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Wireless Transmission of Solar Generated Power

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Abstract—This paper focuses mainly on the generation of electricity by using solar renewable energy with wireless transmission. This solar energy system is eco- friendly that can be harnessed in any remote place wherever the sunshine is available and the locations which are far- flung, deprived and not accessible from conventional power distribution transmission lines. Wireless transmission transfers electric power without any physical contact between source to load. It is based on the two principles: Faraday's law of electromagnetic induction and principle of resonance.

Keywords— Solar Energy, Wireless Power Transfer, Transmitter, Receiver

I. INTRODUCTION

The term 'witricity' is basically wireless electricity. It transmits the electrical energy from one object to the another object without the usage of wires. We can transfer the electric energy over distances without cables.

In the year 1899, Sir Nikola Tesla proposed a method of wireless power transmission. He is known as 'Father of Wireless'. He enlightened 200 lamps at the distance of 40 kilometres which achieved only 15% of the efficiency. But as it is in radiative mode, the most of power was wasted resulting in lesser efficiency.

A group of engineers from MIT developed an idea in order to use the resonant induction for transmitting the power wirelessly. MIT powered 60 Watts light bulb from 2 meters at the efficiency of 40%. This was the first practical example of witricity that was presented in July 2007.

II. NEED FOR SOLAR POWER THROUGH WITRICITY

The increased costs of coal, oil, petroleum and nuclear energy has led to the development of renewable energy power system. As the solar system is eco- friendly and economical, it can be utilized at distant locations. The witricity addition to solar energy system helps in eliminating the usage of heavy cables or wires which makes system even more economical.

III. SYSTEM DESCRIPTION

Figure 1 shows the block diagram for wireless solar power transmission. The wireless solar power transmission system consists of solar system that includes solar panels, charge controller, DC to DC converter, storage battery, impedance matching circuit, transmitter, receiver, fast switching circuit and load.

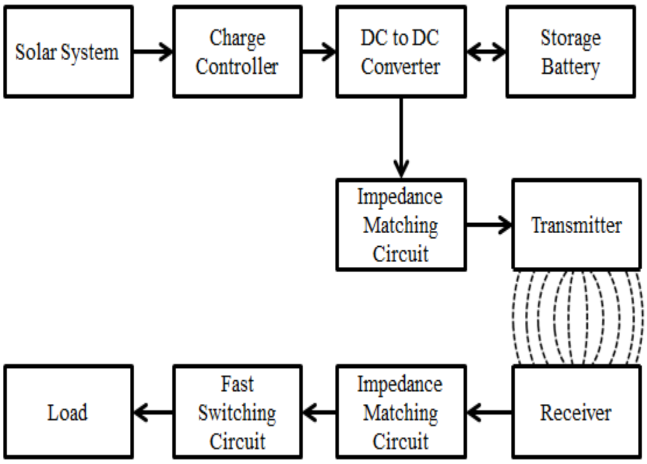

Figure 1. Block Diagram for Wireless Solar Power Transmission

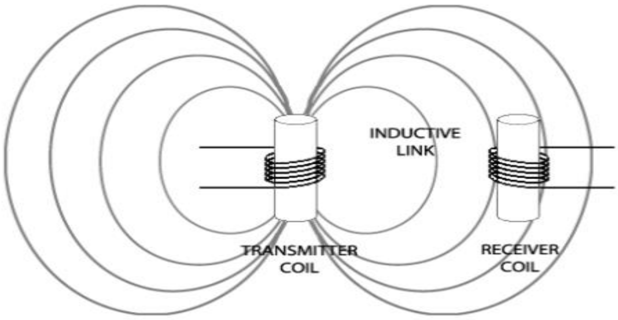

Figure 2. Magnetic Induction

Figure 2 shows magnetic induction which is the cost effective technique and most dependable wireless power transmission. This has the characteristic of non- radiative nature which is not harmful and is environment friendly.

This is based on law of mutual induction. In this technique, a current carrying coil generates a magnetic field when excited, an another second conducting coil is when brought close to the first coil, it captures some portion of that oscillating magnetic field which is present around, this in

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turn, induces an electric current in the second coil. The current generated in the second inductive coil which is used to supply energy to different devices.

The resonant frequency is given by,

$$f = \frac{1}{2\pi\sqrt{L\,C}} \dots (i)$$

where, f: frequency in Hertz (Hz)
L: Inductance in Henry (H)
C: Capacitance in Farad (F)

The inductance is given by,

$$L = \frac{N^2 \mu A}{l} \dots (ii)$$

where, L: Inductance of the coil in Henry(H)
N: Number of turns in the coil
μ: Permeability of air that is core material
A: Area of the coil in square meters (m^2)
l: Average length of coil in meters(m)

The solar efficiency is given by,

$$\eta = \frac{P_m}{E \times A_c} \dots (iii)$$

where, P_m: *Maximum power point in Watts* (W)
E: Input light in W/m^2
A_c: *Surface area of a solar cell in* m^2

Photovoltaic = Photo (Light) + Volt (Electric Potential)

- Photovoltaic solar cells are made of layers of crystalline silicon, covered with a very hard, protective layer of non-reflective glass. Solar cells connected together create a solar panel.
- A solar cell is made up of two layers of silicon that are treated to let electricity flow through them when exposed to sunlight. One layer is positively charged, the other negatively charged. As photons enter the layers, they give up their energy to the atoms in the silicon in the form of electrons. When photons hit the layers of silicon, electrons pass through the junction between the positive and negative layers, generating electric current. Figure 3 shows the solar photovoltaic cell.

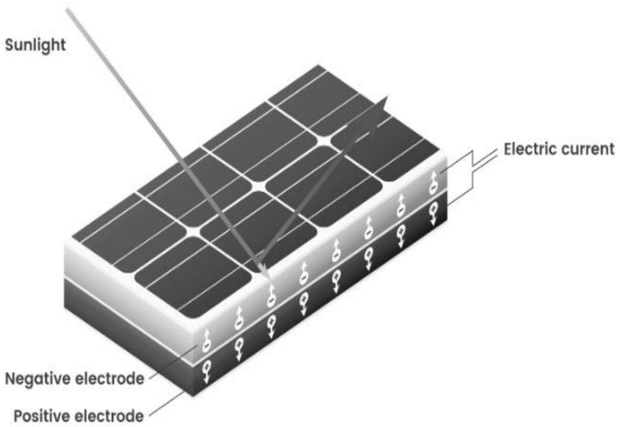

Figure 3: Solar Photovoltaic Cell

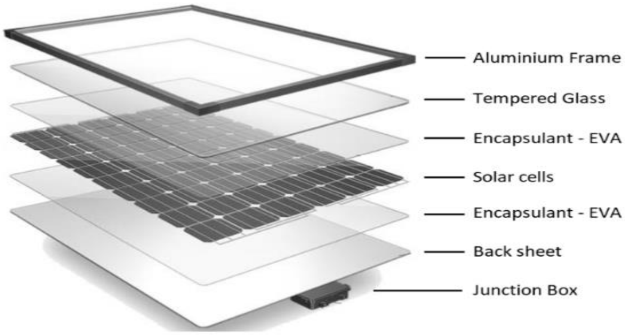

Figure 4: Layers of solar panel

The solar system includes solar panels. Solar panels are the devices that have the collection of solar cells or photovoltaic cells. These absorb the sun's rays and convert them into electricity. It generates the DC that is direct current electricity through photovoltaic effect.

This electricity reaches the charge controller. Solar charge controller is also called charge regulator which is basically voltage/ current regulator. This unit keeps the batteries from overcharging and it also regulates the voltage and current receiving from solar panels going to the battery. Charge controller is connected to DC to DC converter.

DC to DC converter is basically an electronic circuit device that converts the direct current from one voltage level to another. DC to DC converter connects to the storage battery, where the storage battery stores the electrical energy. DC to DC converter is also connected to impedance matching circuit.

Impedance matching circuit is used to effectively couple the primary coil and secondary coil. This minimizes the reactance of input impedance, increases the power transfer efficiency and also reduces the volt- ampere rating of power source. High frequency amplifier converts DC power into radio frequency voltage waveform. This excites the primary coil where the magnetic field generates by electric current. The magnetic field gets induced in the primary coil and is gathered at the secondary coil to transfer the average load power. This power reaches the transmitter.

The transmitter is an electronic device that produces the radio waves with an antenna. The waves reaches to the receiver. The receiver is a wireless electronic device that receives the radio waves and converts into usable energy with the help of an antenna.

From receiver, it reaches to impedance matching circuit and then it reaches to fast switching circuit. The switching circuit is a high frequency quasi-resonant inverter that consists of MOSFET that is metal oxide semiconductor field effect transistor, which has the capacity to operate at the frequencies up to MHz. Then, this circuit is connected to the load.

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An experiment was conducted to get the wireless power transmission efficiency. The difference in the transmitter distance and receiver distance are varied to obtain the optimum distance wireless power transmission.

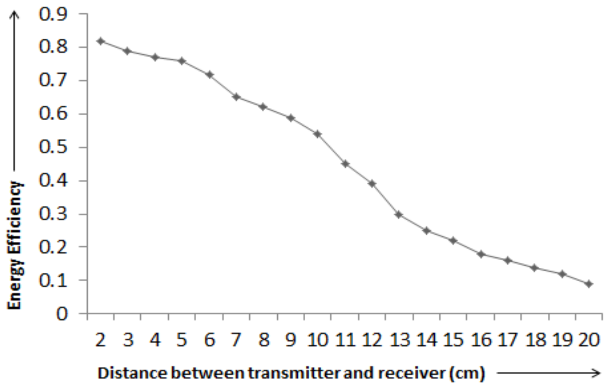

Figure 5: Graph of energy efficiency

Table 1: Tabular column for distance (cm) and efficiency

Dt (cm)	2	4	6	8	10	12	14	16	18	20
Eff (η)	0.82	0.77	0.7	0.6	0.5	0.4	0.25	0.18	0.14	0.09

The figure 5 shows the graph of energy efficiency. We can observe from the graph that the energy efficiency decreases as the distance between the transmitter and receiver increases. Table 1 shows the data of distance in cm and its corresponding efficiency.

IV. RESULTS

As we can observe from the energy efficiency graph as well as a tabular column, at the distance between transmitter and receiver of 2 cm gives the energy efficiency of 82% and at the distance of 20 cm gives energy efficiency of 9%. As the distance between transmitter and receiver increases, the energy efficiency decreases. So, least distance between the transmitter and the receiver should be kept in order to obtain the higher energy efficiency.

The culmination of solar and wireless power has given a big leap in the modern technology by avoiding the clutters of the cables and wires.

V. ADVANTAGES

(i)Since fast rotating parts are not available in the system. Hence, it has low maintenance cost.
(ii)This system does not produce any harmful gases. So, the system is environment friendly which does not pollute the environment.
(iii)Unlike other systems, this does not have the complexities of heavy power cabling and wiring as the system does not have a physical contact with the source to load.
(iv) Since the system is wireless and non- radiative which is safe.

VI. DRAWBACKS

(i)This system has distance constraint where the efficiency decreases with distance.
(ii)As this system is based on wireless, there is a possibility of energy theft.

VII. APPLICATIONS

(i)This system can be used for residential and industrial applications where power lines are not accessible.
(ii)This system can be adopted for thickly populated, congested, remote and hilly areas.

VIII.FUTURE SCOPE

As the system is wireless, there is a possibility of power theft. Hence, a digitalized coding or passwords to be provided for the user. Apart from this, the research should be made to achieve more efficiency by increasing the distance between the transmitter and receiver.

IX. CONCLUSIONS

From figure 5, we can conclude that the energy efficiency is high i.e. 82% at the distance of 2 cm and is diminished at later stages. However, the electrical power can be generated by using freely available renewable resource at any remote locations wherever the distribution lines cannot be accessed. The solar renewable energy in combination with the wireless power transmission system helps in eliminating the usage of heavy cables and wires in populated areas which avoids the electric accidents.

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Amogha. A. K. received M.Tech in Power Systems Engineering at India. She has published many technical papers in reputed International Journals, Seminars and Conferences.

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