
PIEZO ENERGY
A step towards
GREEN ENERGY

UNIVERSITY OF MUMBAI

R.D & S.H NATIONAL COLLEGE AND S.W.A SCIENCE COLLEGE,

BANDRA WEST, MUMBAI - 400050

PROJECT REPORT

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ANUBHAV R. DUBEY
M.Sc. PHYSICS

SEMESTER IV

ELECTRONICS 1

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1. ABSTRACT

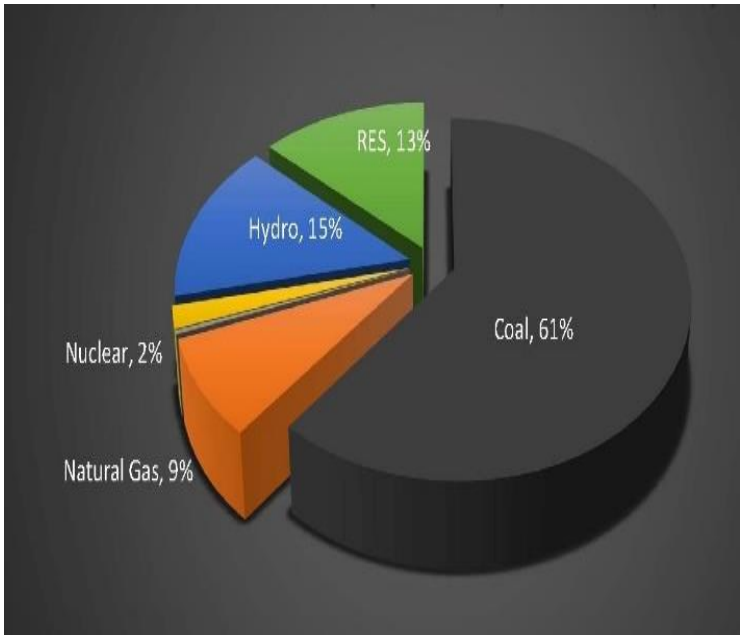
The consumption of energy has always been an exponential growth and also there is always an increasing demand in the requirement of energy in some way or the other. So, there is a need to search for energy availability from alternate sources of energy. The utilization of waste energy of foot power with human locomotion is relevant and important for highly populated countries like India where the railway station, temples, etc., are overcrowded all round the clock.

Piezo electric effect is the ability of certain materials to generate an electric charge in response to applied mechanical stress, when piezoelectric material is placed under mechanical stress, a shifting of the positive and negative charge centres in the material takes place, which results in an external electrical field, the electricity generated by the piezo electric materials can be stored and used later.

The piezo electric device that we have created consists of 25mm piezo crystals that are arranged in series and parallel to increase the voltage and current efficiency, the device can be placed in a crowded location, due to the footsteps of individuals the device will start producing electricity and this electricity will be stored in a rechargeable battery, the charge stored in the rechargeable battery can be used later.

2. INTRODUCTION

In India, Commercial Energy makes 74% of total energy, of which coal-based energy production is around 72-75%, as per 2020 data. For utility power generation, India consumed 622.22 million tons of coal during 2019-20 which is less by 1% compared to 628.94 million tons during 2018-19(present data), Most electricity today is generated by burning fossil fuels and producing steam which is then used to drive a steam turbine that, in turn, drives an electrical generator, More serious are concerns about the emissions that result from fossil fuel burning. Fossil fuels constitute a significant repository of carbon buried deep underground. Burning them results in the conversion of this carbon to carbon dioxide, which is then released into the atmosphere, The estimated CO_2 emission from the world's electrical power industry is 10 billion tonnes yearly. This results in an increase in the Earth's levels of atmospheric carbon dioxide, which enhances the greenhouse effect, and contributes to global warming, So to overcome these alarming issues we thought to come up with a way to generate electricity from PIEZO an alternating and environment-friendly way to generate electricity.

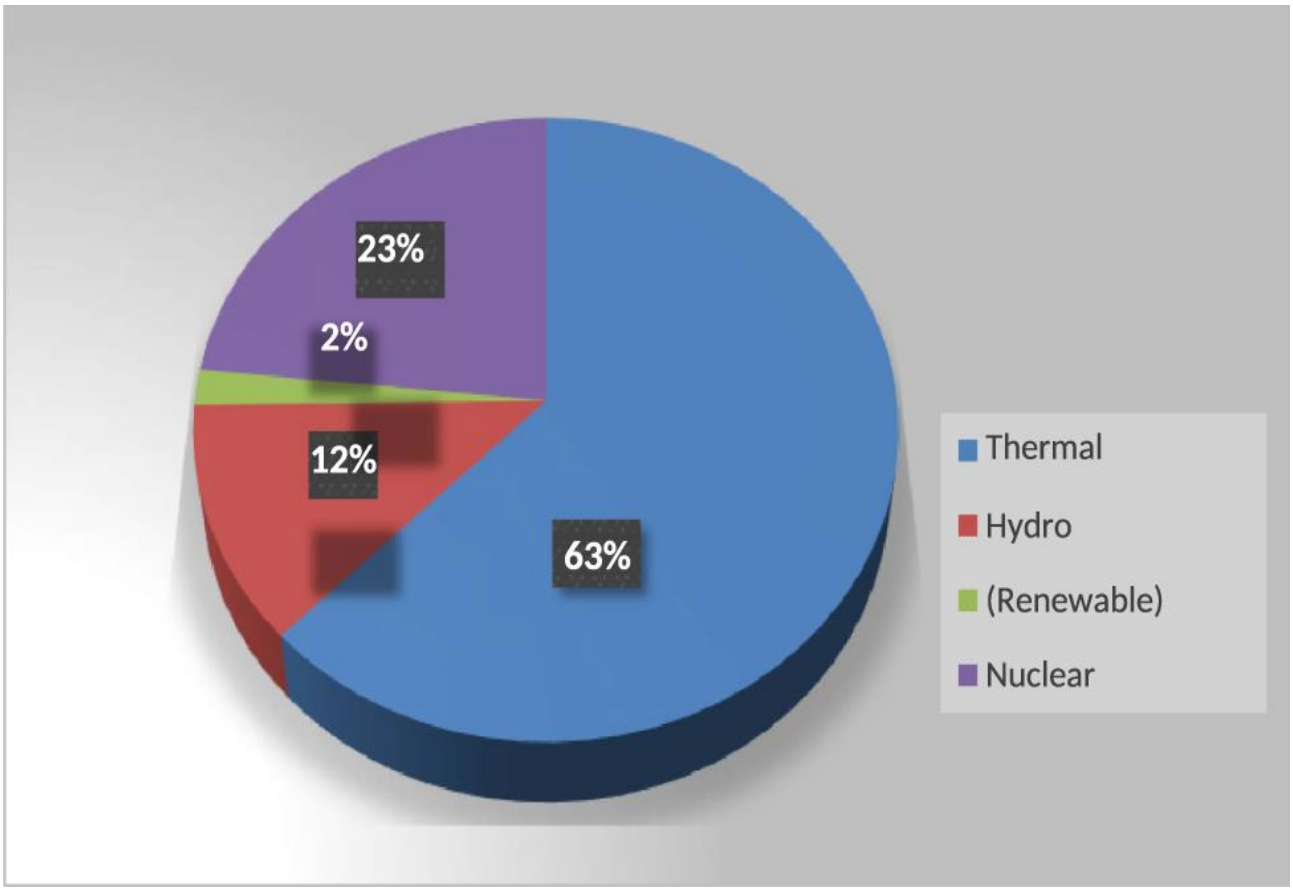


3. OBJECTIVE

- To reduce the use of Fossil fuel and coal for electricity production.
- To find alternative methods of energy harvesting.
- To minimize the pollution that is generated in the production of electricity.
- To reduce the cost of energy harvesting.
- To reuse the mechanical energy that is wasted in our day to day life to produce electricity.
- To find an easy alternative to produce electricity in rural areas and villages.

4. RESEARCH

India is the third-largest producer of electricity in the world. The gross electricity consumption in the year 2019 was 1,208 kWh per capita. India's electricity sector is dominated by fossil fuels, in particular coal, which produced about three-quarters of the country's electricity, The government is making efforts to increase investment in renewable energy. India has recorded rapid growth in electricity generation since 1985, increasing from 179 TW-hrin 1985 to 1,057 TW-hr in



2012, The majority of the increase came from coal-fired plants and non-conventional renewable energy sources (RES), with the contribution from natural gas, oil, and hydro plants decreasing from 2012-to-2017, the drawback of producing

energy from coal and fossil fuel is that it emits carbon and other greenhouse gaseous that are responsible for global warming, hence it is necessary to shift to renewable sources and piezo electricity can be a good alternative, Solar energy has been emerged as a good alterative in the past few decades, however solar energy has its own drawback for example it is not reliable during monsoon, the energy production using solar cell is not stable, hence piezo can be used as an alternative way of producing electricity as it needs mechanical energy to produce energy we do not have to rely on the natural processes to generate electricity, a piezo mat can be installed in a crowded area and the footsteps will help to harvest electricity that can be stored in rechargeable battery, this energy can be used later.

Fuel	MW	% of total
Total thermal	2,30,189.57	63.2%
Coal	1,97,964.5	54.2%
Lignite	6,760	1.7%
Gas	24,955.36	6.9%
Diesel	509.71	0.1%
Hydro (renewable)	45,399.22	12.6%
Nuclear	6,780	1.9%
Renewables	86,321.03	22.7%
Total	368,689.82	

Total power production in India (as on 31.01.2020).**(Source:**CERC 2020)

5. Why Piezo Instead of Solar

Solar has emerged as a major renewable source of energy in the past few decades but solar power harvesting has many drawbacks, some of the drawbacks of solar devices are as follows.

1) High installation cost: One of the disadvantages of solar power is that it comes with a high initial cost of purchase and installation. This includes wiring, batteries, inverter, and solar panels.

2) Intermittent energy source: At night, the sun does not shine. So, the solar panels cannot generate power. Depending on your location, time of the day, and even time of the year, the sun's intensity varies. The amount of energy produced is affected by factors like snow, cloud, and foliage cover.

3)Waste of Space: If you want to produce more electricity, then you will need more solar panels to collect more sunlight. Compared to fossil fuels, solar panels have low power density. A larger area for solar panels is needed for similar amounts of energy production.

4) Initial Pollution: Solar power systems, manufacture, transportation and installation still emit greenhouse gases emission. Some of the materials and products handled during the manufacturing process of a solar photovoltaic system can also be hazardous.

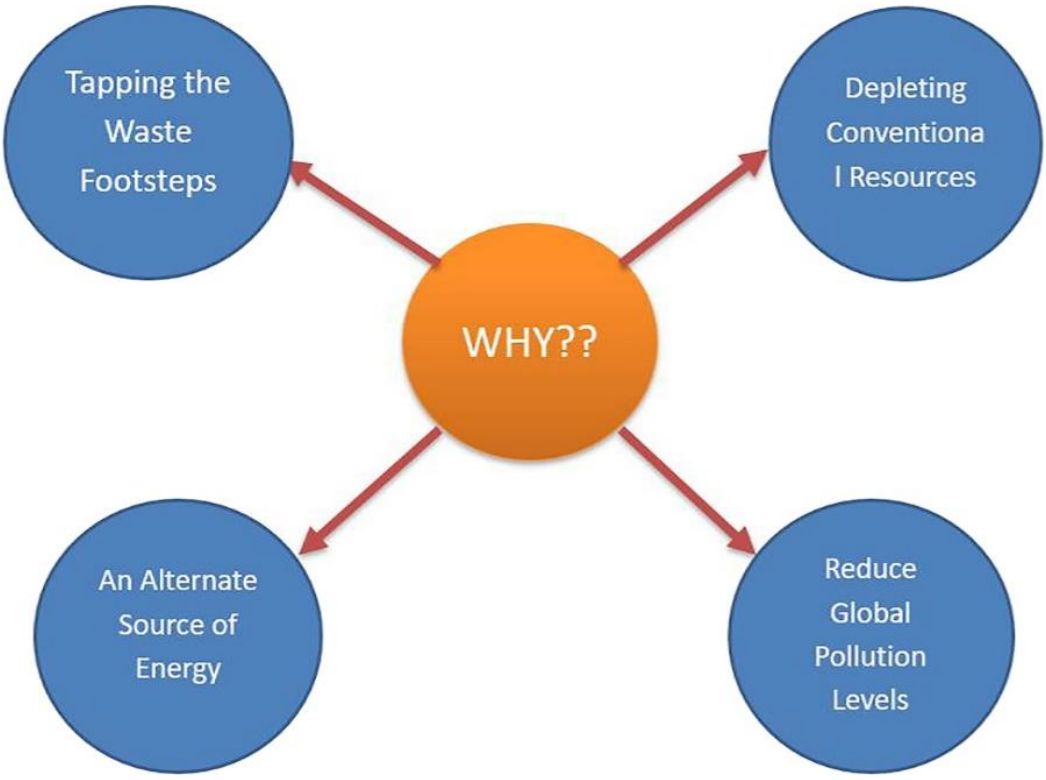
5) Location: Solar cells can be sensitive when it comes to location. If the place where you live is particularly shaded, it can make it difficult for the solar cells to collect energy.

6) Low Energy conversion rate: Currently the efficiency of Solar device is approximately 20 percentage, the efficiency ofthe solar devices has increased from 5 percentage to 20 percentage in the past few decades, research is still in progress to increase the efficiency of the solar device.

Overall Explanation, Why Solar Might be a Bad Option for You

When you get a solar power system, you need to consider both the advantages and disadvantages of solar energy. If you plan to move or sell your home in the near future, it might not be for you.

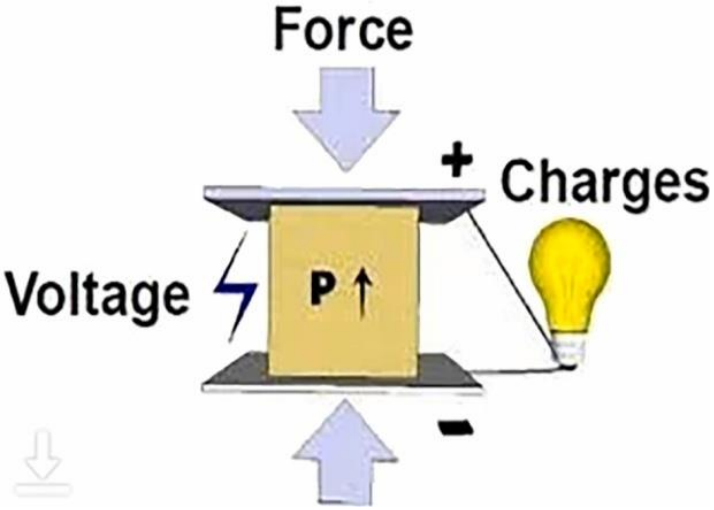
Solar can also be very dependent on weather and location, but most places can have them installed. While your solar panels can still collect energy during cloudy or rainy days, the efficiency of the system drops. The solar panels will also not collect energy at night since there's no sun, but this is easily solved with a battery storage installation which stores your energy for overnight use.



Hence when the drawbacks of solar device is compared to the drawbacks of piezo electricity generator we can conclude that the overall benefits of using a piezo is more than that of using the solar device

6. The piezo electric effect

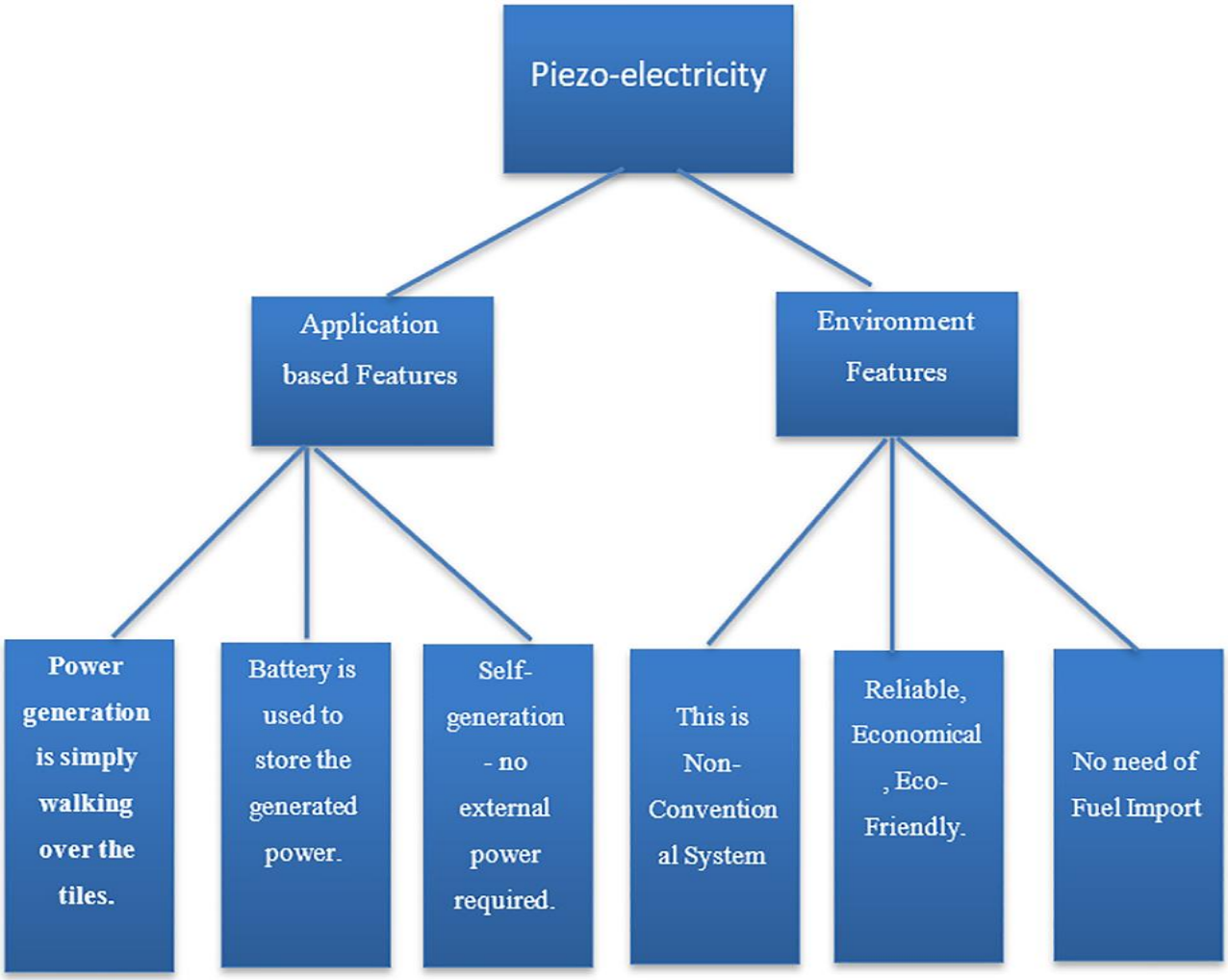
The piezoelectric effect was discovered in 1880, by two French physicist brothers Pierre and Paul. A piezoelectric sensor is a device that uses the piezoelectric effect to measure pressure, acceleration, and force by converting them to an electrical signal. When pressure is applied to piezoelectric crystals electricity is developed over the crystal lattice.



Characteristics of piezo electricity:-

These days most of the research in the energy field is to develop sources of energy for the future. It is time to find renewable sources of energy for the future. Piezoelectric materials are being more and more studied as they turn out to be very unusual materials with very specific and interesting properties.

Energy can never be created nor destroyed; it can only be transferred from one form to another. In fact, their materials could produce electrical energy from mechanical energy and may convert mechanical behavior like vibrations into electricity. While recent experiments have shown that these materials could be used as power generators



7. Hardware Components

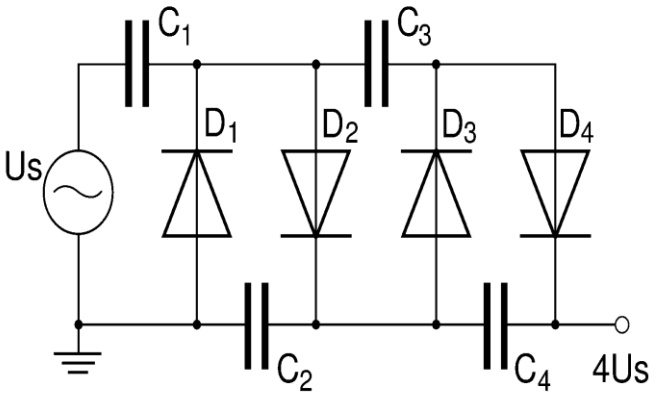
7.1) Piezo electric plate

A piezoelectric plate is a device that uses the piezoelectric effect to generate a voltage difference, it is basically a device which converts voltage to vibration and vibration to voltage.

7.2) Rechargeable battery:

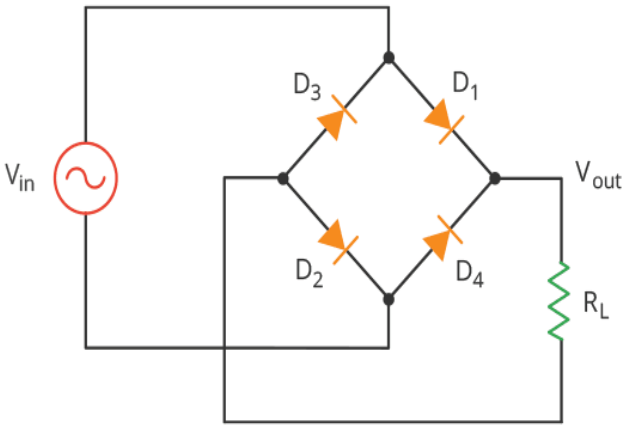
A rechargeable battery formally a type of energy accumulator, is a type of electrical battery which can be charged, discharged into a load, and recharged many times, as opposed to a disposable battery, which is supplied fully charged discarded after use. It is composed of one or more electrochemical cells. The term "accumulator" is used as it accumulates energy, through a reversible electrochemical reaction.

7.3)Voltage Multiplier: A voltage multiplier is an electrical circuit that converts AC electrical power from a lower voltage to a higher DC voltage, typically using a network of capacitors and diodes.



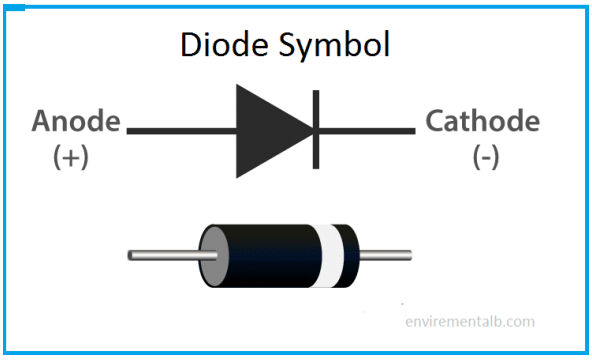
Voltage multipliers can be used to generate a few volts for electronic appliances, to millions of volts for purposes such as high-energy physics experiments.

7.4) Rectifier circuit: A rectifier is an electronic device that converts an alternating current into a direct current by using one or more P-N junction diodes. A diode behaves as a one-way valve that allows current to flow in a single direction. This process is known as rectification.

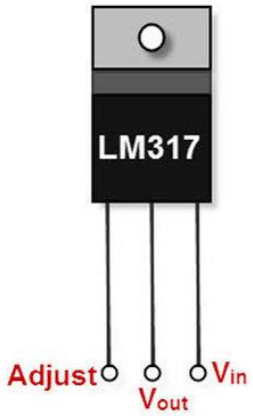


7.5) Diode:

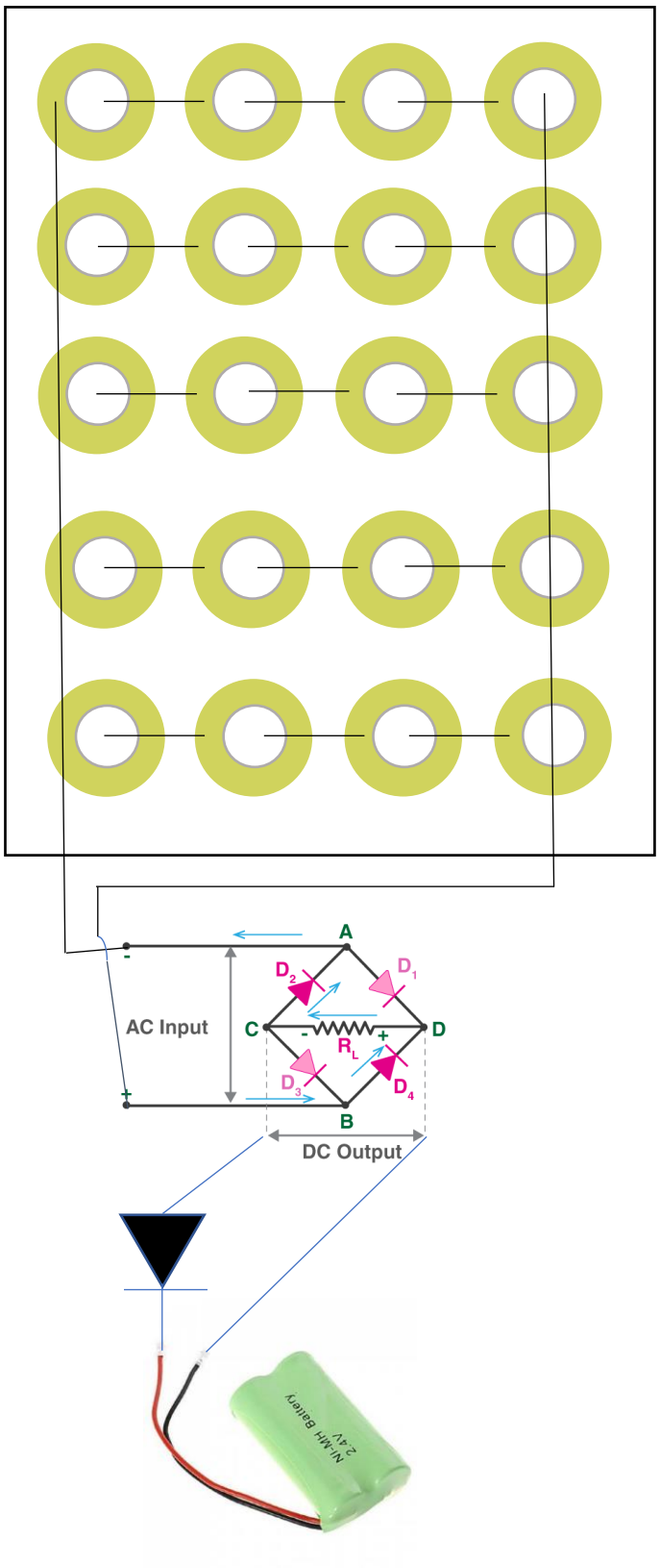
Diode, an electrical component that allows the flow of current in only one direction. In circuit diagrams, a diode is represented by a triangle with a line across one vertex.



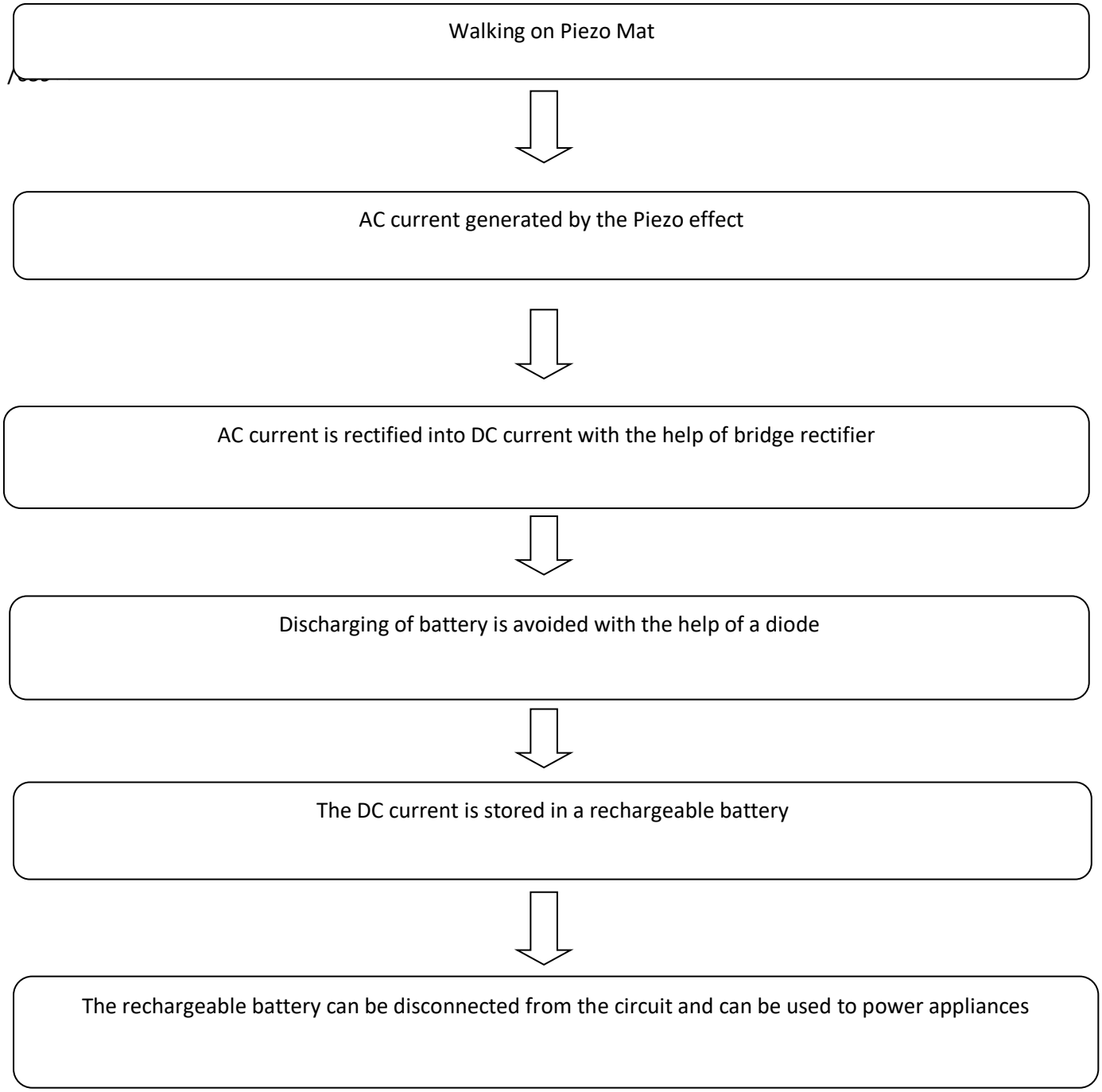
7.6) The LM317 device is an adjustable three-terminal positive-voltage regulator capable of supplying more than 1.5 A over an output-voltage range of 1.25 V to. 37 V



8. Circuit Connections:



9. Flow-Chart:


Walking on Piezo Mat
AC current generated by the Piezo effect
AC current is rectified into DC current with the help of bridge rectifier
Discharging of battery is avoided with the help of a diode
The DC current is stored in a rechargeable battery
The rechargeable battery can be disconnected from the circuit and can be used to power appliances

10. Experimental observation

- ***STANDARD DATA:-***

  - The average weight of the 11 Msc. Students is approximately 73kg.
  - Piezo tested by :- ADULT 1
  - Weight of Adult 1 :- 73kg

- **Battery Charging:-**

  - Charging 2 small rechargeable "AA" Batteries connected in series for 15 minutes.

	Reading Before Charging	Reading After charging	Change in Reading
Voltage	2.02V	2.08V	0.06V
Current	0.4mA	1.2mA	0.8mA
Total power	0.808mW	2.496mW	0.048mW

  - Charging 2 small rechargeable "AA" Batteries connected in series for 30 minutes.

	Reading Before Charging	Reading After charging	Change in Reading
Voltage	2.02V	2.09V	0.07V
Current	0.3mA	2.9mA	2.6mA
Total power	0.606mW	6.061mW	0.182mW

- **Battery Specification based on above calculation:-**

  - For any appliance working on 30W consumption for 8 hours will be = **240W.**
  - A battery of 12V-15AH will be required.
  - A 30W appliance consumes power of 2.8 A/hours so for a 25AH battery, it will last for **= 8.9 hrs**

- **Calculation:-**

  - Normal Walking:-

Unregulated Parameters	Per piezo output
Voltage	7.3V
Current	35uA

Power (calculated)	Per Piezo output
Power generated/sec	0.00025Wsec
Power generated after 1 hr	0.936Whr
Power generated after 15 hrs	14.04 Whr
Power generated after 30 hrs	28.08Whr

NOTE: - ADULT 1 is used to obtain the above value

  - While Dancing:-

Unregulated Parameters	Per Piezo output
Voltage	10V
Current	50uA

Power (calculated)	Per Piezo output
Power generated/sec	0.0005Wsec
Power generated after 1 hr	1.8Whr
Power generated after 15 hrs	27Whr

NOTE: - ADULT 1 is used to obtain the above value dancing.

- **Result :-**

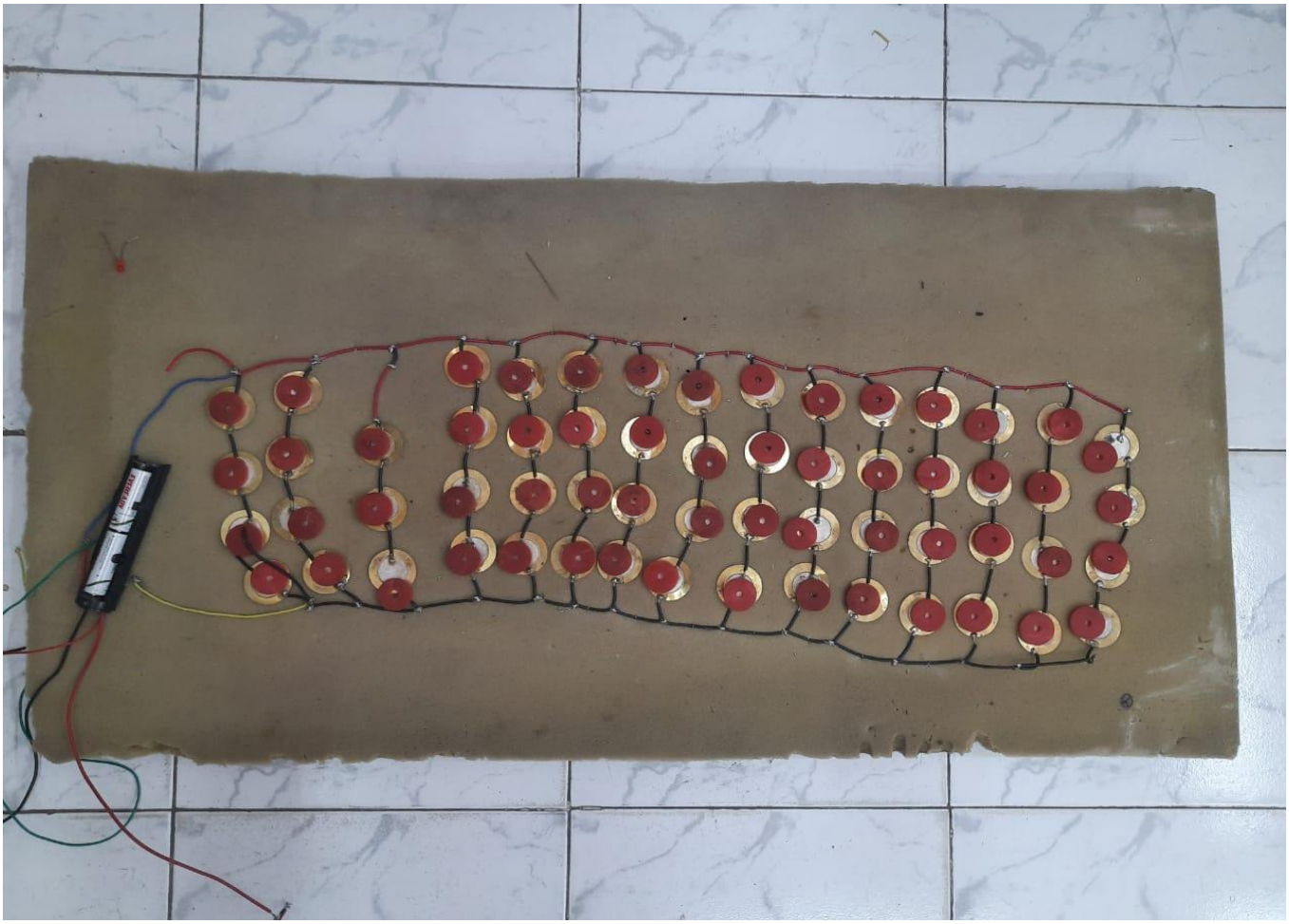
  - By considering an average weight of 73kg and taking a reading of that weight Adult 1 the result stated are below:-
  - A 30w appliance will last for 8.9 hrs by walking 30 hrs.(single individual walking)
  - A 30w appliance will last for 8.9 hrs by dancing 18 hrs. (single individual walking)

- **Consider the above unit is placed in a school :-**

  - Considering average weight of a child/kid **= 30kg**
  - The power a child generates is **= 0.384whr**
  - By dancing for 15hr the power = 5.76whr/kids
  - Therefore considering a batch of 100 kids dancing per hours the power generated will be = **38.5**whr
  - If 90 kids dancing for 1 hr then 1 appliance of 30w will work/last till **8.9 hrs**

11. Interfacing the Prototype

Testing the prototype before mounting the setup each component was tested, the earlier test was done with a single piezo, the voltage and the current for each piezo was noted for people with different weight. After doing few test it was verified that each component was functioning as we required, once the initial tests were completed we decided what would be the piezo circuit, few



test were performed to check if all components were functioning, we faced difficulties to find the required rechargeable battery, finally we found a battery that met our requirement, that's when we moved on the final stage where we had to mount the setup create an actual prototype, the main aim during this stage was to keep the prototype as compact as possible so that it could be easily portable.

12. Future Scope

This project can be improved in the following ways.

1) Using Quartz crystal as a piezo material to get better current output.

2) Increasing the size of the crystal and making an entire plate of the crystal.

3) Different ways to multiply the current output can be used for example using Mosfet can increase the current output.

13. References

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14. Log book

Date	Task	Issue	Solution
25/01/22 - 15/02/22	Research on project ideas to decide a topic.		Got an idea about the piezo device.
16/02/22 – 21/02/22	Shortlist the components to be used and purchased them.	Faced Difficulty finding a piezo sizeable piezo.	Finalized to use the 35mm piezo available in market.
22/02/22 – 25/02/22	Researched on the piezo combination that should be used.		Connected the piezo in series and parallel.
26/02/22 – 15/03/22	Measured the output by connecting piezo in different combination.	The output of piezo were not as expected.	Tried using LM317 to increase the current output.
16/03/22 – 21/03/22	Measured output of LM317.	The current output was not as expected.	Researched on ways to increase the output.
22/03/22 – 02/04/22	Tried finding MOSFET as we found that it increased the current output.	Didn't find a vendor who provides a MOSFET.	Switched back to the original setup
03/04/22 - 12/04/22	Worked on increasing the voltage output.		Used Cockroft Walton circuit to increase the output.
13/04/22 – 24/04/22	Decided the number of piezo to be used in series and parallel.	Faced problem is soldering.	Created a prototype.
25/04/22 – 29/04/22	Obtained the readings for the prototype.		Finalized the setup.
30/04/22 – 15/05/22	Researched on the ways to store the piezo energy.	Didn't find the desired rechargeable battery.	Used a 1.2V rechargeable battery.
16/05/22 – 24/05/22	Took readings about the charge stored in the battery.	Faced issues with the amount of charge stored.	Researched about the amount of charge that should be stored.
25/05/22 – 29/05/22	Took the readings after including a diode.	.	The readings were as expected.
30/05/22 – 5/06/22	Fixed all components and assembled the final setup.	.	Tested the prototype with acceptable outcome.