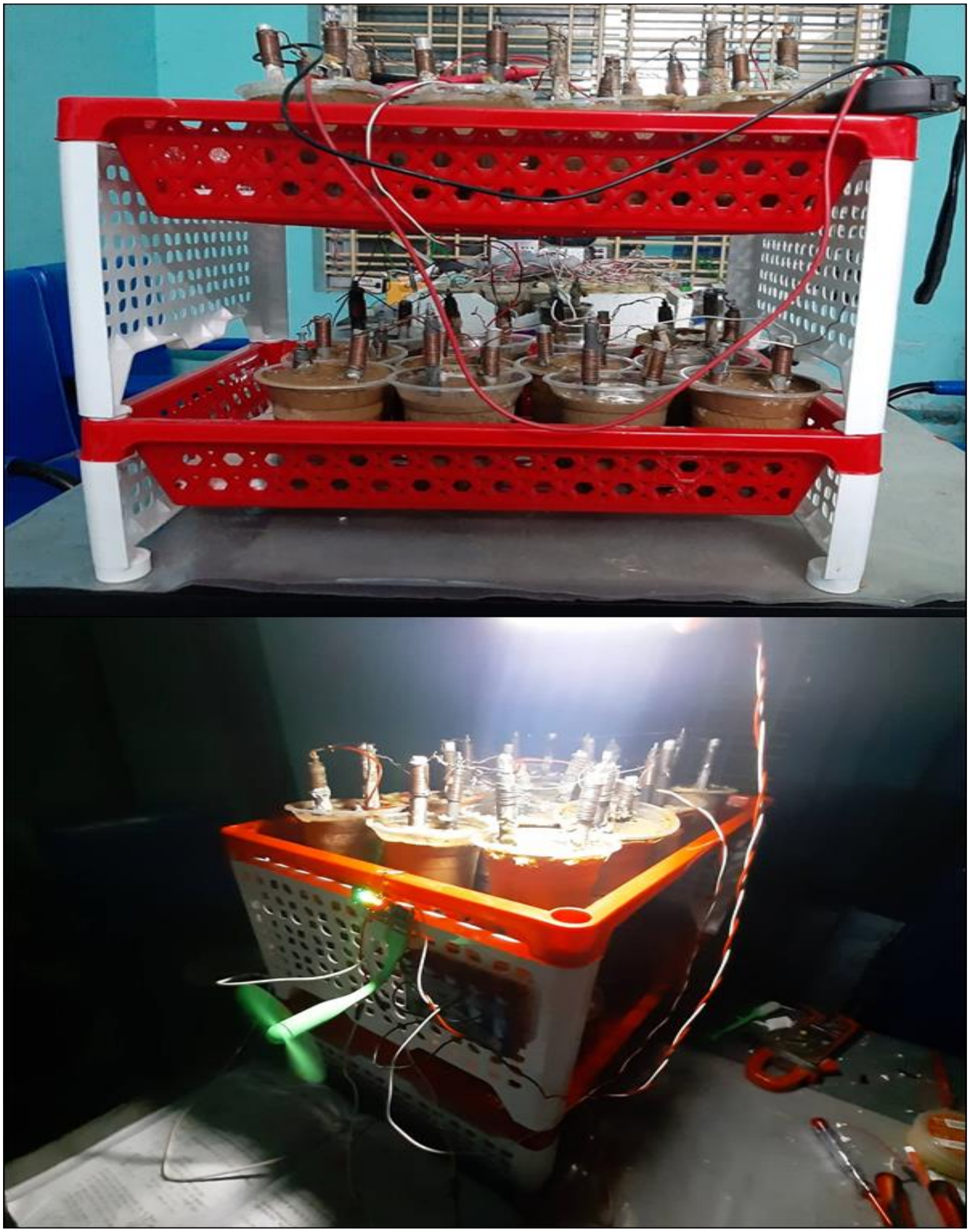


Fig.5.12. Working Series-Parallel connected standard prototype

- **Series-parallel Connected Standard Prototype with charging circuit & DP switch**

The Earth-Battery is connected with a switching circuit and a Secondary battery. When the DP Switch is off, the secondary battery continuously charges from the Earth battery to the secondary battery's limit. When the DP is on, The Earth battery and The Secondary battery gets parallelly connected to turn on the load.

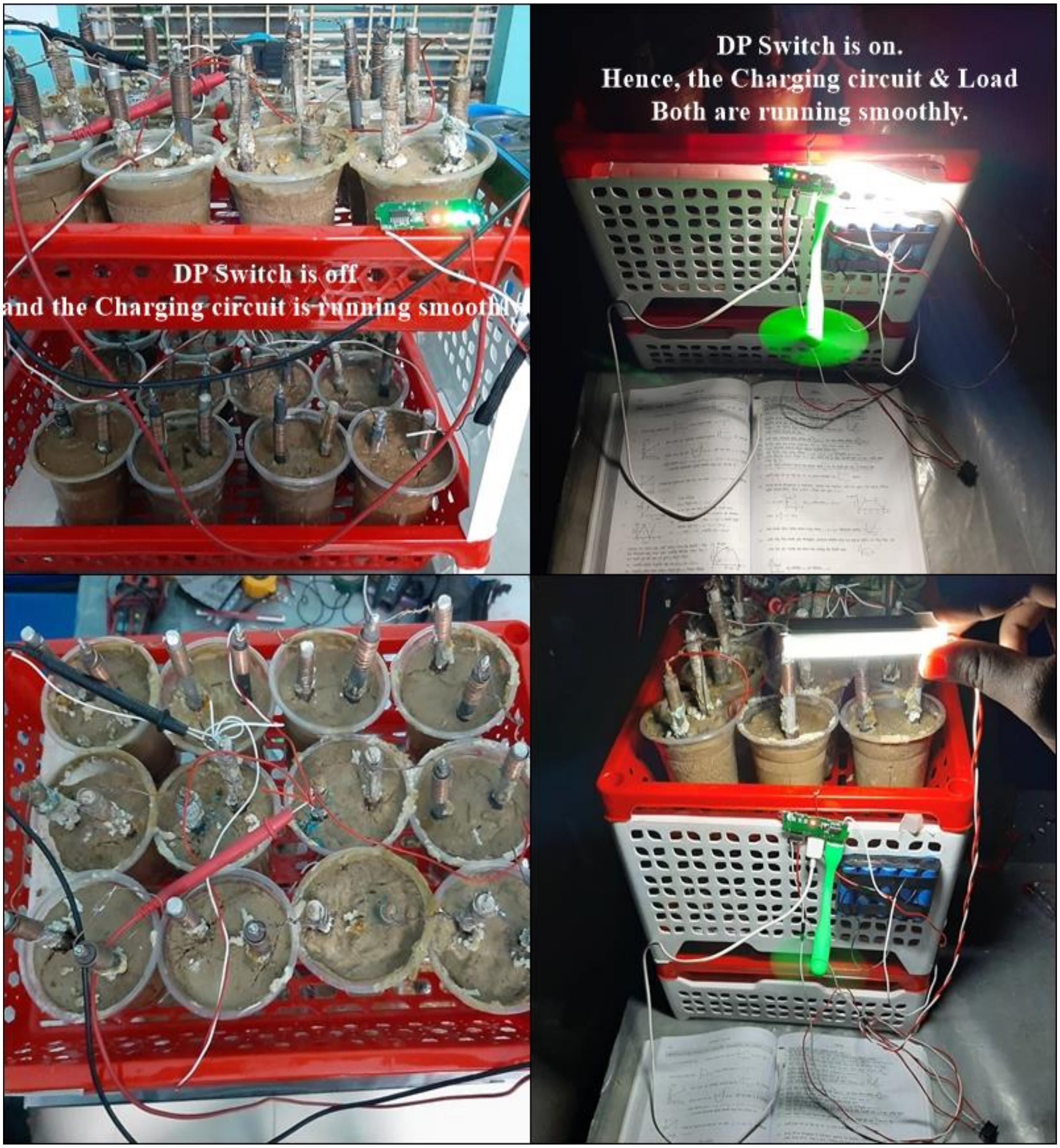


Fig5.13. Working Series-Parallel connected standard prototype with charging circuit and DP switch

From the Fig.5.13. we can see the working Series-Parallel connected standard prototype with charging circuit and DP switch with load and with no load condition which has recorded. The 3 W LED light and a 5 W fan were running smoothly after switching ON the DP switch, and when the DP switch is OFF the charging circuit starts to charge the secondary battery from Earth-Battery.

5.6. Summary

This chapter provides in-depth knowledge of each selected variable and the procedure for implementation. There are various models available with different components that have different outcomes. The rationale for choosing the specific models of each particular element had also stated. Finally, a short description of the process for implementing the project had given.

Chapter 6

RESULTS, DATA ANALYSIS & FINDINGS

6.1. Introduction

This chapter addressed data analysis and research findings. The methods used in this prospective study had thoroughly checked to ensure that, with tables, figures, and graphs, the information collected was clearly defined where possible. A spreadsheet analysis had conducted to collect the data required to achieve the study objectives.

6.2. Simulink Diagrams

- **Series Cell Design**

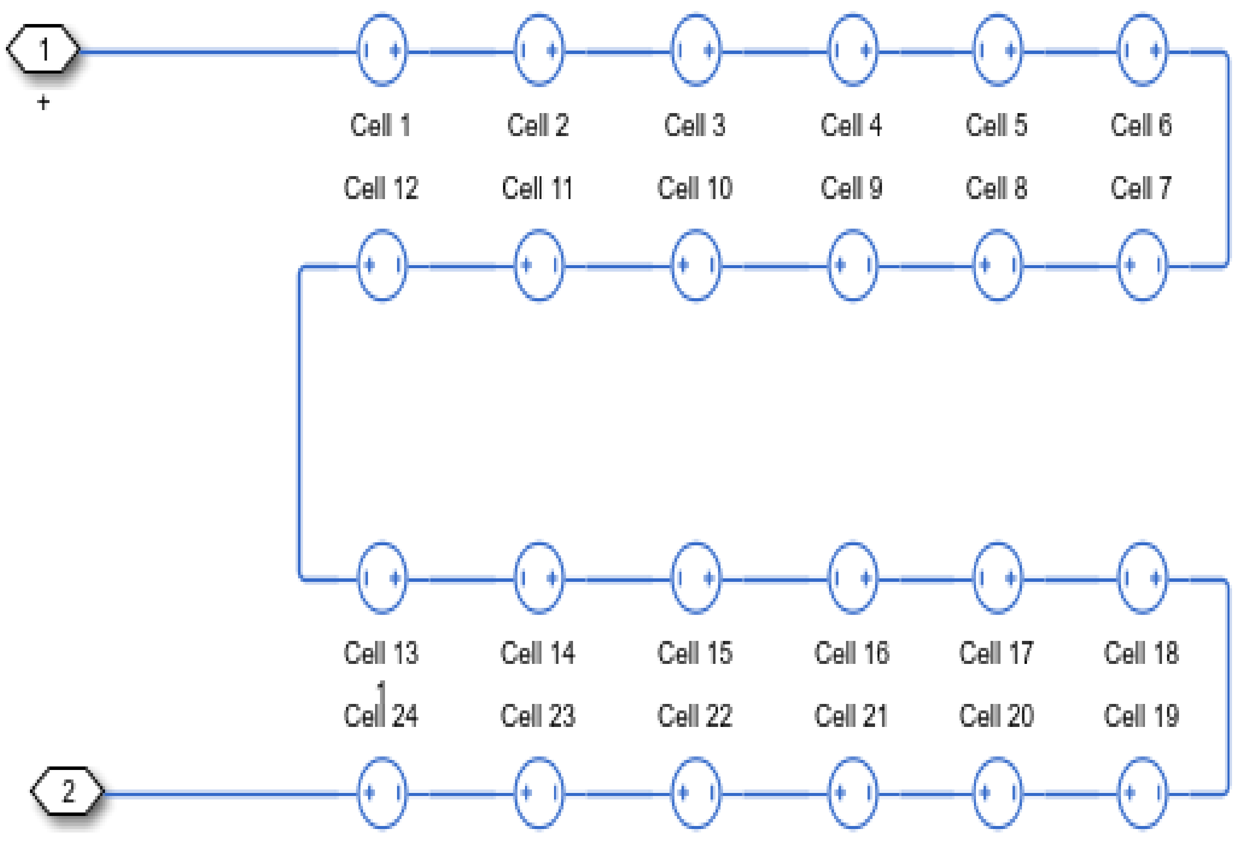


Fig.6.1. Cell design of the prototype

- **Earth-Battery integrated with Switching Circuit**

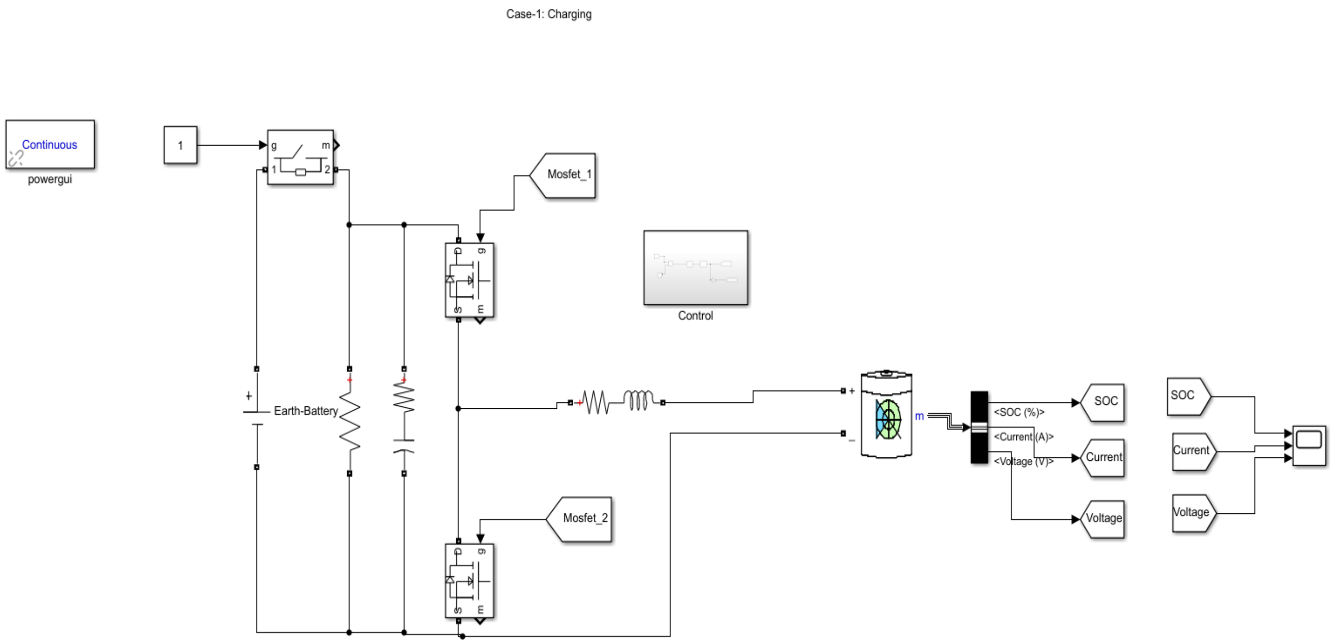


Fig.6.2. Earth-Battery integrated with Switching Circuit

- **Control Box Design**

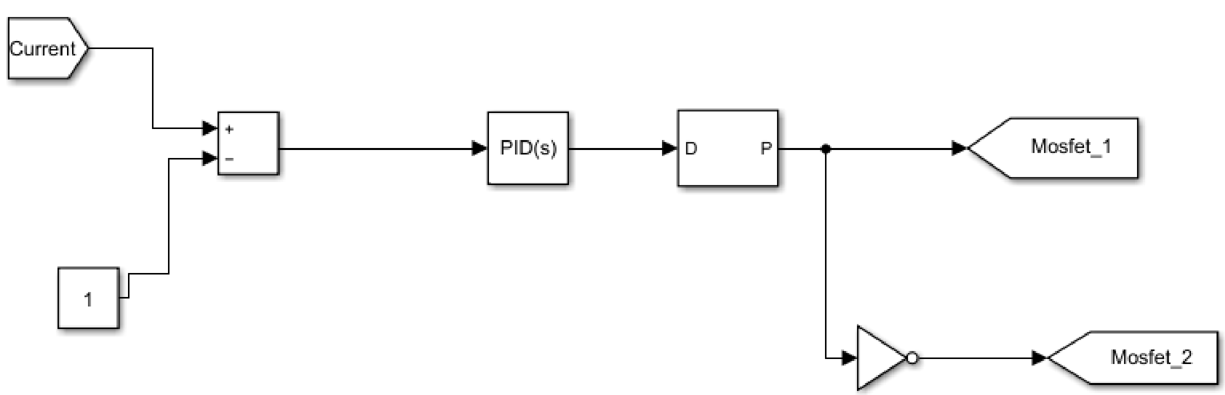


Fig.6.3. Control Box Design of the prototype

- **Whole prototype Design with output**

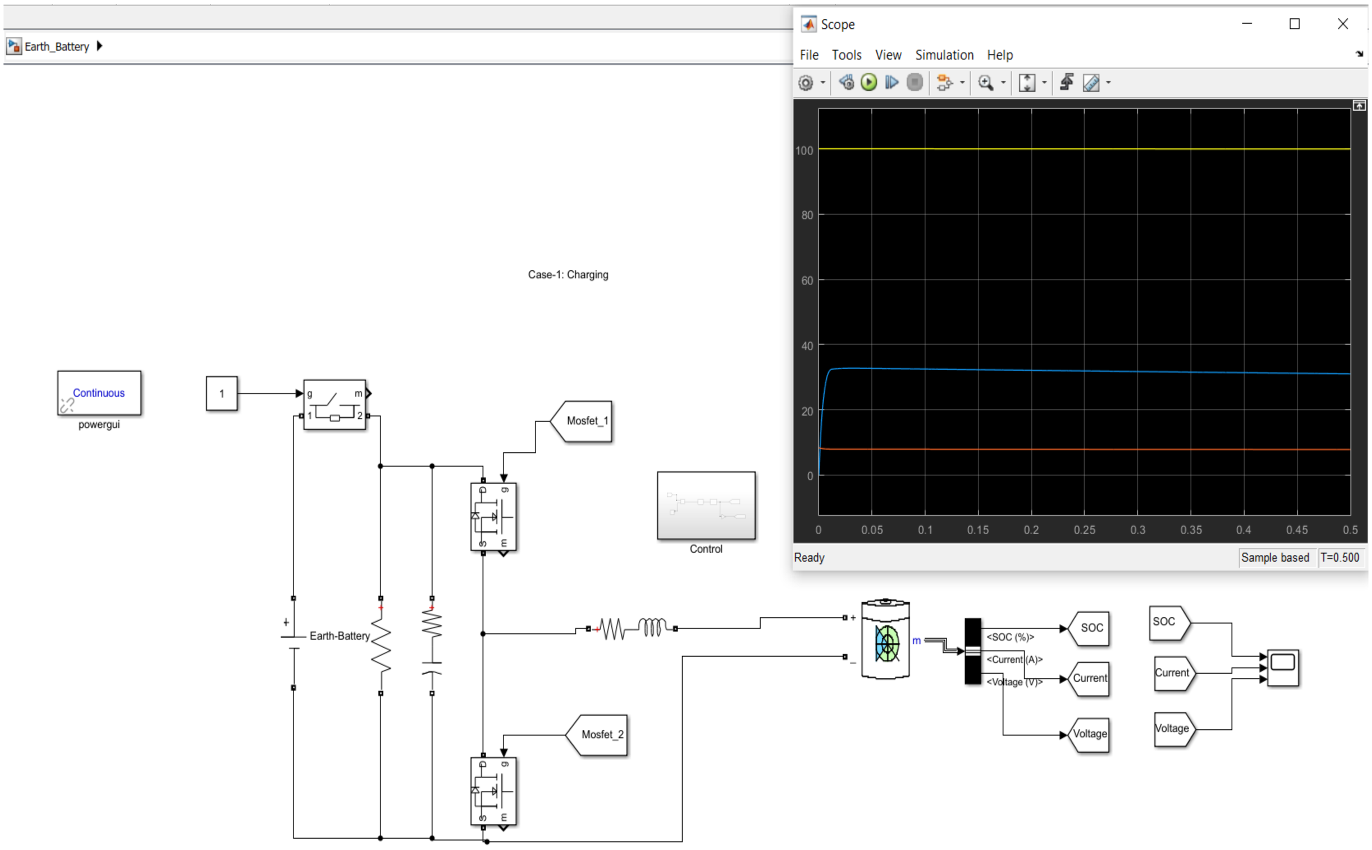


Fig.6.4. Whole prototype Design with output

- The output result of the Prototype

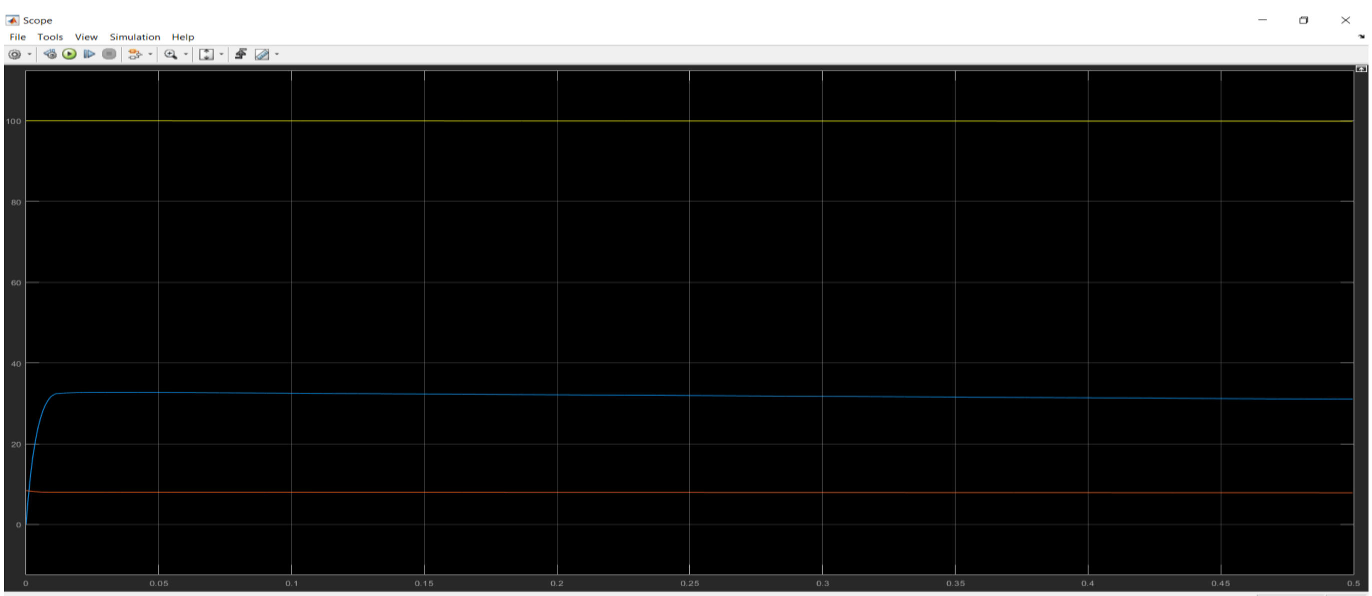


Fig.6.5. The output result of the prototype

6.3. Data Findings

6.3.1. Series connected cells data

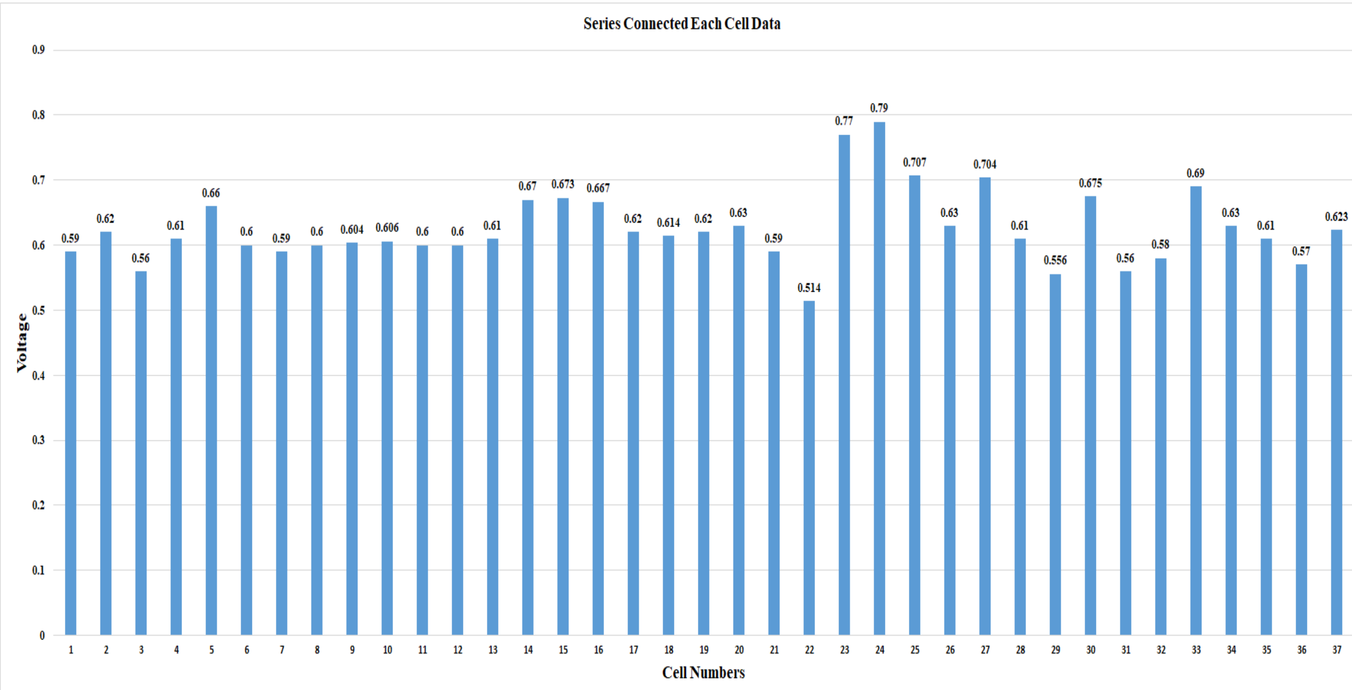


Fig.6.6. Series connected cells data

In series connection there are thirty-seven cells are connected in series where cell no. 37 had been used as a backup cell to stabilize the voltage.

We gathered seven days of Series connection Data to find the average output voltage and calculated voltage, which has shown in Table.6.1.

Table.6.1. Series connected Output and Calculated Voltage data of seven days

Date	Output voltage V(DC.)	Calculated voltage V(DC.)
7/12/2020	17.55	23.12
7/13/2020	17.53	22.2
7/14/2020	17.65	21.12
7/15/2020	17.85	20.33
7/16/2020	17.4	21.3
7/17/2020	17.2	21.03
7/18/2020	17.7	23.12
Average	**17.55**	**21.74**

From Table.6.1. above, we can see that the average output voltage by observing it for seven consecutive days is lower than the average measured data. We also draw a graph to see if there is any voltage loss, shown in Fig.6.7.

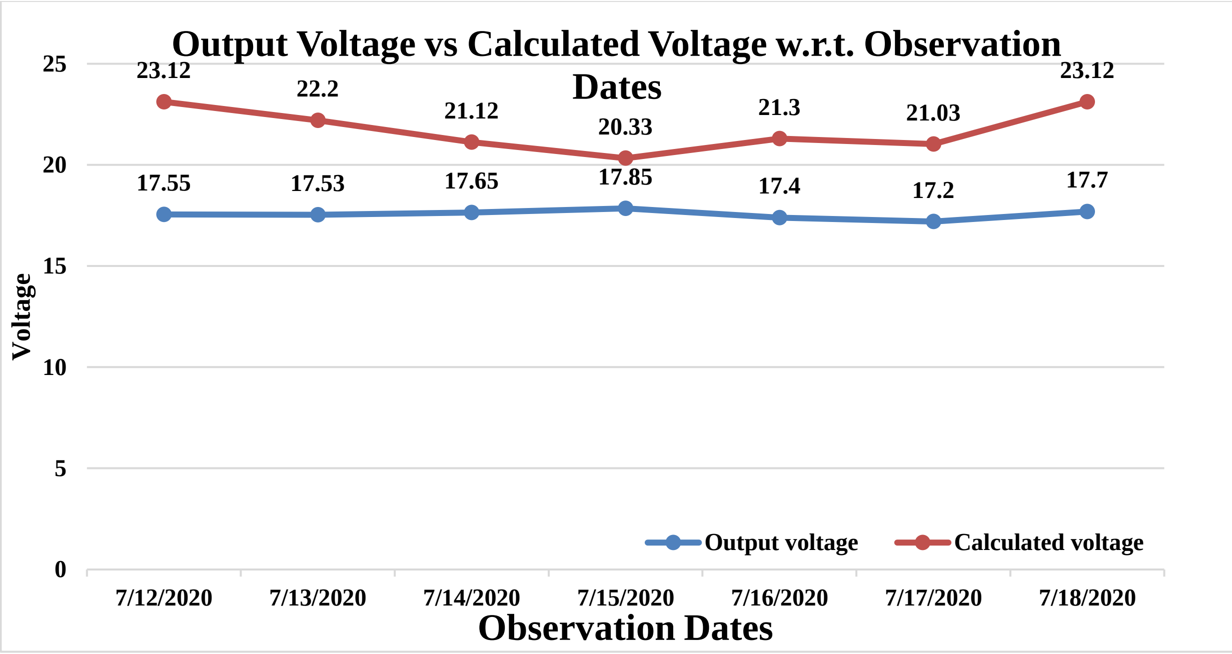


Fig.6.7. Output Voltage vs. Calculated voltage w.r.t Observation Dates

The above graphical presentation shows the difference between the Output voltage and Calculated voltage. Where output voltage is the result of the whole prototype by measuring it with a digital multimeter meter, and Calculated voltage is the summation voltage of each cell voltage, which may vary for voltage loss in different criteria such as internal resistivity of wire and low conductivity. That is why the Calculated voltage is changing over time.

We may observe the loss of voltage in the device by looking at table 6.1 and Fig.6.7.
The loss of voltage can occur due to water, which may cause the electrodes to rust. There is also a chance that the electrodes were not stable as they were not clustered because of the electrodes' movement; the device may have a voltage loss.

We know that the voltage loss is the result of the subtraction between Calculated voltage and Output voltage.

So, **Voltage Loss** = Calculated voltage – Output voltage

= (21.74 – 17.55) V = **4.19 V**

$$\text{\% Voltage loss} = \frac{voltage\ loss}{Calculated\ voltage} \times 100 = 19.27\%$$

So, there is a 19.27% voltage loss in the series connection.

We know, Power = Voltage × Current

So, P = 17.55 × 30 mA = 0.5265 W

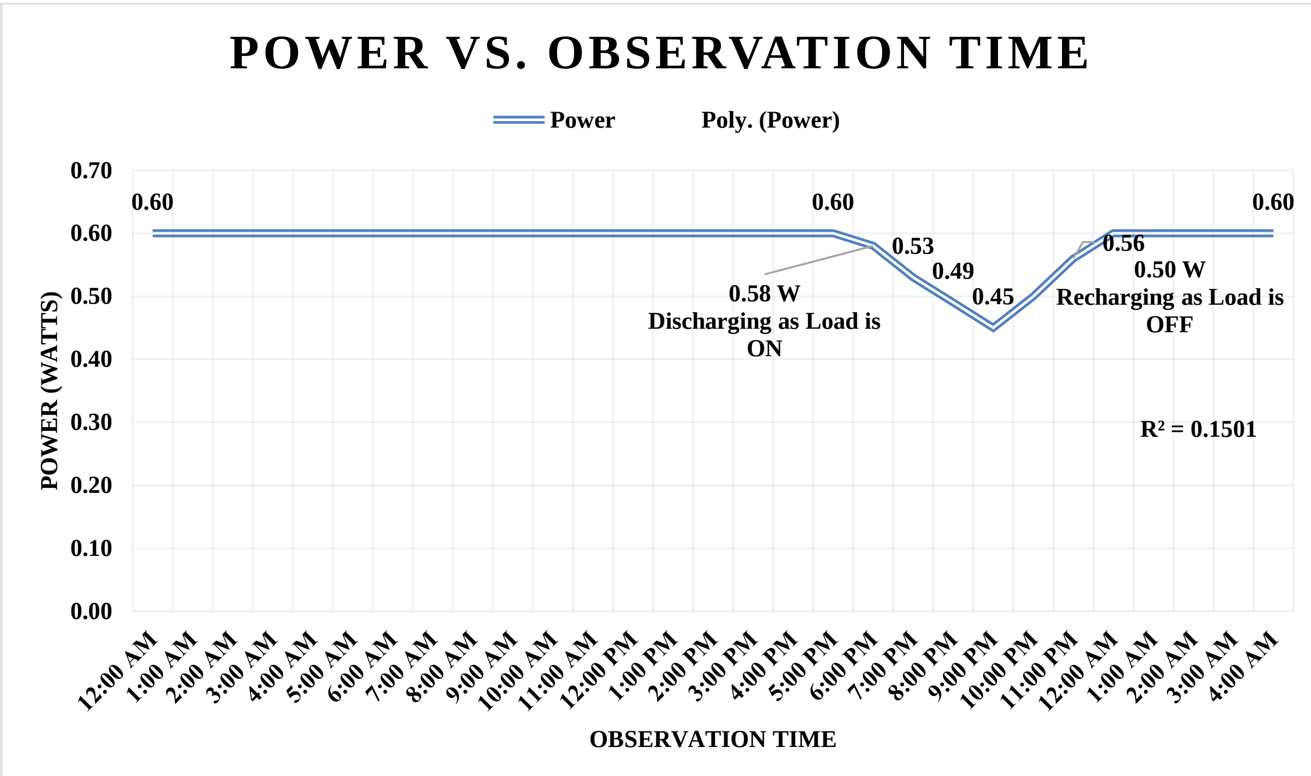


Fig.6.8. Power vs. Observation Time

In Fig.6.8. a graph has shown, which determines the Power vs. Time plot. From 12 am- 5 pm the prototype is in NO LOAD condition. Hence, the power is stable and its value is 0.58 Watts. From 5 pm-9 pm the prototype is in load condition and the power is decreasing which means the voltage of the earth-battery is discharging and after 9 pm its again goes to Load condition and its power is increasing which means the earth battery is recharging. It goes to its original or stable power output within three hours.

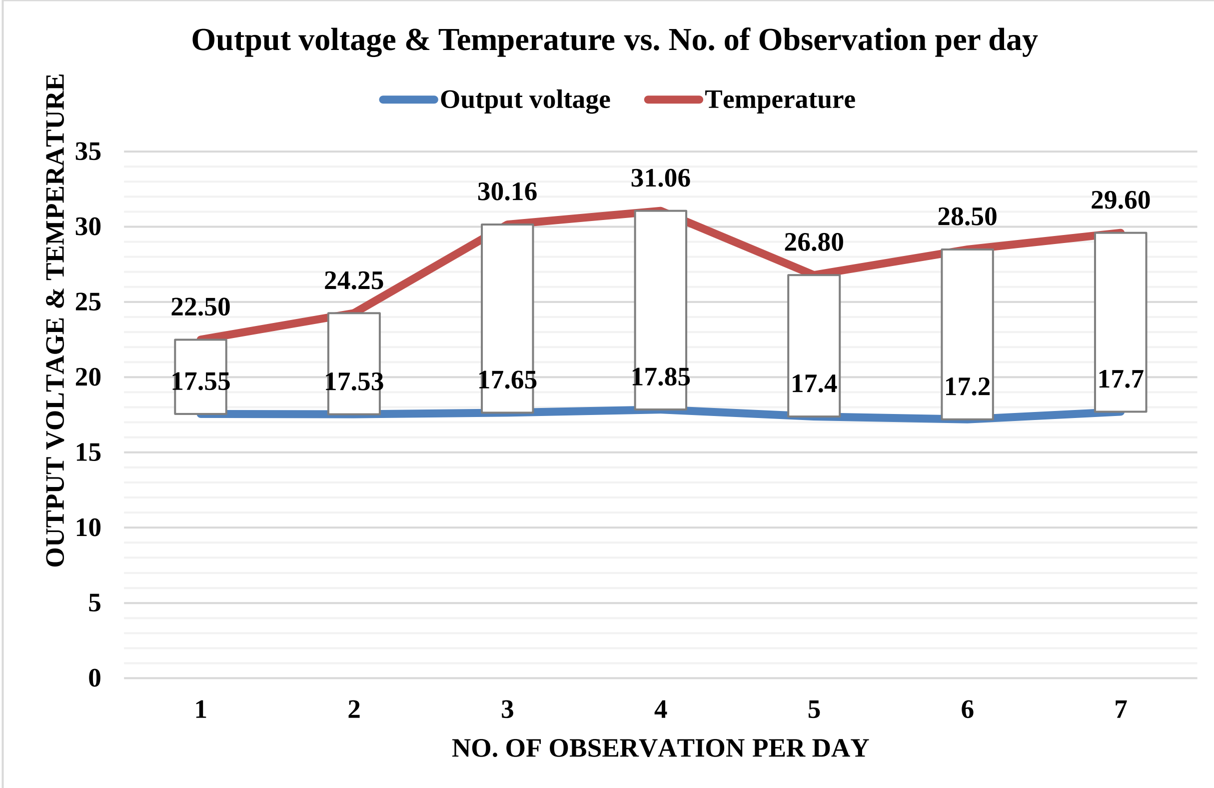


Fig.6.9. Temperature & Output Voltage vs. No. of Observation days

From the graph, indeed, environment temperature doesn't affect the voltage, as shown in Fig.6.9. If it does so, then the percentage is rare, like (0.1 – 0.3) %, which is rarely accountable.

6.3.2. Series-Parallel Connection Data

Table.6.2. Series-Parallel connected Output and Calculated data of seven days

Date	Output voltage V(DC.)	Calculated voltage V(DC.)
7/19/2020	8.88	9.56
7/20/2020	8.9	9.66
7/21/2020	8.89	9.86
7/22/2020	8.78	9.78
7/23/2020	8.87	8.99
7/24/2020	8.88	9.64
7/25/2020	8.86	9.21
Average	**8.87**	**9.53**

From Table.6.2. above, we can see that the average output voltage by observing it for seven consecutive days is lower than the average measured data. We also draw a graph to see if there is any voltage loss, shown in Fig.6.10.

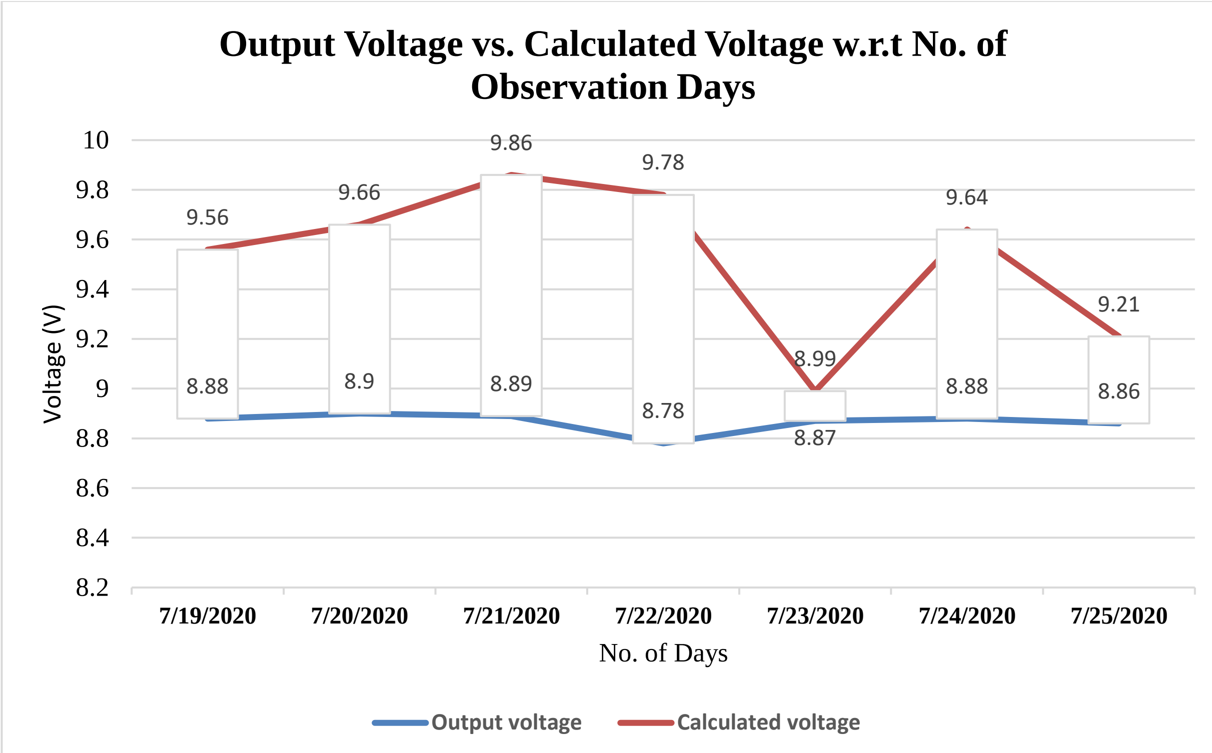


Fig.6.10. Output Voltage vs. Calculated Voltage w.r.t No. of Observation Days

The graphical representation above indicates the difference between the voltage output and the voltage measured. Where the output voltage is the result of measuring the entire prototype with a digital multimeter meter and the measured voltage is the summation voltage of each cell voltage, the voltage loss may differ according to various parameters, such as internal wire resistivity and low conductivity. That is why, over time, the measured voltage varies.

We also observe the loss of voltage in the device by looking at table 6.2 and Fig.6.10.

The loss of voltage can occur due to water, which may cause the electrodes to rust. There is also a chance that the electrodes were not stable as they were not clustered because of the electrodes' movement; the device may have a voltage loss.

So, **Voltage Loss** = Calculated voltage – Output voltage

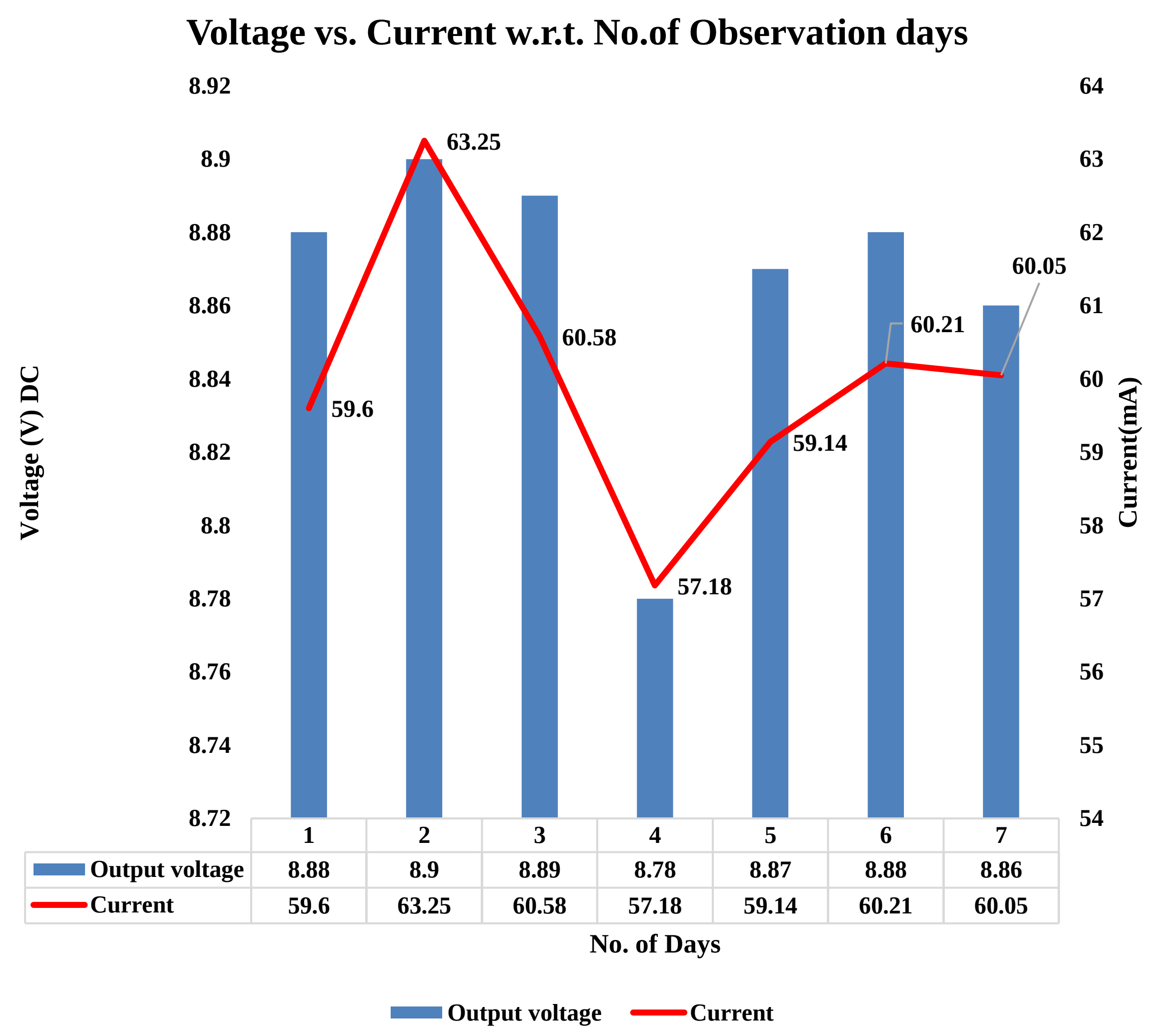
= (9.53 – 8.87) V = **0.66 V**

$$\textbf{\% Voltage loss} = \frac{0.66}{9.53} \times 100 = 6.92\%$$

So, there is a 6.92% voltage loss in the series-parallel connection.

We know, Power = Voltage × Current

So, P = 8.87 V × 60 mA = 0.5322 W



	1	2	3	4	5	6	7
Output voltage	8.88	8.9	8.89	8.78	8.87	8.88	8.86
Current	59.6	63.25	60.58	57.18	59.14	60.21	60.05

Fig.6.11. Voltage vs. Current w.r.t. No. of Observation days

In Fig.6.11, a graph is shown, which determines the current vs. voltage plot. During day 4, voltage and current drop as the presence of the water are reduced due to the high temperature which is why there is a fluctuation. As we are calling it a water-activated battery. When we added the water it slowly goes to its actual saturation point.

6.3.3. Standard Prototype Data Analysis

- **Series Connection**

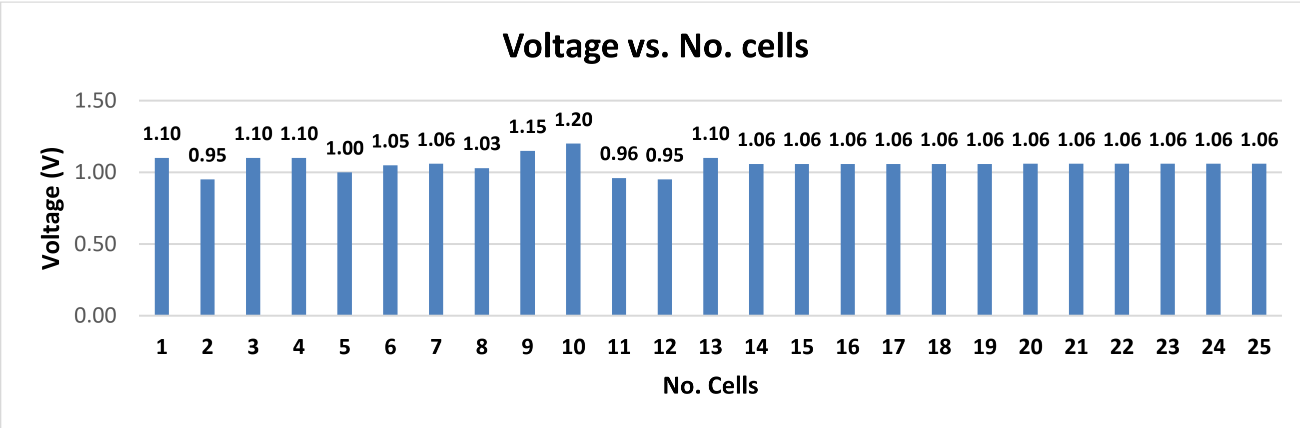


Fig.6.12. Voltage vs. No. of cells

From Fig.6.12. we can see that there are 25 cells connected in series where the average voltage of each cell is approximately 1 V (DC). Furthermore, Cell No. 25 had used here as a power backup cell, and the average current rating per cell is 1.25 mA.

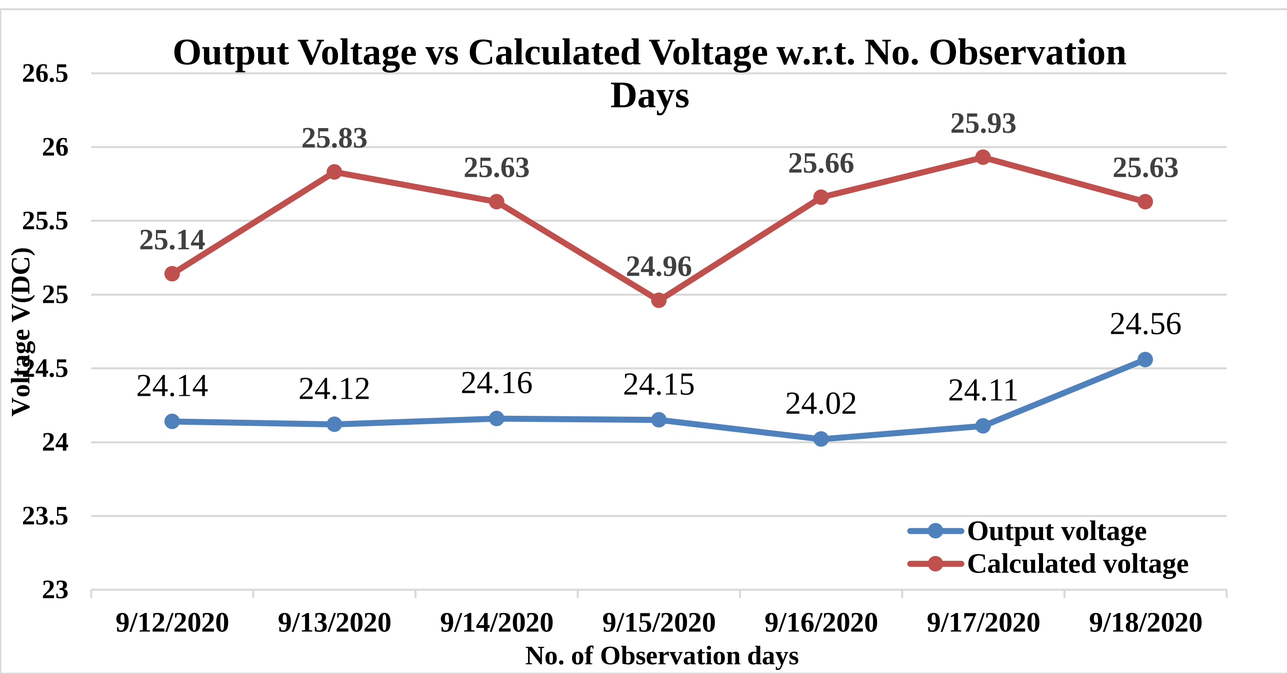


Fig.6.13. Output Voltage vs. Calculated Voltage w.r.t. No. of Observation Days

The graph displays the difference between the output voltage and the voltage measured. Where the output voltage is the result of measuring the entire prototype with a digital multimeter meter, and the measured voltage is the summation voltage of each cell voltage, the voltage loss which differs according to various parameters, such as internal wire resistivity and low conductivity. That is why, with time, the measured voltage increases.

We may observe the loss of voltage in the device by looking at Fig.6.13.

The loss of voltage can occur due to water, which may cause the electrodes to rust. There is also a chance that the resistivity of the connecting wire is high.

So, **Voltage Loss** = Calculated voltage – Output voltage

= (25.54 – 24.18) V = **1.36 V (DC)**

$$\textbf{\% Voltage loss} = \frac{\mathbf{1.36}}{\mathbf{25.54}} \times \mathbf{100} = \mathbf{5.32\%}$$

So, there is a 5.32% voltage loss in the standard series connection.

We know, Power = Voltage × Current

So, P = 24.18 V × 25 mA = 0.6045 W =0.6 W

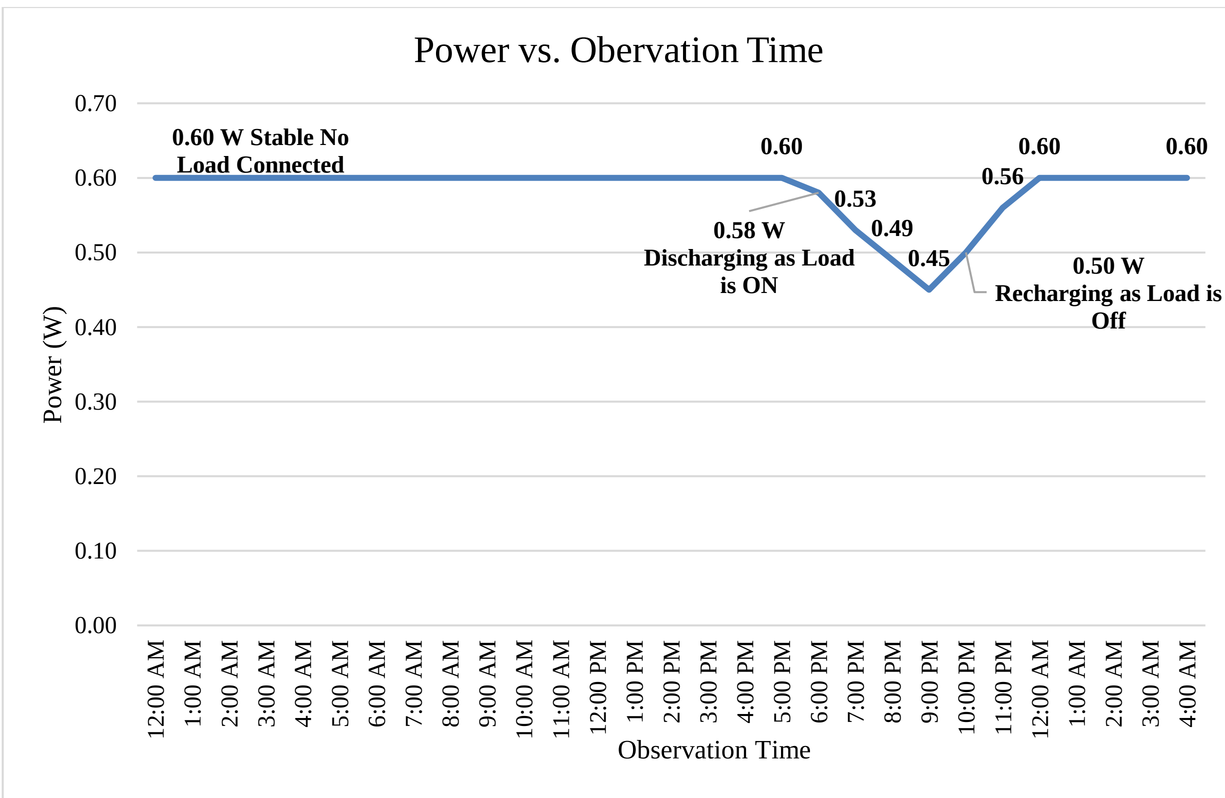


Fig.6.14. Voltage vs. Current w.r.t. No. of days for Standard series connection

- **Series-Parallel Standard Connection**

Table.6.3. Standard Series-Parallel connected Output and Calculated Voltage data of seven days

Date	Output voltage	Calculated voltage
11/19/2020	6.12	6.47
11/20/2020	6.13	6.46
11/21/2020	6.05	6.33
11/22/2020	6.15	6.48
11/23/2020	6.12	6.46
11/24/2020	6.11	6.26
11/25/2020	6.22	6.55
Average	**6.13**	**6.43**

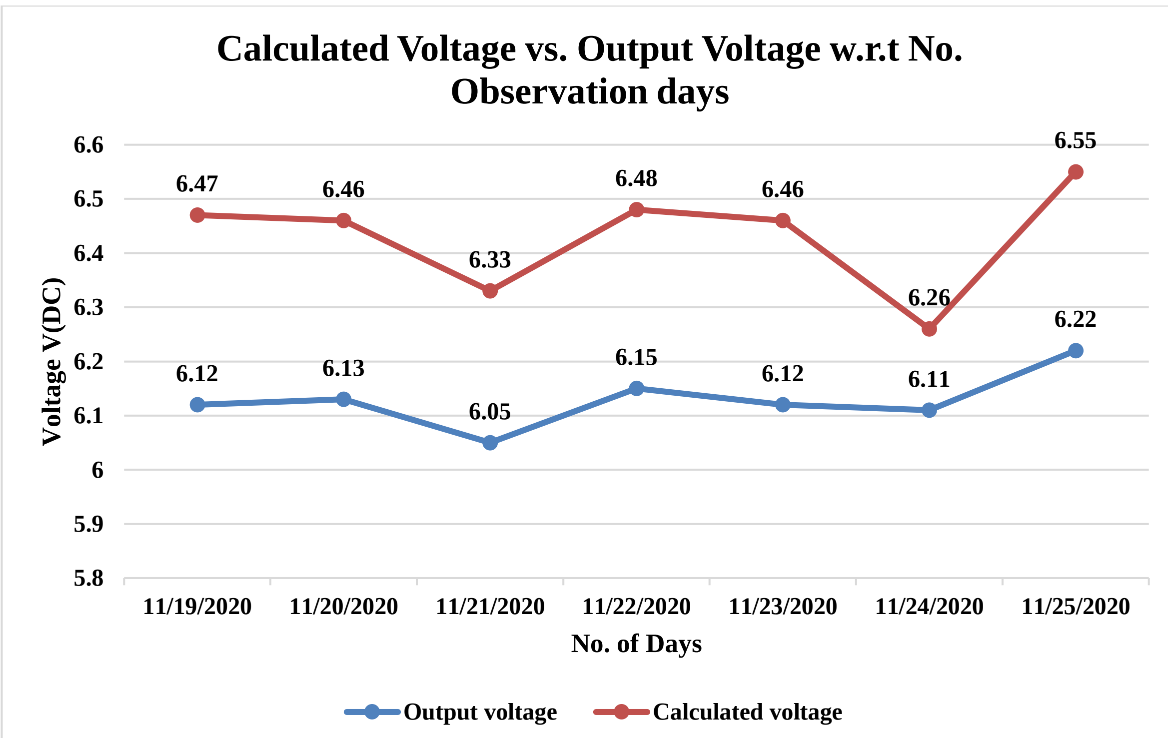


Fig.6.15. Standard Series-Parallel connected Calculated Voltage vs. Output Voltage w.r.t No. of Observation days

The above figure indicates a disparity between the output tension and the measured tension. The voltage of the entire prototype is measured using a digital meter and determined voltage represents the summation voltage of each single cell voltage, which can vary in terms of voltage loss according to various parameters including internal wire resistivity and low conductivity. Therefore, over time the measured voltage varies.

We may observe the loss of voltage in the device by looking at Table.6.3. and Fig.6.15.
The loss of voltage can occur due to water, which may cause the electrodes to rust. There is also a chance that the resistivity of the connecting wire is high. The average current is approximately 100 mA, and the average output voltage is 6.12 V (DC.)

So, **Voltage Loss** = Calculated voltage – Output voltage

$$= (6.43 - 6.13)\ \text{V} = \mathbf{0.3\ V\ (DC)}$$

$$\textbf{\% Voltage loss} = \frac{\mathbf{0.3}}{\mathbf{6.43}} \times \mathbf{100} = \mathbf{4.66\%}$$

So, there is a 4.66% voltage loss in the standard series-parallel connection.

We know, Power = Voltage × Current
So, P = 6.13 V × 100mA = 0.613 W

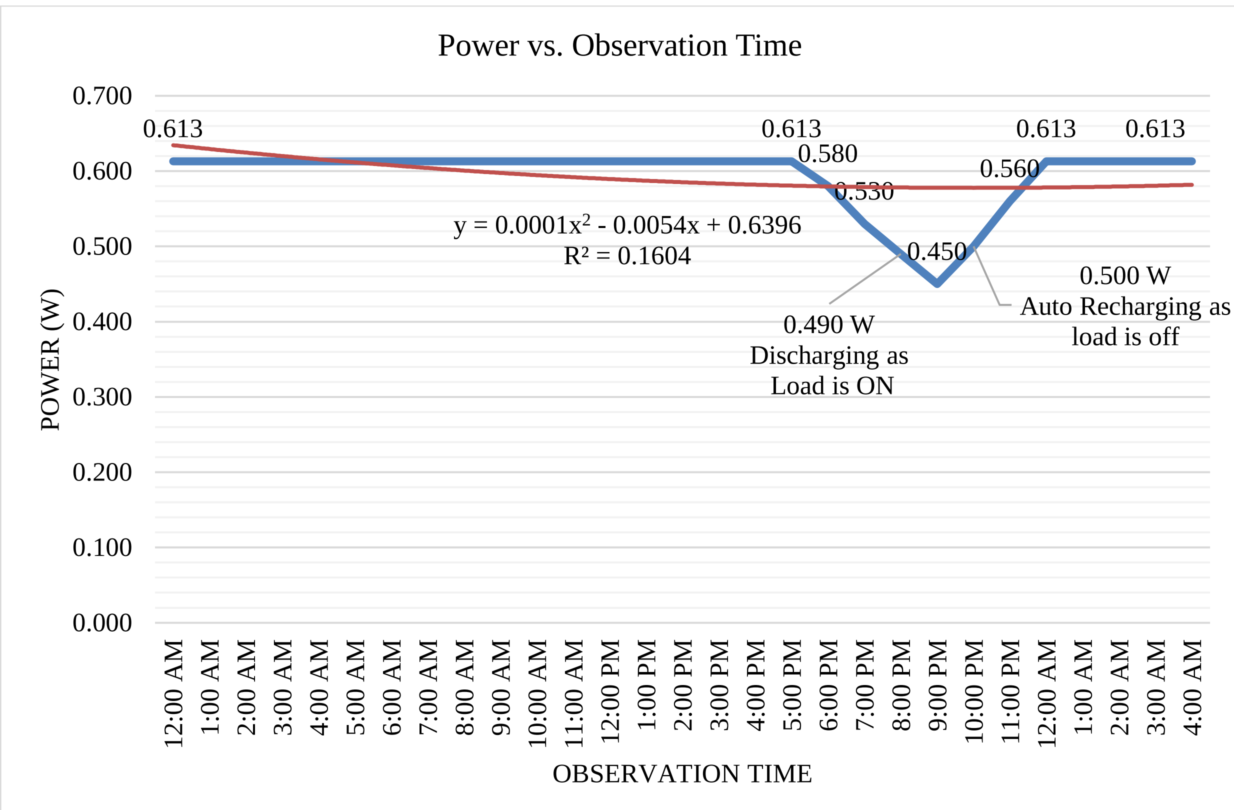


Fig.6.16. Power vs. Observation Time

6.3.4. Comparison between all Connections

Table.6.4. Comparison of all connections

Connection Type	Average Output Voltage V(DC.)	Average output current(mA)	No. of total cell	Voltage loss
Series	17.55	30	37	19.27%
Series- parallel	8.87	60	37	6.92%
Standard Series	24.18	25	25	5.32%
Standard Series- Parallel	6.13	100	25	4.66%

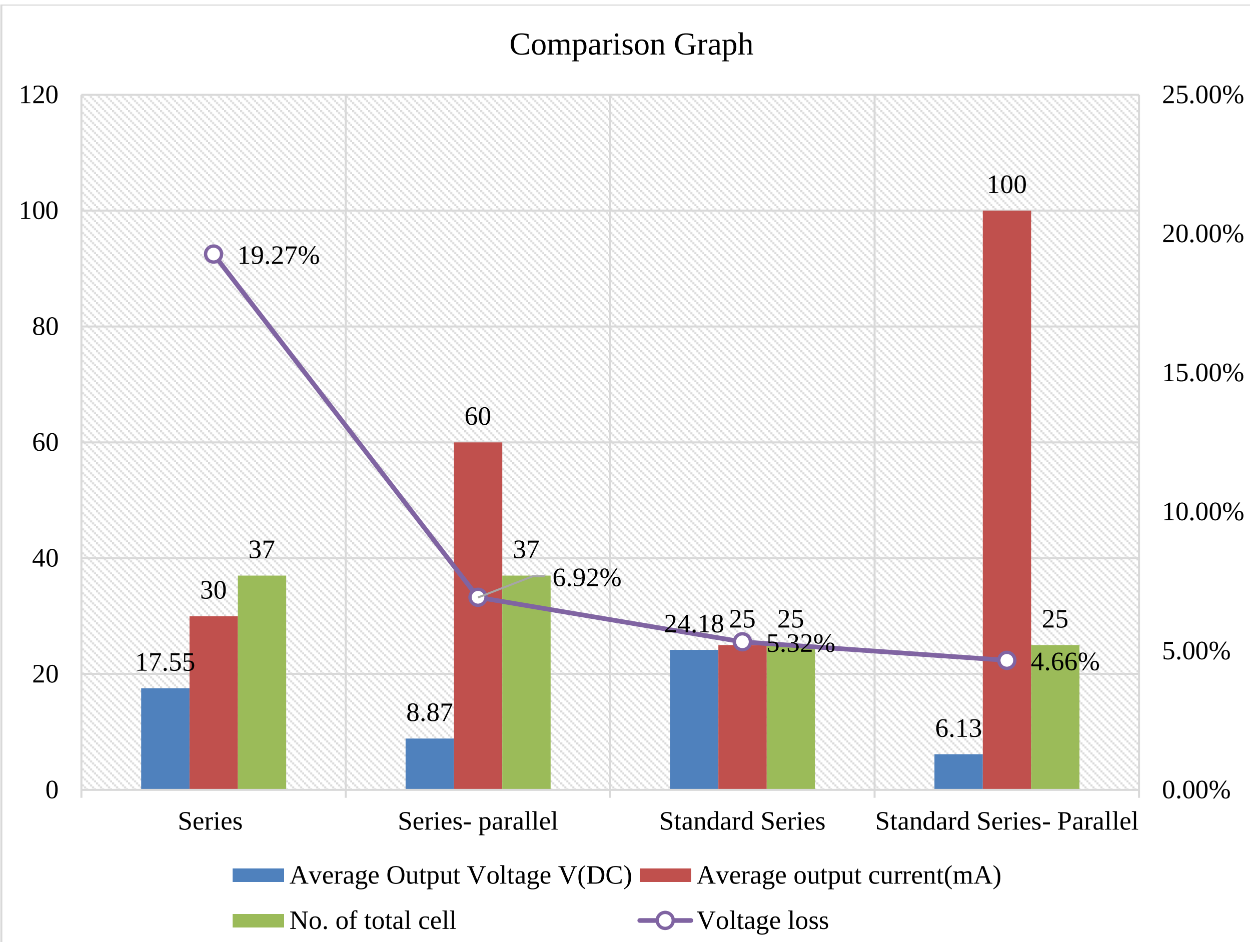


Fig.6.17. Comparison graph of all connection

From the Fig.6.17. and table 6.4. we can say that the Standard series-parallel connection is the best one here as it has a high current rating with low voltage loss and stable output voltage.

6.4. 24-hour Observation of the Standard Prototype

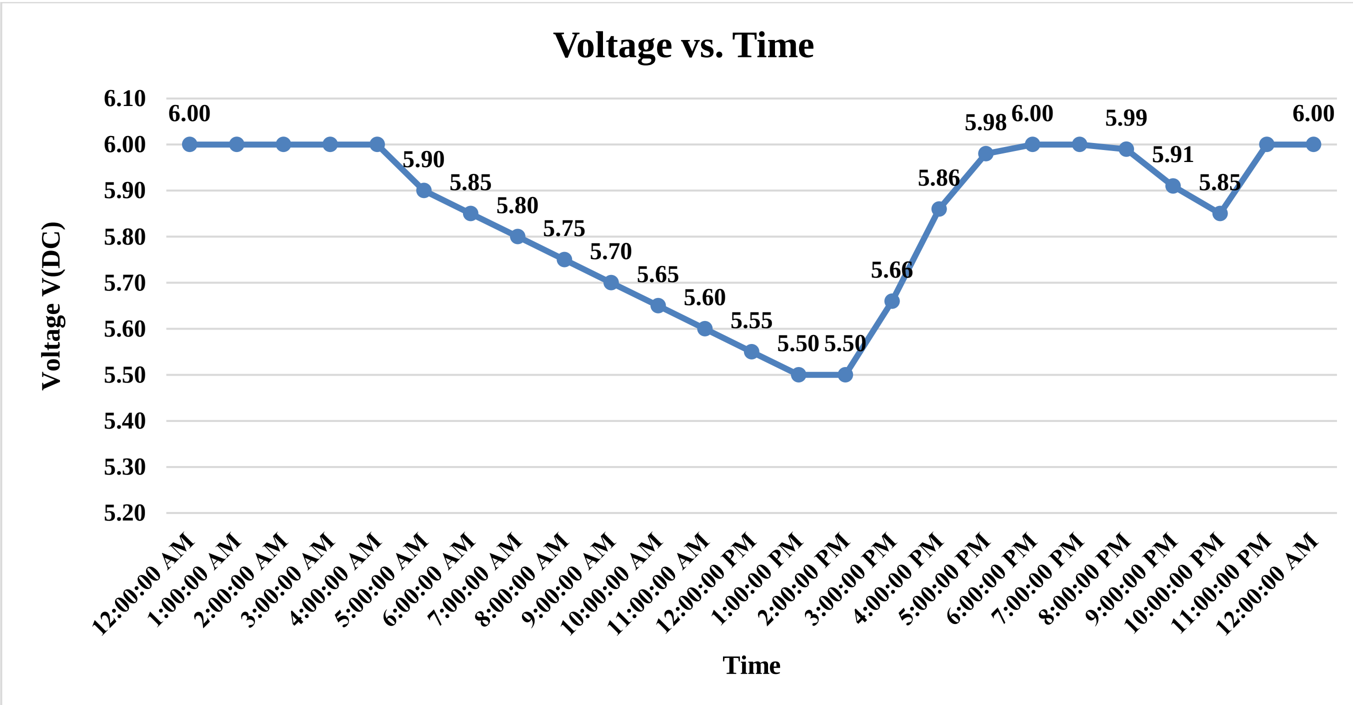


Fig.6.18. Voltage vs. Time Observation

From the above graph, we can see from 12 am-4 am there was No-load connected, and the voltage is 6 V(DC), but at 4 am-1 pm, the load is connected, and the earth battery is discharging, and it goes to 5.50 V(DC). Then the load was disconnected, and from 2 pm-6 pm, the earth battery is naturally auto recharged to its maximum capacity, which is 6 V(DC).

- **Reason for Naturally Auto recharging of the Earth Battery**

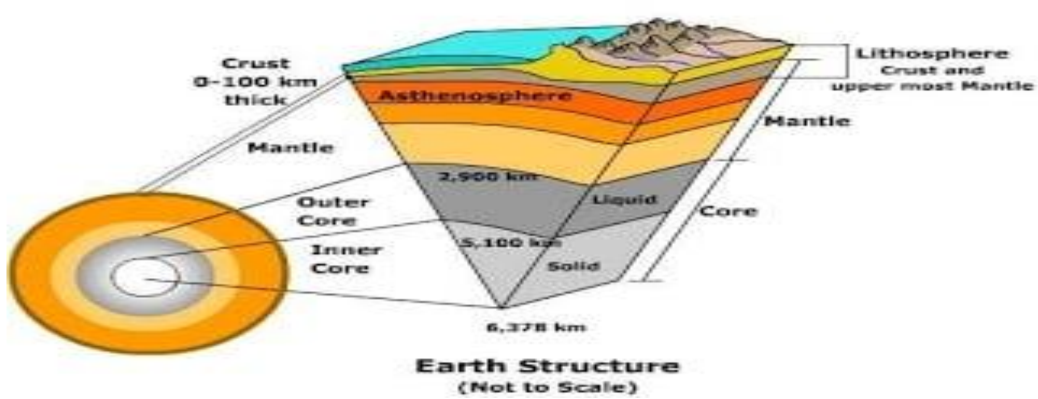


Fig.6.20. Earth Structure

Fig.6.20. represents the Earth's structure. It has four primary levels: Crust, Mantle, Outer Core, and Inner Core.

We had used Crust level soil to develop a sustainable earth battery. Crust level soil has nine primary types of elements.

Table.6.5. Earth's Structural Element

Serial No	Elements name	Ratio
01	Oxygen	46.60%
02	Silicon	27.72%
03	Aluminum	8.13%
04	Iron	5.00%
05	Calcium	3.63%
06	Sodium	2.83%
07	Potassium	2.59%
08	Magnesium	2.09%
09	Others	1.41%

Silicon, Aluminum, Iron, Calcium, sodium, potassium, magnesium is found as ore in soil. A small amount of metal is also found in soil. These are very active chemically, and they have a very electron affinity. As a result, they participate in different kinds of reactions continuously. So, energy is repeatedly exchanging. Continuous reaction means continuous electron movement, which is the flow of current. Therefore, this is how Continuous current is produced. So, we don't need to charge our battery with an external source.

6.5.Summary

In this chapter, necessary data analysis and graph were presented and obtained was compared, and analyzed. While data analysis, several errors were found and corrected. The data had to run a few times to get to the desired output. Finally, an observation of the overall project was presented.

Chapter 7

Conclusion

7.1. Summary of findings

A sustainable energy solution with a low soil rate is the primary objective of this project. In this project, we built a system where we generate electricity from soil cells. We made a plan, known as the Gantt map, to continue with this project properly. From the very beginning, we aim to control the Gantt chart and to complete this project. We follow the plan step by step. According to the Gantt chart, we evaluate our project's problem and attempt to solve the problem, and investigate several articles and journals. We collect the equipment we need after having completed our mission. To accomplish our desired project, we split our project into two parts. We research resources, papers, books, and the internet and then begin to implement the electrode with some readily available servitor such as salt where we used soil.

7.2. Project finance

Keeping the cost as low as possible was one of the essential goals of this project. A minimal study of the actual cost was a prototype rather than a hands-on experiment for the implemented project. A cost analysis of the planned Model shows the following table:

Table.7.1 Project finance

Equipment Name	Buying Cost (BDT.)
Carbon (Anode)	1920
Aluminum (Cathode)	480
Plastic Container	96
Cement, Sand	120
Patch Wire	480
Switching circuit	200
Secondary battery	300
others	150
Total	**3,746**

Pie Chart of project finance had shown in Fig.7.1.

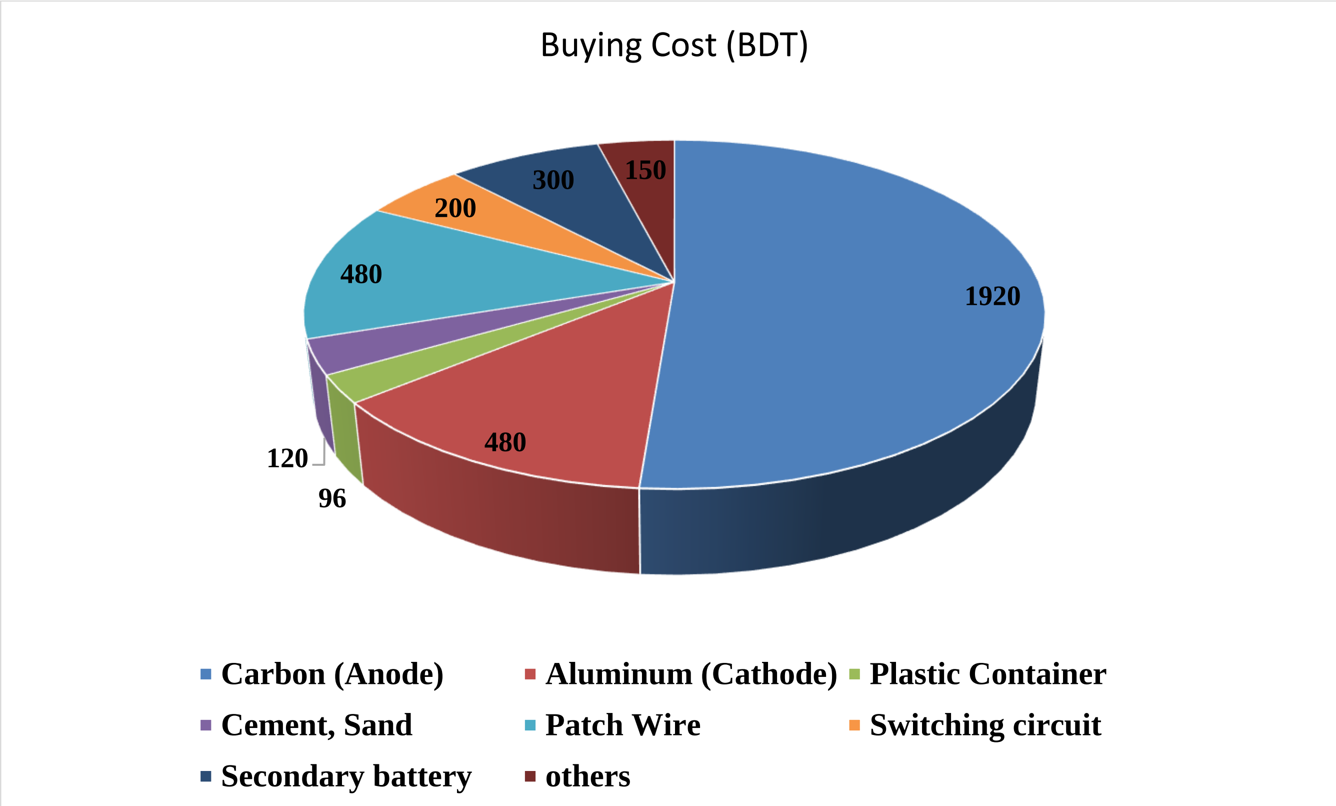


Fig.7.1. Pie chart of project finance

7.3. The novelty of the work

The methodology was based on this study of papers, books, posts, and creativity of its own. A unique design for the extraction of electricity from the soil. There are an imaginative approach and great potential to solve the energy problem in society. We've got infinite raw materials to build this battery. With low installation costs and affordable for all people, clean and green energy supplies. Eco-friendly, zero-emission. This project's most remarkable feature is that the Earth-Battery itself naturally recharged to its maximum capacity within 2-3 hours without using any external source.

7.4. Final Impact of This Project

We are developing a viable power generation approach. It has to be economical, pleasant to the community, and socially acceptable. It is essential to consider the social, economic, and environmental costs of an engineering project. Future aspects, the impact of the project, and further improvements must also be taken into account.

7.4.1. Survey on Environmental or Social Impact

We developed a survey form for our project and examined the repository of consumer preference, suggestions, ideas, and arguments for this project. They will help us improve the plan to make it more user-friendly for individuals.

- 90.9% of people in their daily lives are facing a power crisis at this time.
- Top individuals agree that our initiative will solve the power crisis.
- The majority of individuals want a monthly maintenance check.
- The project would fulfill the green energy criteria for SDG-7.
- Top individuals agree that this initiative can potentially be beneficial for society.
- A large number of clients want a portable battery device.
- Price of the Earth battery, amp, and substantial productivity for citizens.
- Many individuals have not heard of any other choices like this.
- Top individuals want to use this battery for its low-cost productivity of electricity
- A significant number of individuals involved in this project's utility and protection prefer those similar to them.

7.4.2. Project Sustainability and Future Scopes

It is an alternative approach to solving the energy problem and a great opportunity for society. We have infinite raw materials at a cheap rate to build this battery. With low installation costs, clean and green energy sources are affordable for poor people. Environmentally friendly and zero emissions.

The critical consumers of this product are people from rural and urban areas. With better performance, this battery's production costs are meager and can reduce the power crisis. For all people, it is affordable. Poor people have an opportunity to get electricity at a low price. It is the best option in rural, hilly areas. A power plant will stand by earth battery in the future and operate a company with the consumer's satisfaction.

7.4.3. Recommendation on future developments

We can develop the system and generate electricity for our country, which will reduce load shedding. We would allow people to use the 'Earth Battery' at a low price. Our research is ongoing to find more power in our system, as we can add electricity to our national grid.

7.5. Limitations of work

This project has some limitations. In our initial process, we face some limitations.

- **Flow of Current**

The electron speed of this project is low, and as a result, we have little current. Current ratings are between 50 mA and 60 mA.

- **Size of the battery**

We also increase cells to increase the current flow and strength. With our cells growing, our battery is large and not attractive.

7.6. Ethical Concern

Our projects are primarily concerned with electricity production using soil and electrodes. During the study, there was no conflict between the team members. They helped each other to solve the problem. All segments were split, and project work was dispersed among the members. All worked hard and finished work timely. The research was conducted purposely to add unique features and to make them successful. Plagiarism was discouraged, and the subjects were kept distinctive. During the study and work, no false or illegal attempts were used.

7.7. Conclusion

Today's world has a significant electricity demand. A vast amount of people suffers from the electricity crisis, long-term load shedding. We made a solution more efficient. Produce electricity by a simple method with available raw materials and cost-free soil collection. Cost-effective power sources. Renewable and eco-friendly. Very low-cost installation and affordable for poor peoples.

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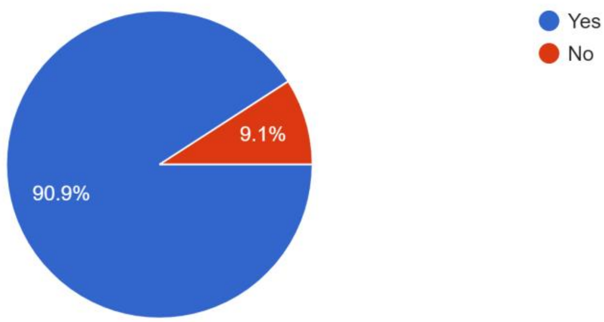
APPENDIX A

SURVEY QUESTIONNAIRES

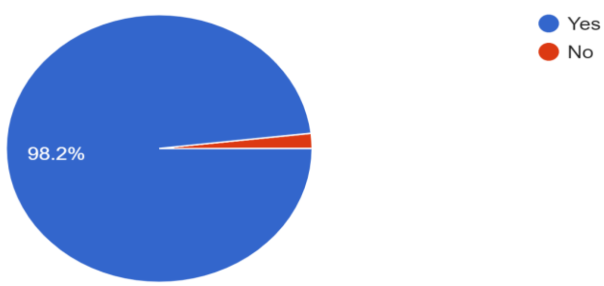
Are we facing any power crisis?

55 responses



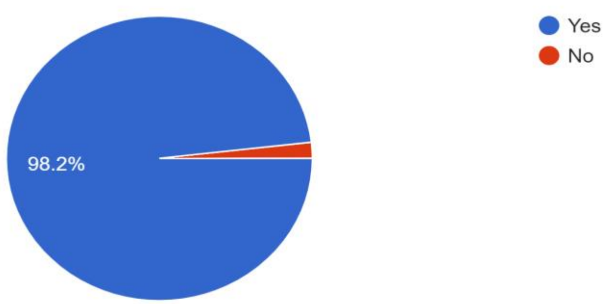
Our prototype can generate electricity from soil. Do you think this project will help to overcome the power crisis?

55 responses

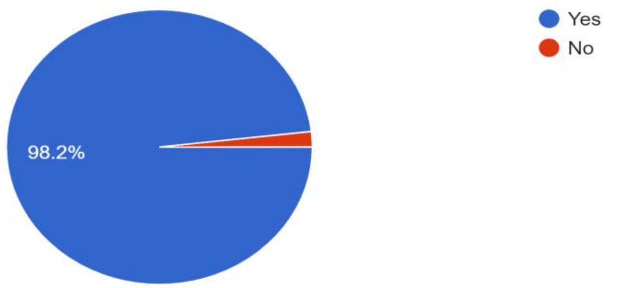


Do you think this project can meet the demands of Green Energy for SDG-7?

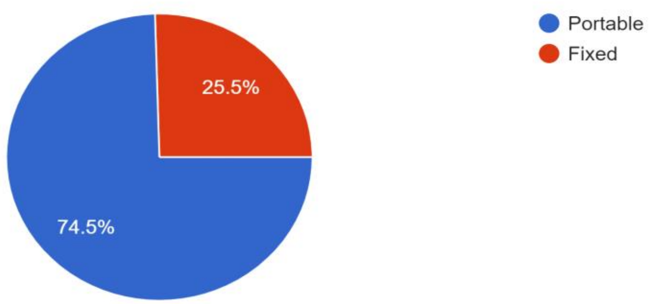
55 responses



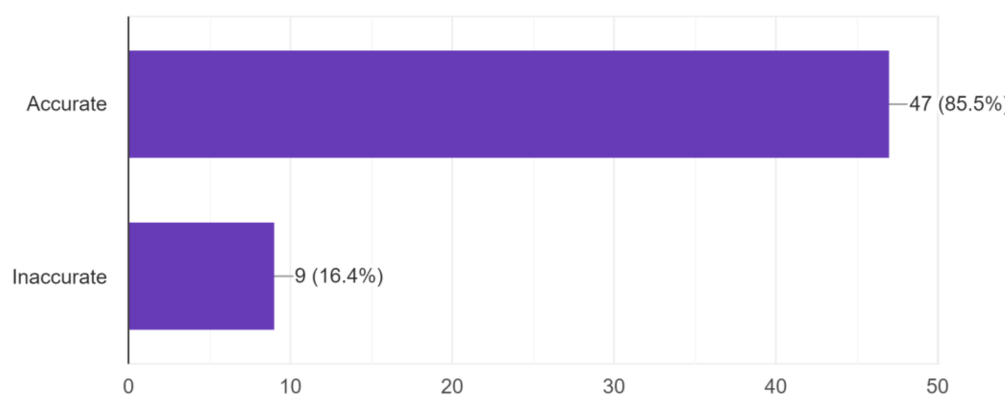
Do you think this product can actually be useful for society?
55 responses



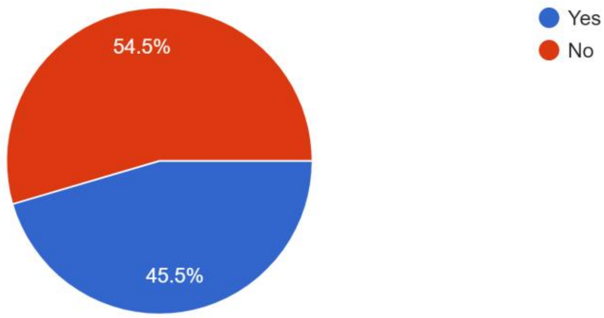
What should be the most acceptable design for you or someone you know ?
55 responses



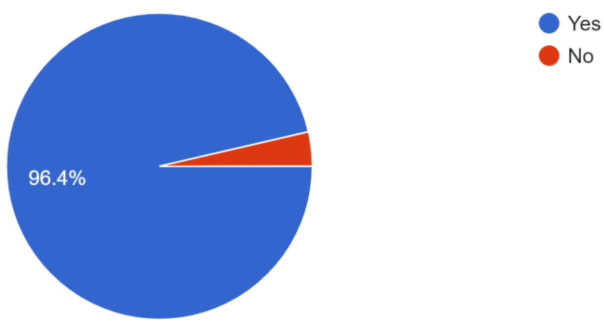
What will be the impact of these project with price & efficiency consideration?
55 responses



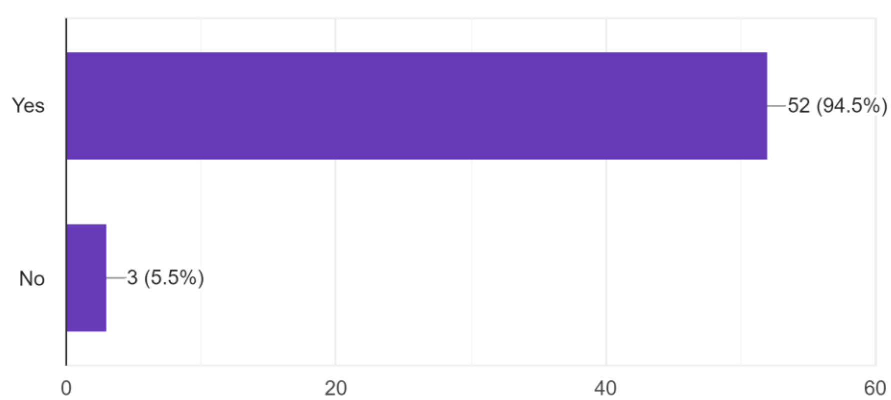
Did you heard about any other options available like this ?
55 responses



Would you prefer this product for someone close to you regarding the usefulness and safety of this product?
55 responses

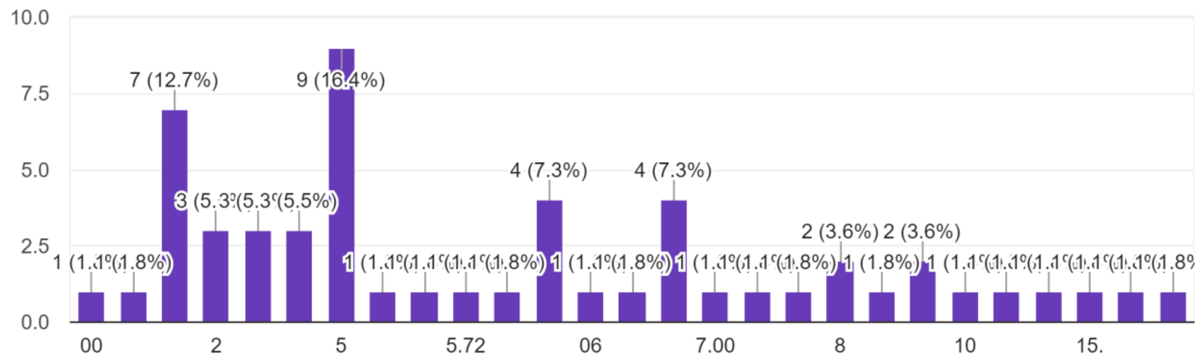


All necessary parts will be easily collectable from the company ?
55 responses



Per unit electricity cost (In BDT) ?

55 responses



APPENDIX B

ITHENTICATED PLAGIARISM REPORT