EXPERIENTIAL LEARNING PROJECT

THEME: ENERGY

TOPIC: GENERATION OF ELECTRICITY FROM ACOUSTIC ENERGY

TEAM MEMBERS

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Introduction

In the modern era, the quest for energy has predominantly been fulfilled by fossil fuels. However, the environmental and geopolitical consequences of this dependence have led to a global realization: the transition to renewable energy is not just beneficial, it is essential.

As we know, sustainability refers to the ability to meet the needs of the present without compromising the needs of the future generations. In this view, utilization of renewable energy sources instead of energy from fossils fuels is the key idea of our project.

Problem Statement

“Depletion of non-renewable sources of energy due to increase in energy consumption has created the need to find alternative sources of renewable energy like generating electricity from unwanted noise.”

Objectives

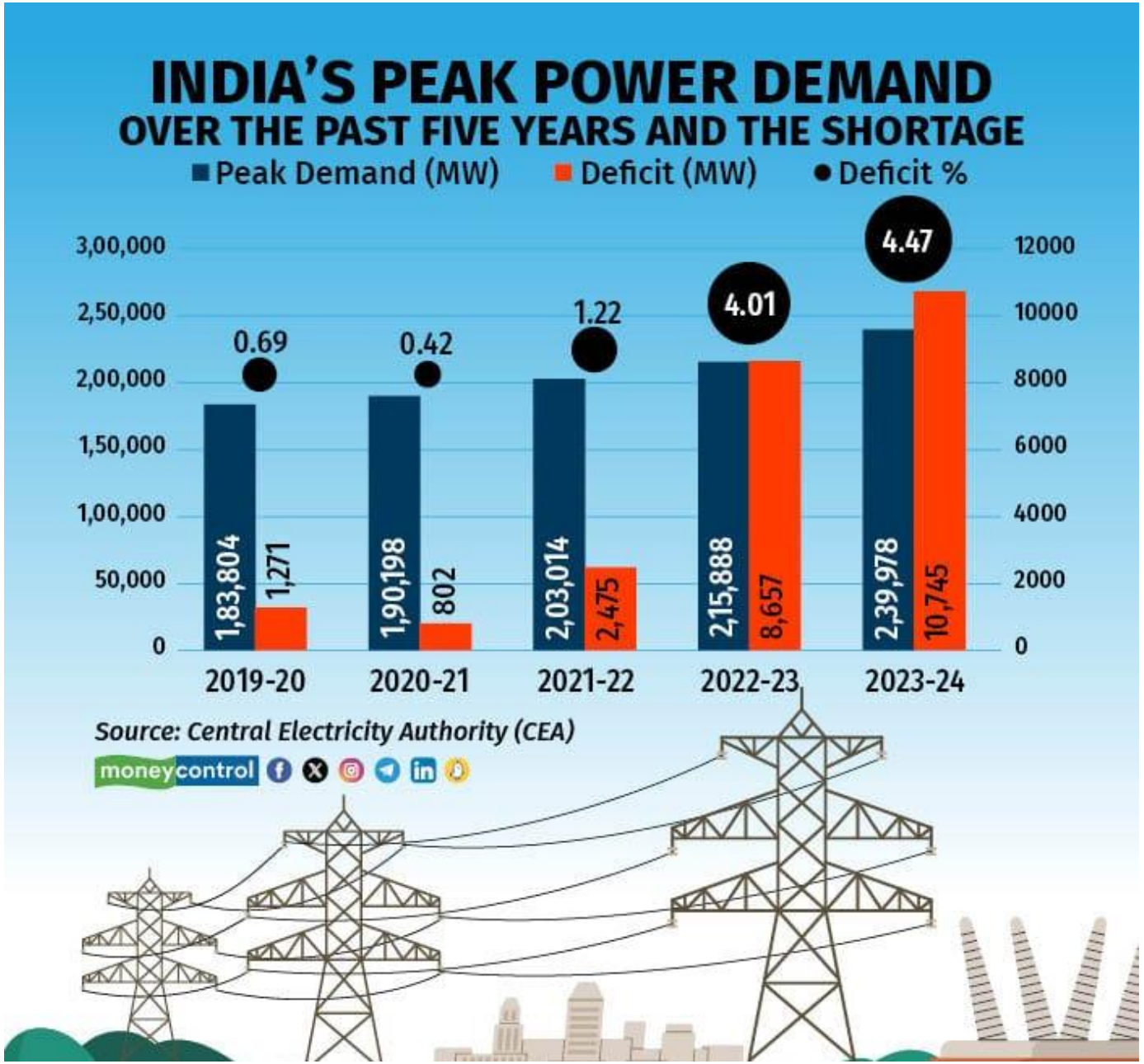
- ✓ To **investigate** various **innovative methods** to generate electrical energy from acoustic sources.
- ✓ To **implement and generate electricity** from acoustic sources of energy.
- ✓ To **increase the efficiency** of generating electricity from acoustic sources.

Literature Review

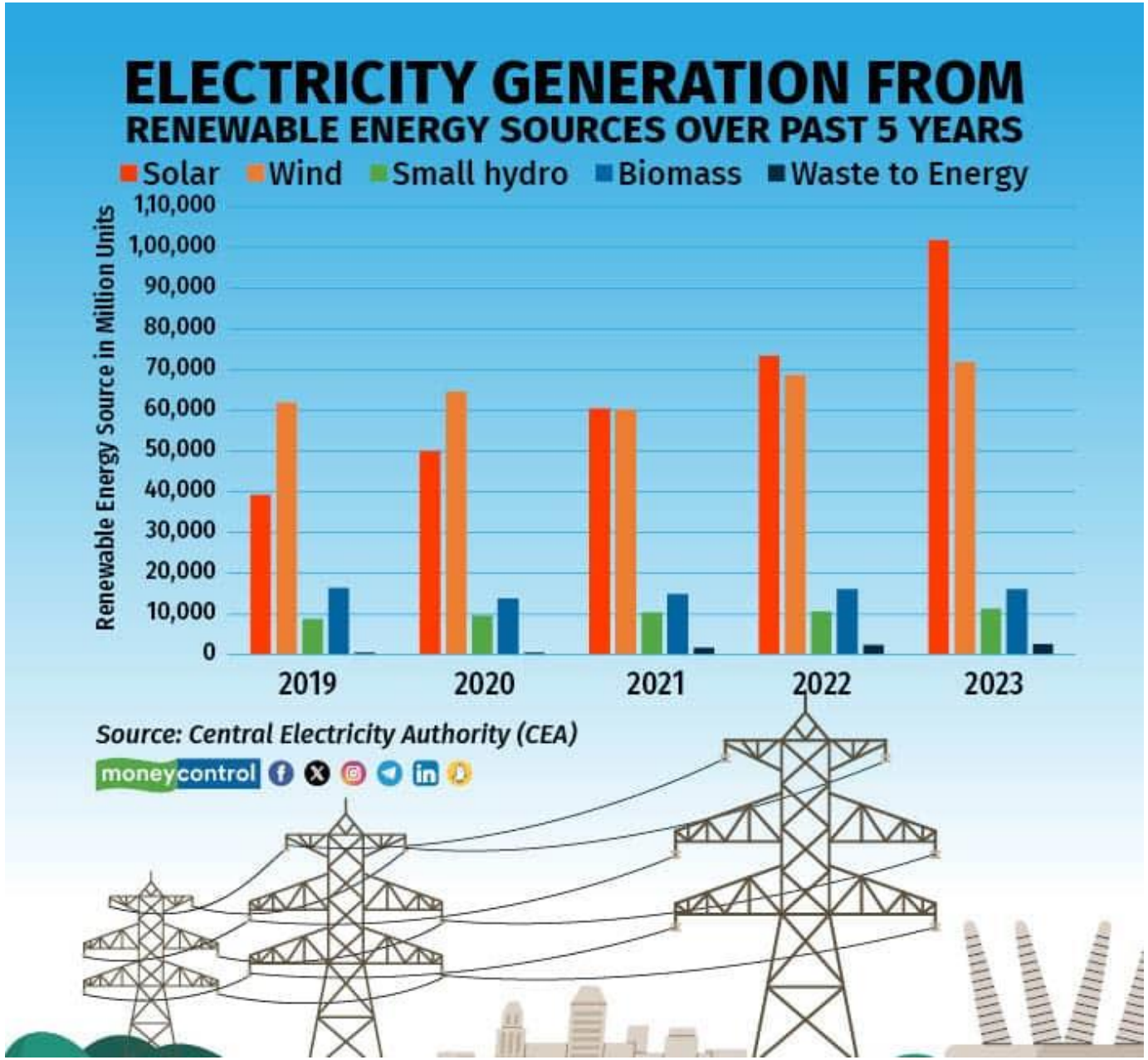
AUTHOR	PAPER TITLE	ABSTRACT	PUBLICATION DETAILS
Alankrit Gupta, Vivek Goel, Vivek Yadav	**Conversion of Sound to Electric Energy**	Sound energy is an untapped resource with tremendous potential to meet future electricity demands in an eco-friendly and renewable way.	**International Journal of Scientific & Engineering Research, Volume 5, Issue 1, January-2014** **ISSN 2229-5518**
A.Subramaniya Siva , N.Vinothini , S.Sathieshkumar	**Piezoelectric Based Electric Energy Generation From Sound Energy**	This paper proposes a method to convert sound into electrical energy for various applications. Here, they have used a piezoelectric transducer to achieve this conversion.	**INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH VOLUME 9, ISSUE 04, APRIL 2020**

Literature Review

AUTHOR	PAPER TITLE	ABSTRACT	PUBLICATION DETAILS
Yuan Wang, Xin Zhu, Tingsheng Zhang, Shehar Bano, Hongye Pan, Lingfei Qi, Zutao Zhang ,Yanping Yuan	**A renewable low-frequency acoustic energy harvesting noise barrier for high-speed railways using a Helmholtz resonator and a PVDF film**	This paper proposes a new type of noise barrier which is a Helmholtz resonator to amplify low-frequency noise, which is then converted into electricity by a PVDF film..	**School of Mechanical Engineering, Southwest Jiaotong University, Chengdu 610031, PR China**



Source: September 21, 2023 The Times of India Newspaper



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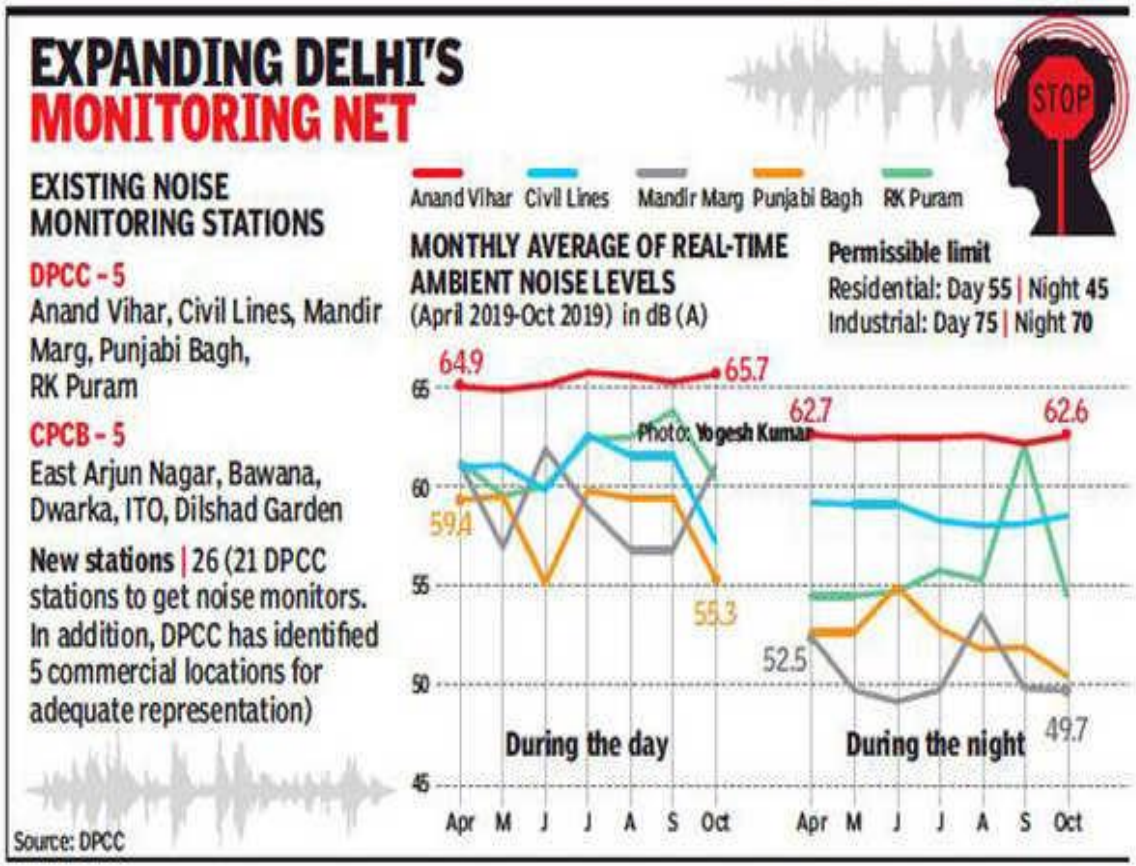
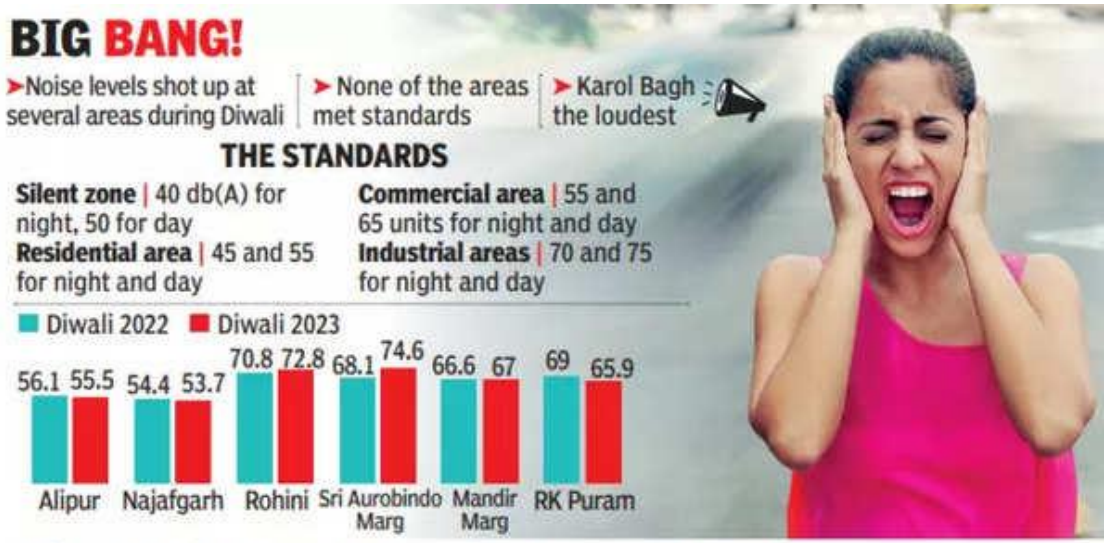
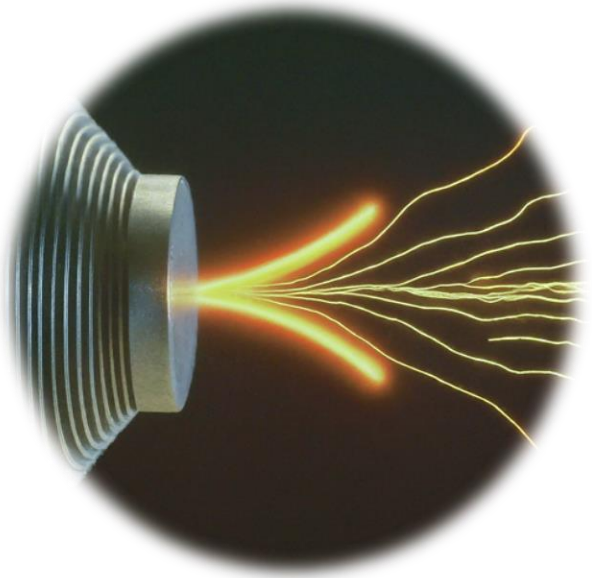




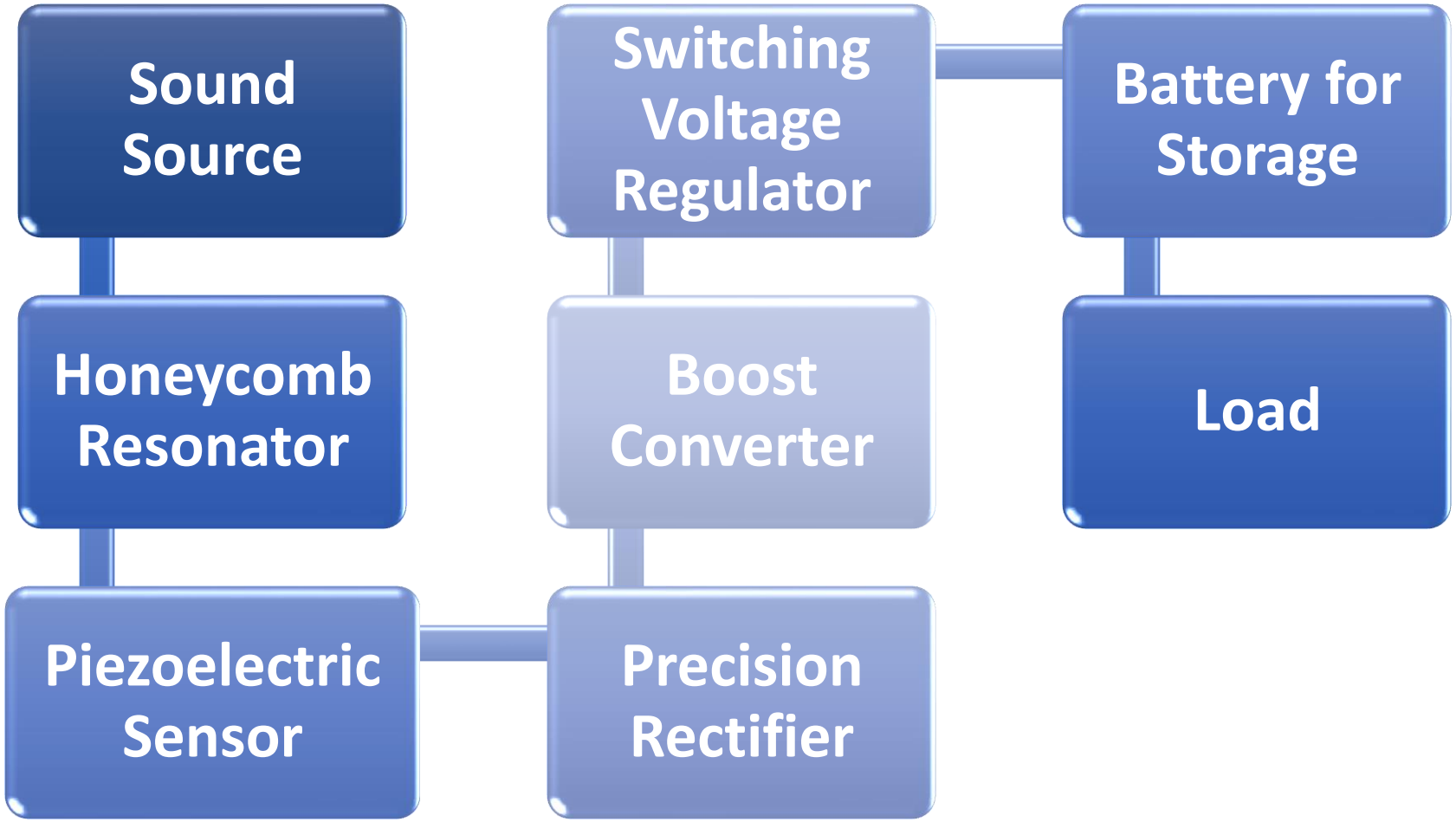
Source: September 4, 2021 The Times of India

METHODOLOGY



- **Conceptualization: Define problem statement and objectives**
- **Specifying Components: Analyzing the need and configurations of the components**
- **Simulations: Testing the components using software**
- **Optimization: To conceptualize and implement ways to increase efficiency of energy conversion**
- **Model building: Hardware model development and testing the output**
- **Economic feasibility: Analysis on cost and environmental benefits of the energy production mechanism**

Block Diagram



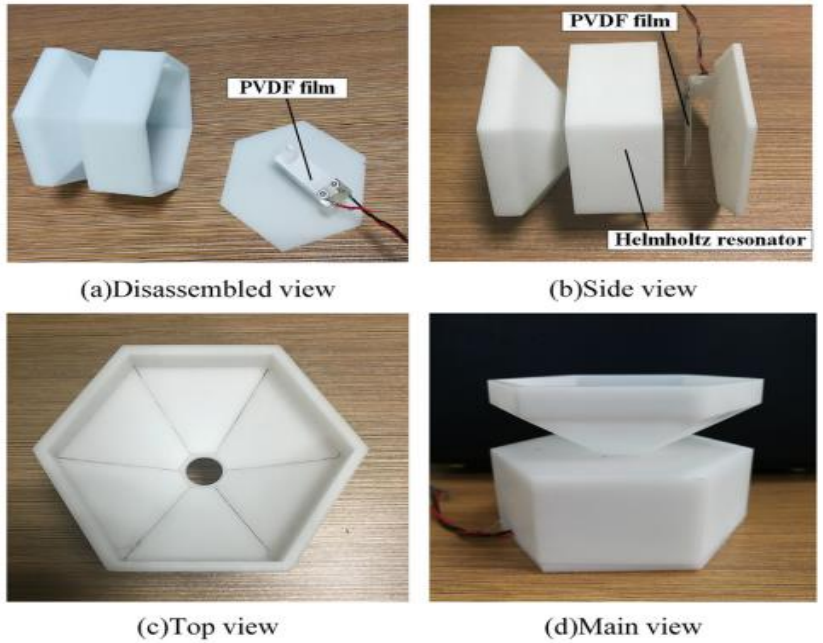
HONEY COMB STRUCTURED HELMHOLTZ RESONATOR

A Helmholtz resonator is a cavity with an opening that resonates at a specific frequency.

The operation of an acoustic resonator is governed by the principles of wave interference and resonance.

The resonant frequency of a Helmholtz resonator is governed by a well-established equation:

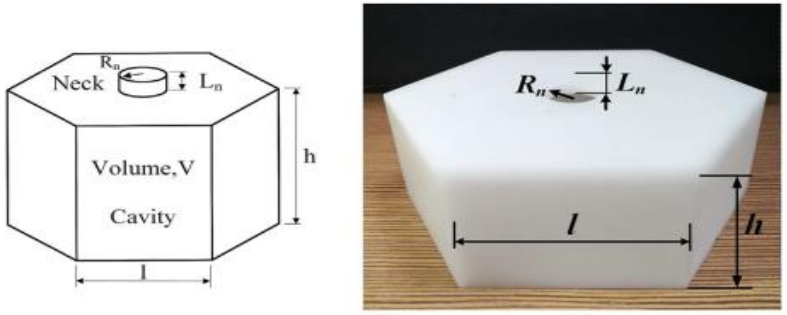
$$f = c / (2\pi) * \sqrt{(A / (V * L))}$$



(a)Disassembled view (b)Side view

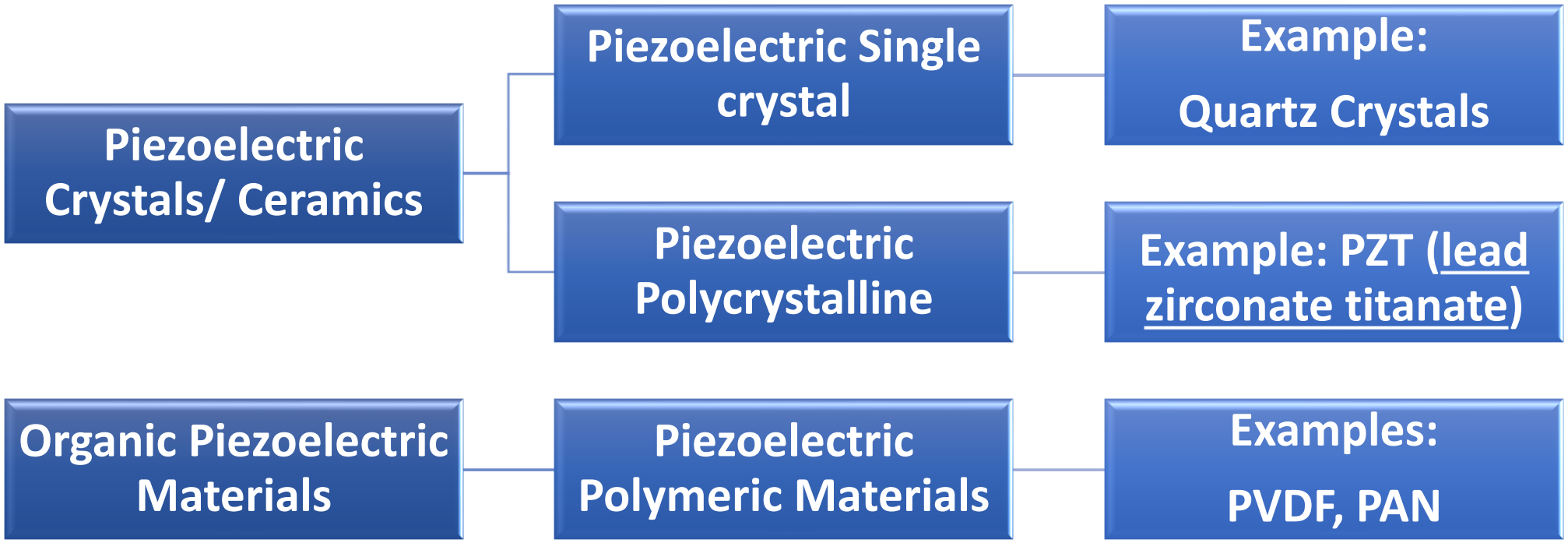
(c)Top view (d)Main view

Fig. 2. Prototype of the AEHU.

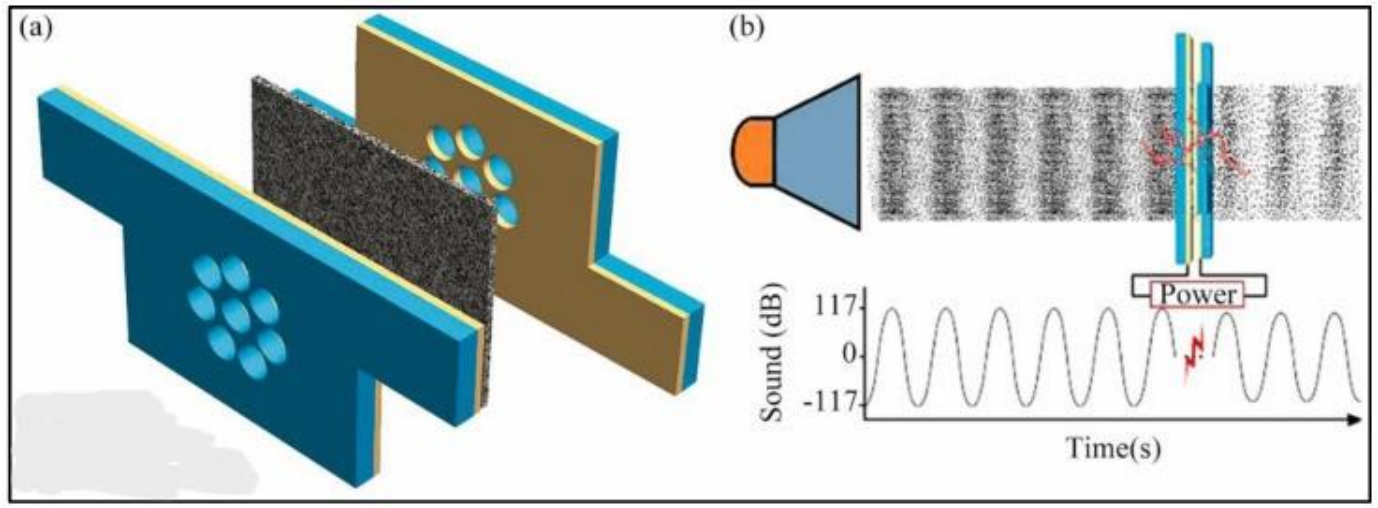


(a) Theoretical model (b) Prototype structure

Piezoelectric Sensor Material



Electrospun Polyacrylonitrile Membranes



- **Electrospun Polyacrylonitrile (PAN) nanofibrous membranes** have the ability to convert low-mid frequency noise into electricity with high voltage outputs.

- The acoustoelectric device is prepared by sandwiching a thin PAN fibrous membrane between two metal-coated plastic film electrodes.
- Under **117 dB sound** (frequency 100–500 Hz), the nanofiber device can generate peak electric outputs as high as **58 V** and 12 μA, with a maximum output power of 210.3 μW, which is much larger than that of other acoustoelectric devices.

Electrospun Polyacrylonitrile Membranes

S.No	DECIBEL (db)	Voltage
1	60	0.29V
2	69	1.2V
3	75	1.7 (Average)
4	Normal Conversion (one Person)	140 mV
5	Bike Horn (80-85 db)	2.4V(near)
6	Car Horn (80-85 db)	200mV to 500mV(far)
7	Carpentry work (81 db)	150-200 mV(little far)

Electrospun PAN Material
29.74 V
34.20 V
37.19 V

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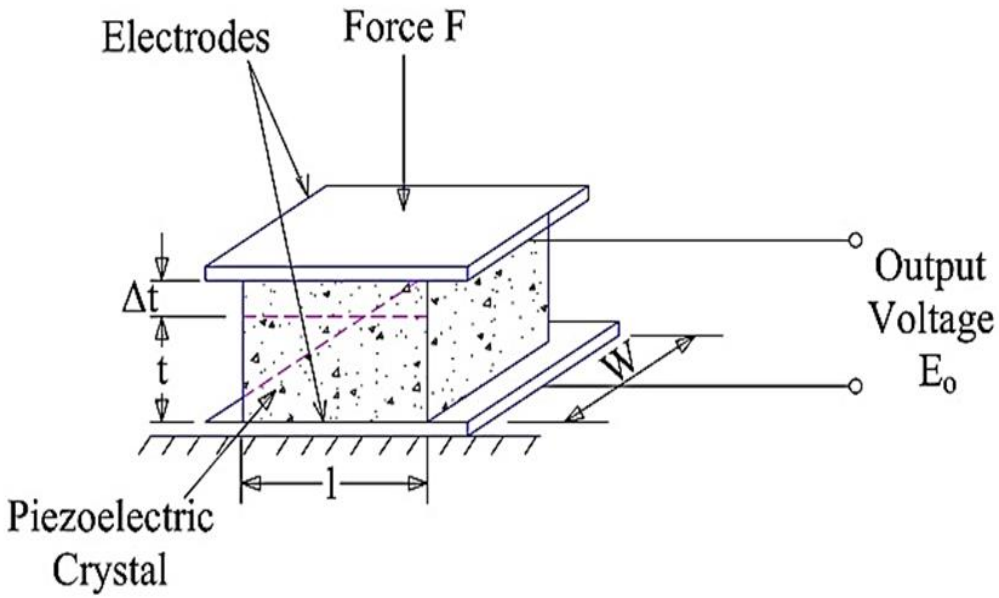
Working Principle

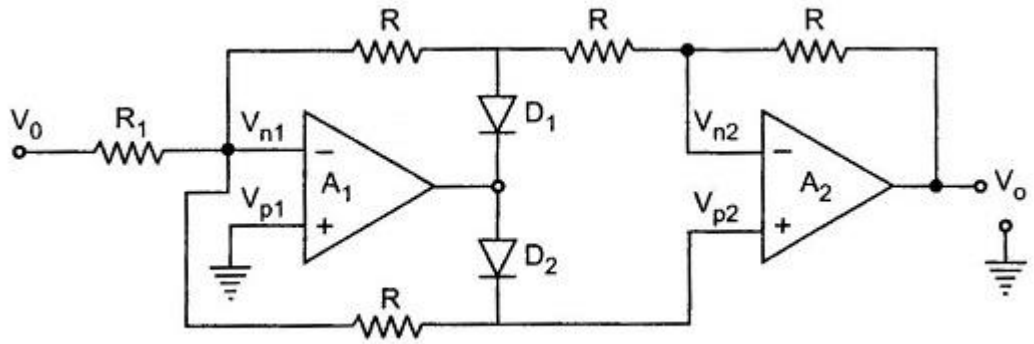


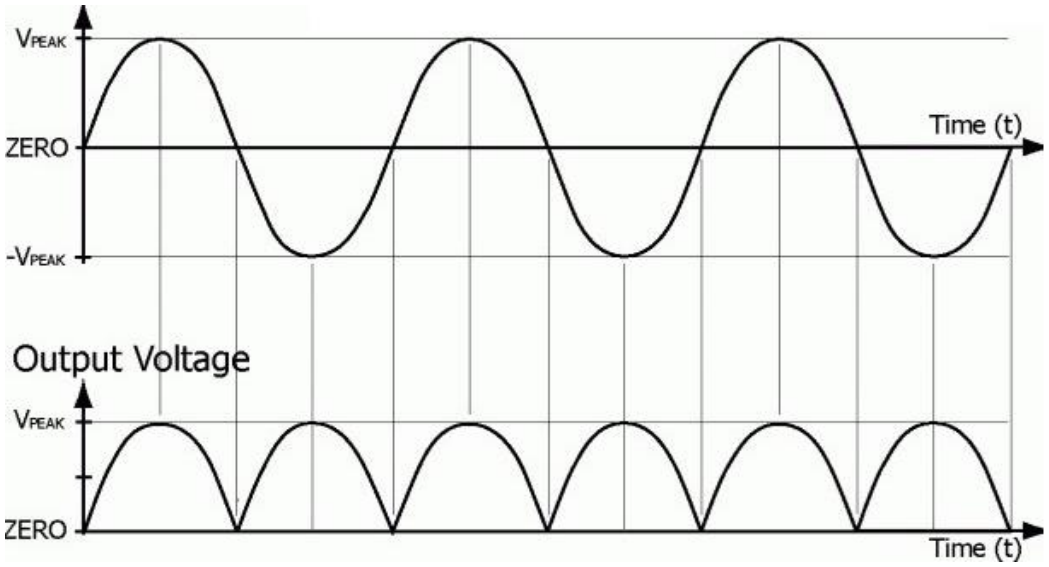
When sound waves (acoustic energy) strike a piezoelectric material, they cause mechanical vibrations within the material.

These vibrations lead to the deformation of the crystal lattice structure, resulting in the separation of positive and negative charges.

The accumulation of these charges creates a potential difference across the material, thus generating electricity.

PRECISION FULL WAVE BRIDGE RECTIFIER

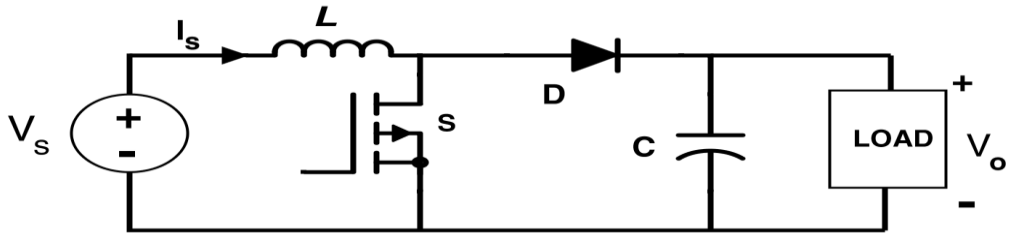


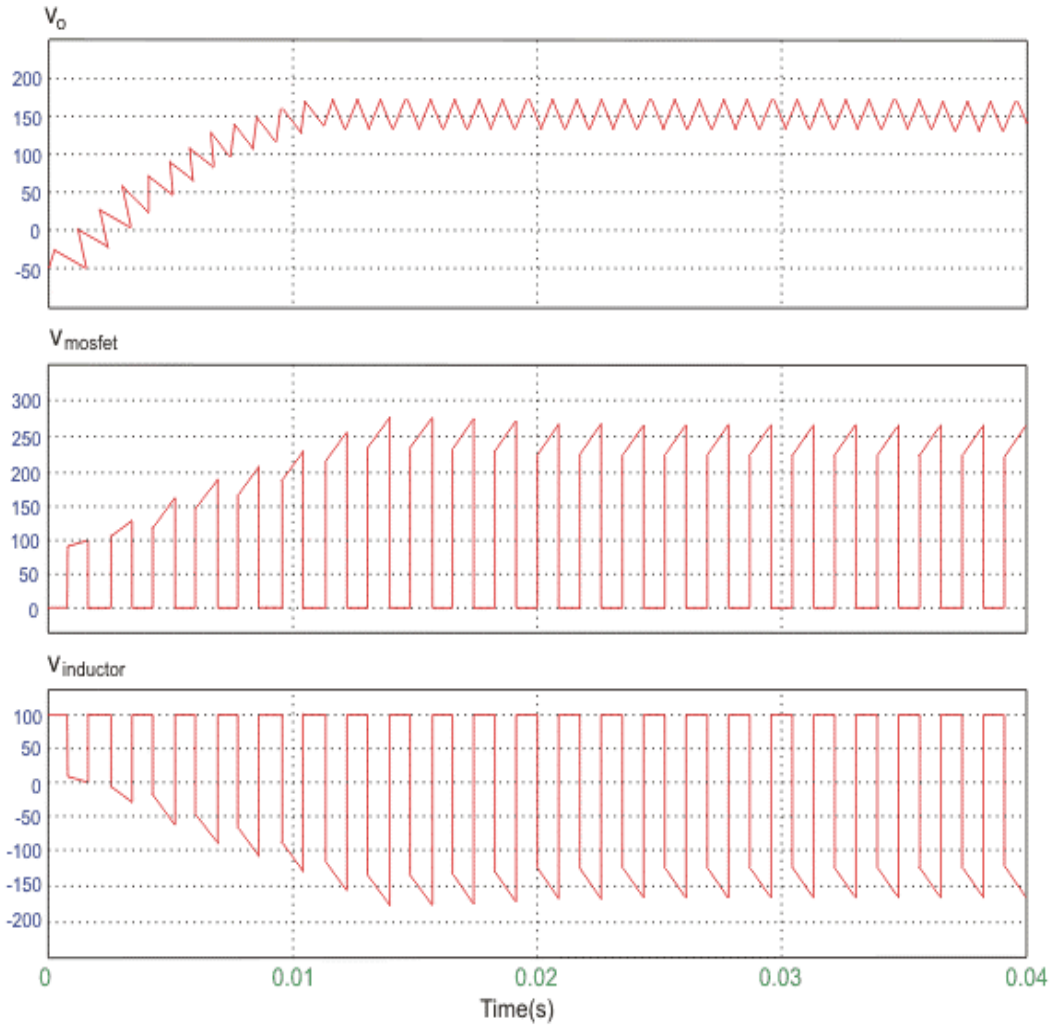


- **A precision full-wave bridge rectifier uses operational amplifiers (op-amps) along with diodes to achieve accurate rectification.**
- **This configuration reduces the forward voltage drop across the diodes and allows the rectifier to handle very small signal levels with high accuracy.**
- **Advantages: high sensitivity, accuracy, linearity.**
- **ensures high accuracy and sensitivity, making it an ideal choice for applications requiring precise and reliable signal rectification from low-level AC signals.**

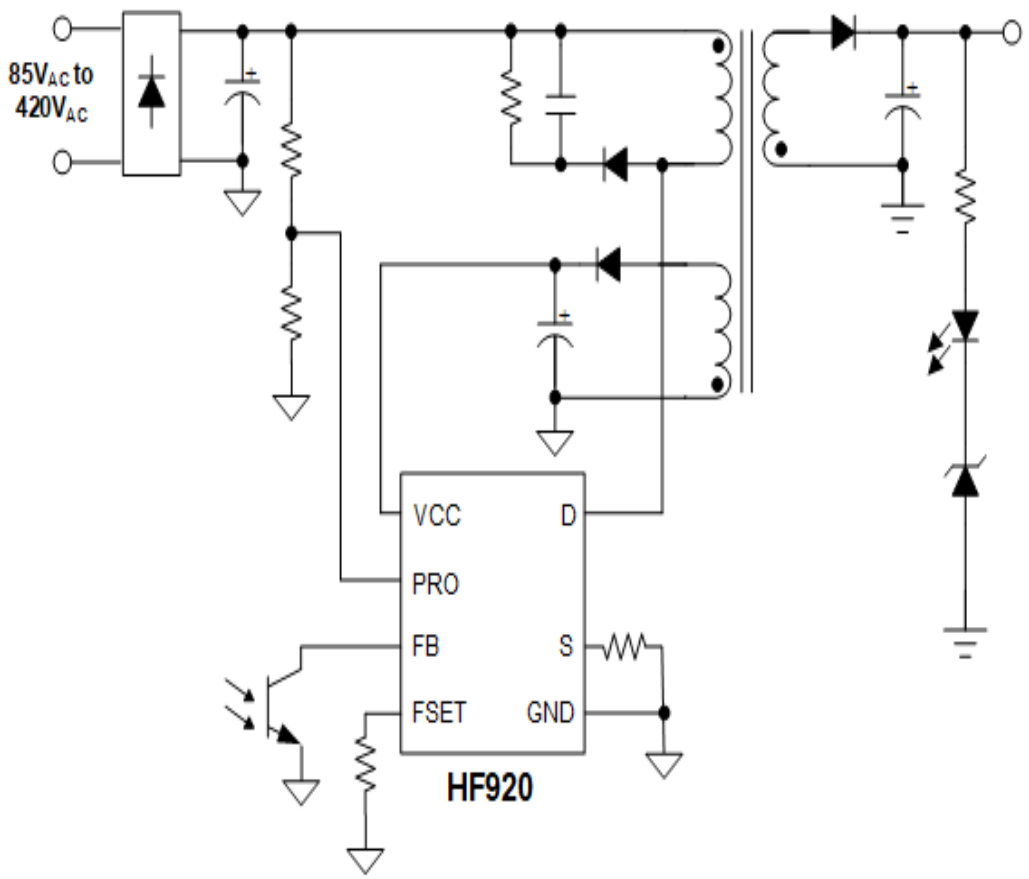
BOOST CONVERTOR

- A boost converter is a type of DC-DC converter that steps up (increases) the input voltage to a higher output voltage.
- Advantages: Inductor based energy storage, switching mechanism, diode for directional current flow, output capacitor, efficiency, voltage gain, PWM control





SWITCHING VOLTAGE REGULATOR



A voltage regulator is a circuit that creates and maintains a fixed output voltage, irrespective of changes to the input voltage or load conditions.

Advantages of switching regulators include that they are highly efficient, have better thermal performance, and can support higher current and wider V_{IN} / V_{OUT} applications. They can achieve greater than 95% efficiency depending on the application requirements.

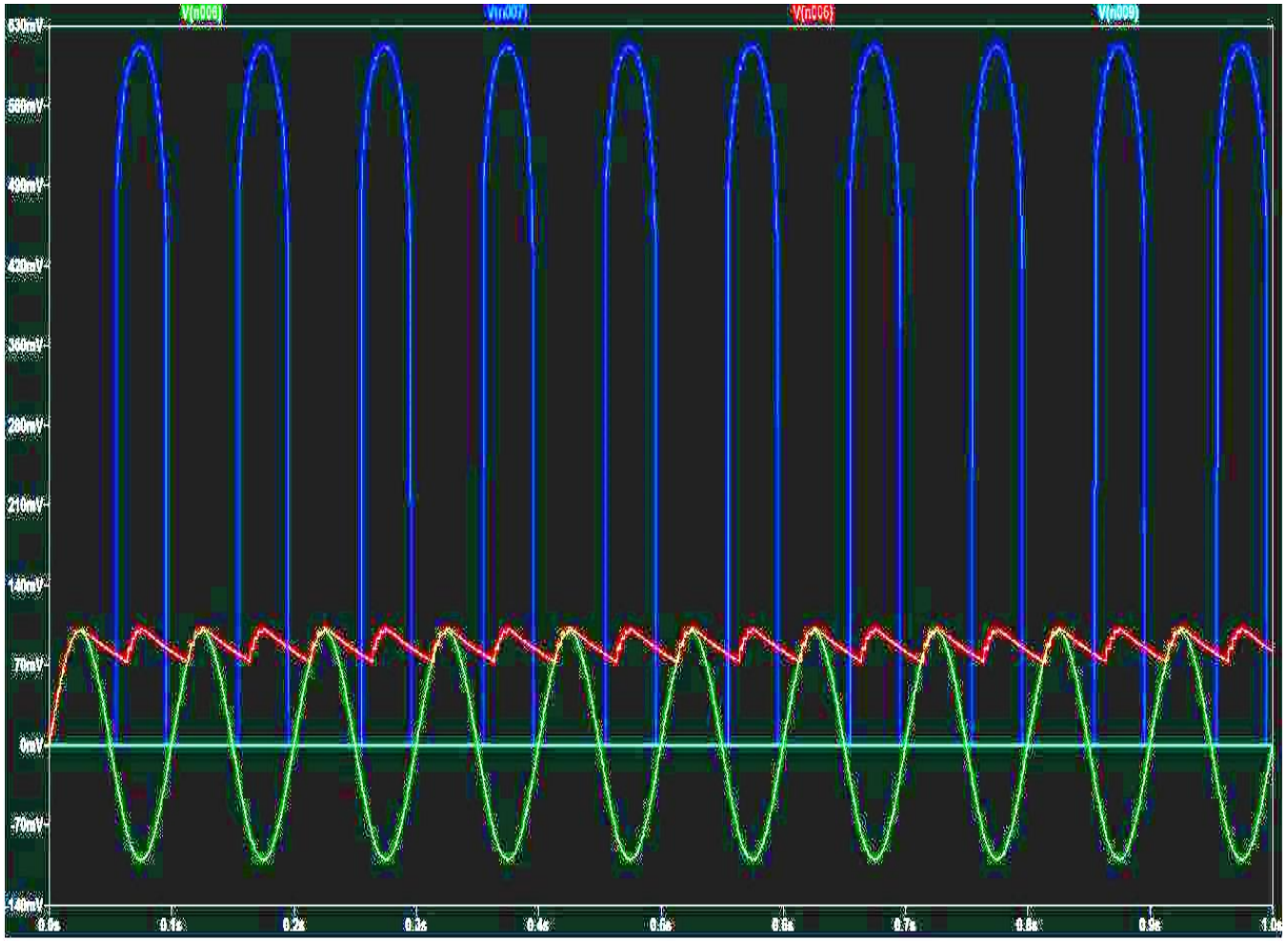
For switching regulators, there are three common topologies: step-down converters, step-up converters, and buck-boost converters.

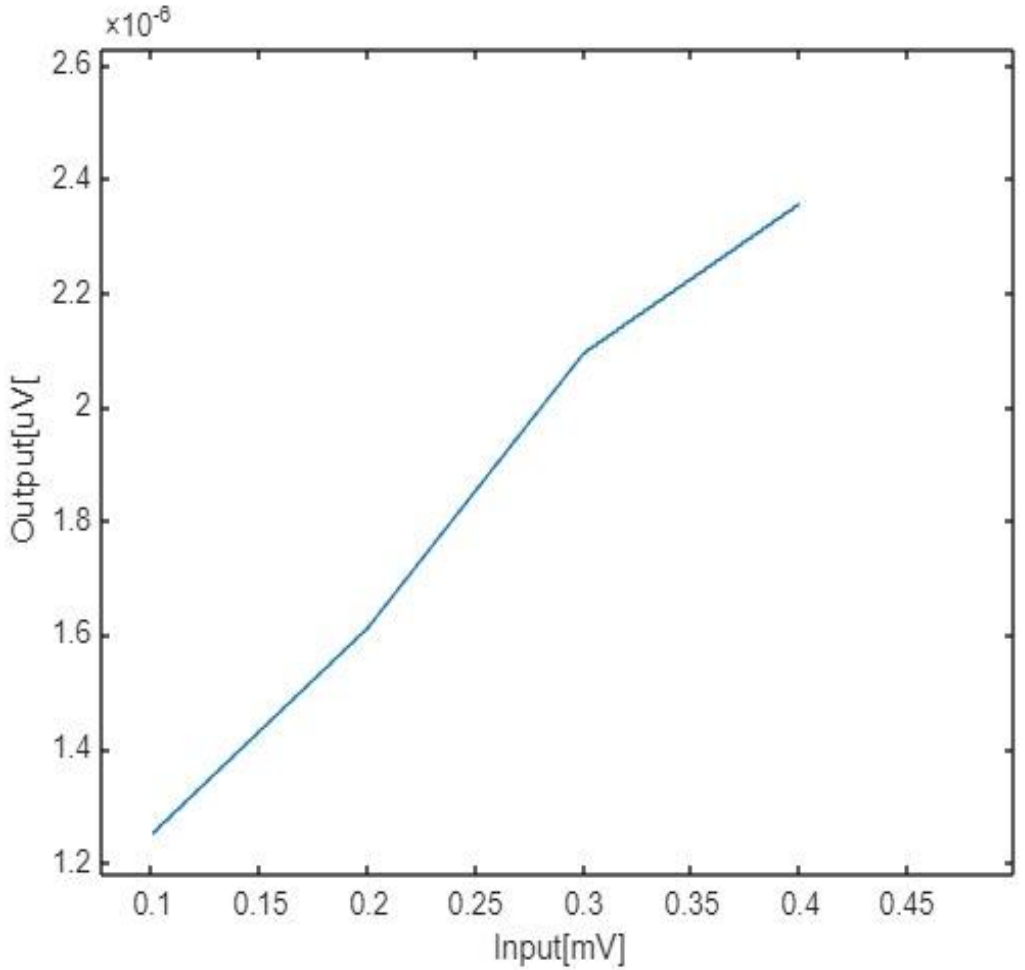
FUTURE SCOPE

- Automatic mobile phone recharging techniques.
- Industries utilize the sound energy produced to their advantage by storing it.
- Concerts can be run without external energy source.
- IC which can perform all the operations and convert acoustic energy to electricity.

Go, change the world

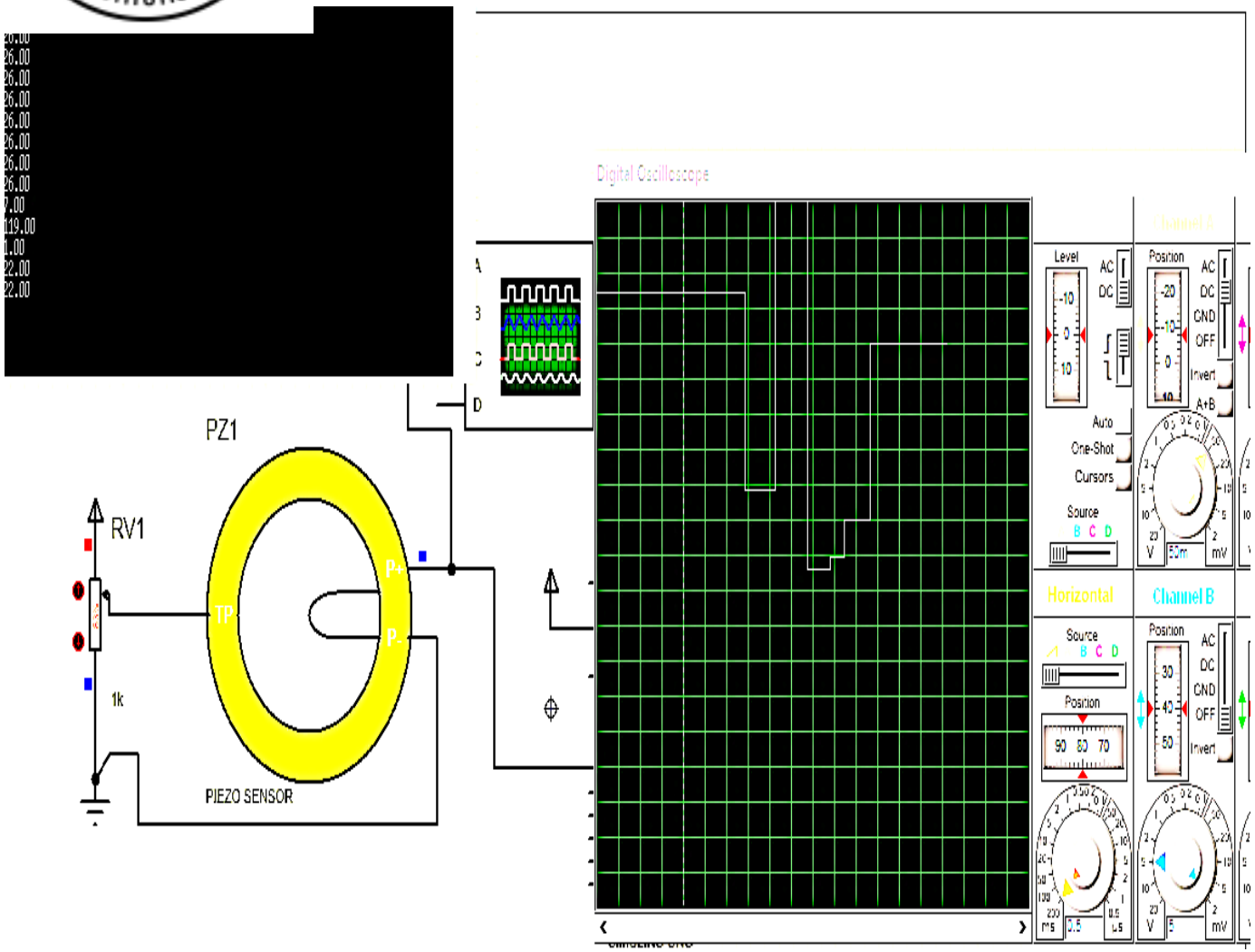
GRAPHICAL RESULTS

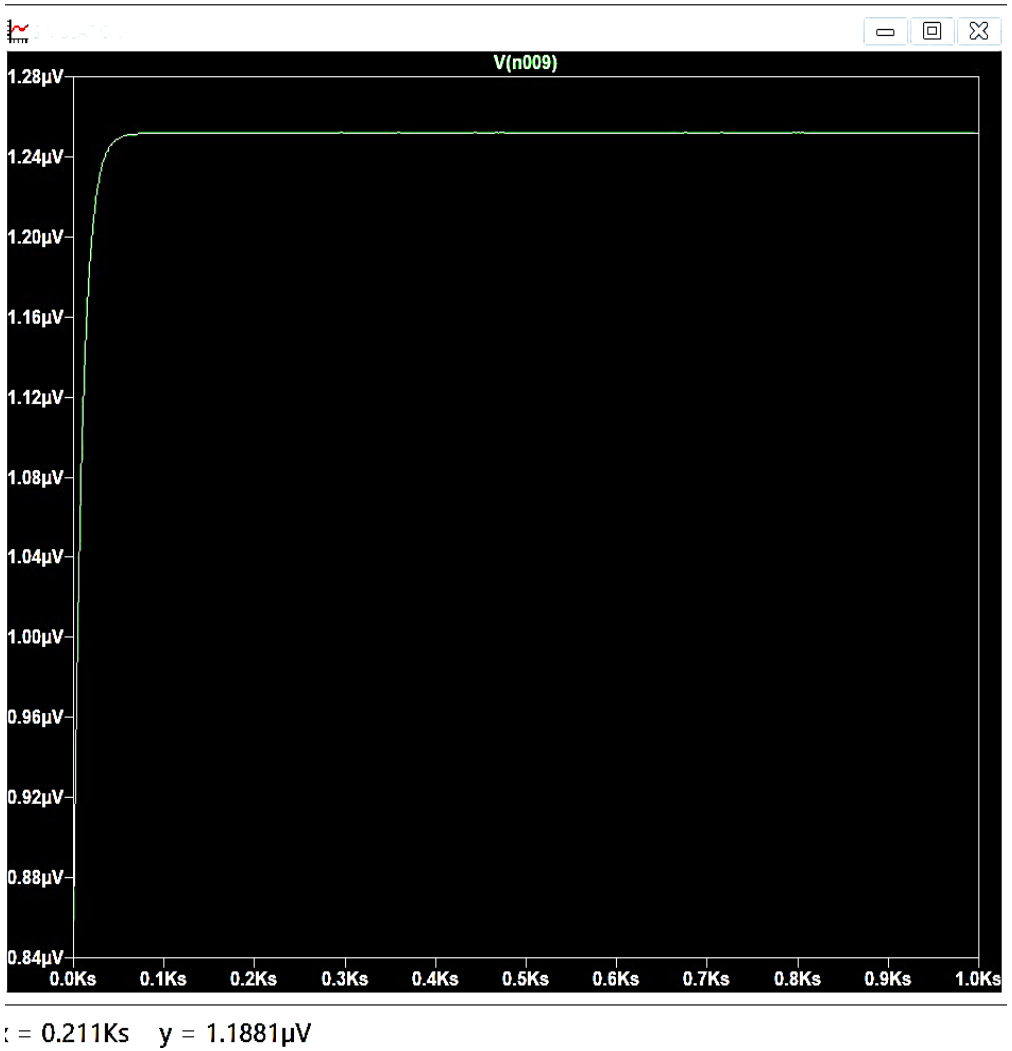




Simulation results of Ltspice and MATLAB

CIRCUIT SIMULATION:





Simulation images from proteus and Ltspice software

COMPONENTS

Component	Quantity	Cost per unit
Piezoelectric Sensor	1	89
Arduino UNO Board	1	253
Bridge Rectifier	1	270
Amplifier	1	4374
Voltage Regulator	1	350
Battery	2	170
Load	1	8
Sound Sensor	1	229
Total		5743

References:

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Thank
You!