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# Study on applications of radio frequency nano antenna energy conversion and supercapacitors

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**Abstract**
In this paper, the study on applications of radio frequency nano antenna energy conversion and supercapacitors is presented. Radio Frequency (RF) signals are a form of electromagnetic radiation with wavelengths greater than 3 meters. Initially used in wireless communication devices like radios and walkie-talkies, RF signals have found their way into energy conversion and storage applications. When RF signals are received by an antenna with coupled capacitors and a rectifier circuit, they generate a potential difference of a few millivolts. This potential difference can be used as a stable source of energy to power low-voltage applications through ambient RF radiation, and excess energy can be stored in electrochemical storage systems like supercapacitors and lithium-ion batteries. While this technology is currently limited to low-power applications, it has immense potential in various fields such as medicine, automotive industry, military applications, and more. Researchers are currently working to improve the energy density of supercapacitors by modifying their electrode materials using nanotechnology. One promising material is lignin, derived from wood fibers, which has shown great performance in tests and is expected to be a low-cost solution for high-performance batteries and supercapacitors. As the renewable energy sector continues to advance, we can expect to see more useful applications based on RF nano antennas and micro/nano-sized supercapacitors. The work done & presented in this paper is the result of the mini-project work that has been done by the first sem engineering students of the college and as such there is little novelty in it and the references are being taken from various sources from the internet, the paper is being written by the students to test their writing skills in the starting of their engineering career and also to test the presentation skills during their mini-project presentation. The work done & presented in this paper is the report of the assignment / alternate assessment tool as a part and parcel of the academic assignment of the first year subject on nanotechnology & IoT.
**Keywords:**Frequency, Radio, Antenna, IoT, Nano, Energy, Super-capacitor, Battery

## Introduction

The history of RF energy harvesting dates back to the early 20th century when researchers first discovered the phenomenon of electromagnetic radiation. However, the first practical demonstration of RF energy harvesting was not done until the mid-20th century [1]. In 1964, William C. Brown, a physicist at Raytheon Corporation, demonstrated the first successful wireless power transmission using microwaves – [2]. He was able to transmit a small amount of power (enough to light a small bulb) over a distance of several feet, using a beam of microwaves at a frequency of 2.45 GHz. This demonstration was a significant milestone in the development of RF energy harvesting, as it showed that it was possible to convert electromagnetic energy from one form to another (from RF waves to electrical power) without the need for a physical connection between the energy source and the device being powered. [3]

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**Radio Frequency Concepts**

Since then, there have been many advancements in RF energy harvesting technology, and it is now used in a wide range of applications, including wireless sensors, medical implants, and Internet of Things (IoT) devices [4]. However, the design and construction of the RF nano antenna depends on several factors like size, power requirement and application. In order to develop a nano RF antenna, it requires specialized techniques. Mainly, lithography is used to develop nano scale p-n junction diodes, capacitors and transistors [5]. Also, Chemical Vapour Deposition (CVD) and Chemical Exfoliation processes are often used to synthesize Single Walled- Carbon Nanotubes (SW-CNT) and Multi Walled- Carbon Nanotubes (MW-CNT) which are essential in developing nano-scaled Field Effect Transistors (FET) for Amplifier circuits [6].

**Supercapacitors**

Coming to Supercapacitors, the concept isn't new and its discovery was done while the scientists were trying to modify electrolytic capacitors and its application in electrochemical energy storage systems. The supercapacitor, also known as an ultracapacitor or electrochemical capacitor, was first discovered in the 1950s, but its development and commercialization took several decades. In 1957, researchers at Standard Oil Company of Ohio (now known as BP) discovered that high surface area activated carbon could store large amounts of electrical charge in a porous structure – [7 ]. However, the technology was not widely recognized or developed at that time. In the 1960s and 1970s, further research was conducted on the electrochemical behaviour of high surface area materials, which led to the development of electrochemical double-layer capacitors (EDLCs), the forerunner of modern supercapacitors. In the 1980s and 1990s, advances in materials science and manufacturing techniques led to the commercialization of supercapacitors for a wide range of applications, including backup power systems, hybrid electric vehicles, and renewable energy systems. Therefore, looking at its importance we will move onto its salient applications from now on. The Fig. 1 gives the testing of the cell, whereas the Fig. 2 gives the viewing the reading using the multimeter along with the checking of the battery of supercapacitor with the multimeter shown in the Fig. 3[8].

**Scopes & Objectives**

Restricted research is available that provides information about RF nano antenna Energy Conversion and Supercapacitors. This study paper seeks to assess the existing literature on RF Nano antenna Energy Conversion to recognize the gaps in knowledge for succeeding experimentation. The file collates and contrasts outstanding energy conversion systems and applications and explores one-of-a-kind materials that are used to enhance the overall performance of the working systems, as well as the tests performed to validate the efficiency of the used materials. The review recognizes and categorizes current developments in the field of Renewable energy sector and updates are done accordingly as the technologies seeks advancements. This structured review is likely to help researchers working in this field by highlighting current advancements in RF energy conversions and supercapacitors, as well as the challenges that will need to be controlled in the time ahead for dependable energy production and storage. Hence, the objective of this study is to improve the existing renewable technologies to deliver better efficiency and reliability to the consumers [9].

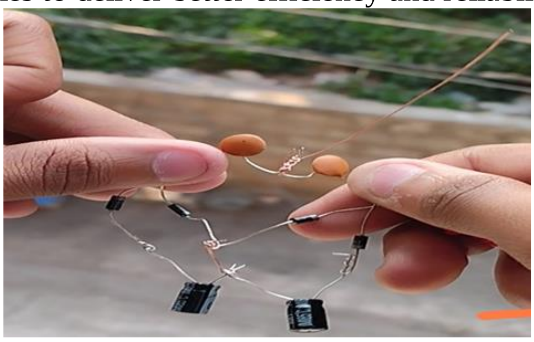

Fig. 1 : Testing of the cell

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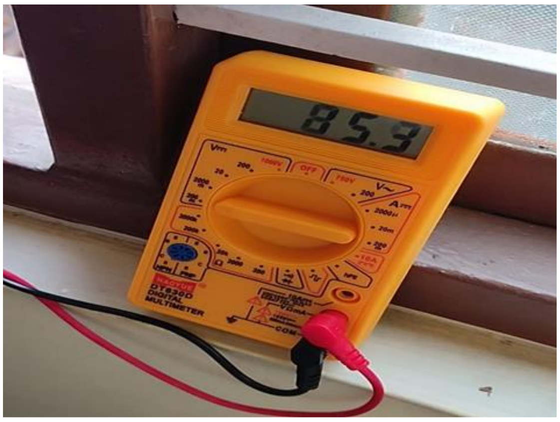


Fig. 2 : Viewing the reading using the multimeter

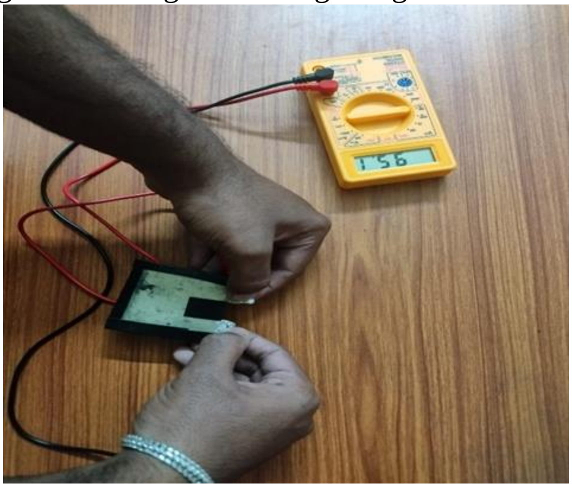

Fig. 3 : Checking of the battery of supercapacitor with the multimeter

**Advantages**

- RF energy is available virtually everywhere, making it a potentially abundant and renewable source of power.
- RF energy harvesting can be used to power low-power devices, reducing the need for traditional power sources such as batteries.
- RF energy harvesting can extend the life of batteries or eliminate the need for them altogether, reducing electronic waste.
- RF energy harvesting is a passive technology that requires no fuel, moving parts, or maintenance, making it a reliable and cost-effective source of power.
- RF energy harvesting is environmentally friendly and reduces carbon footprint.

**Conclusions**

In conclusion, the use of RF energy harvesting technology has the potential to greatly improve the efficiency and sustainability of various electronic devices and systems. By capturing and utilizing ambient RF energy, devices can operate with less reliance on traditional power sources, reducing the need for frequent battery replacements and reducing the environmental impact of electronic waste. Overall, the use of RF energy harvesting is a promising avenue for advancing the capabilities of electronic devices while reducing their environmental impact, and is an area that will likely continue to grow and evolve in the coming years.

In conclusion, supercapacitors have become increasingly popular in modern day applications due to their unique set of properties, such as high power density, fast charging and discharging, long cycle life, and wide operating temperature range. Supercapacitors are being used in a variety of fields, such as transportation, renewable energy, consumer electronics, and medical devices. They are being used to power electric vehicles, provide backup power for solar panels, enhance the performance of smartphones, and enable implantable medical devices, among other applications.

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