Green Energy Harvesting Through Plants: A Renewable Source

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Abstract. Power generation is a challenging area of research due the never-ending demand across the world, especially renewable source is one such neighborhood where new innovations are taking place. This work is an attempt to generate the energy from the root of plants. Plants absorb light energy, which is stored in the chemical bonds of carbohydrates (in form of sugars). This chemical energy is transferred to the roots area and is acquired by bio-electrochemical process. The microorganisms which exist in the root zone oxidize the organic matter which results in transmitting high electrons energy to the electrodes. This energy is used as electrical energy. At cathode, these electrons react with the oxygen to form water. Electrical energy can be conserved and used. The primary advantage of this project is production of renewable and clean electricity, this facility can be well integrated in the landscape. Another positive aspect of this project is improvement of the air quality in the atmosphere obtained due to planting a greater number of plants to generate higher valued DC voltage, which eradicates tremendous increase in the pollution. Overall, it is a very effective way to generate and harvest electrical energy using plants.

Keywords: Renewable source, photosynthesis, graphite electrodes, energy harvesting, electrical energy

I. INTRODUCTION

Photosynthesis is the natural process which helps plants to take in carbon-dioxide and release oxygen in the daytime. Plants are the most useful renewable energy source for producing electricity, leading in sustainable livelihood of people and nature. Electricity is widely needed resource to innumerable number of people in both urban and rural areas. Generating Electricity using plants develops pathway towards protecting our environment and satisfying our daily needs without causing detrimental effects towards nature [1]. Plants absorb photo energy during photosynthesis from the sun. Carbon dioxide (CO_2) and water (H_2O) are acquired during photosynthesis and transforms into chemical bonds of glucose. Some amount of this chemical energy is send to the soil via roots and sinks. Further, this energy is captured by the electro-chemical active bacteria from the soil [2]. The active organisms help in the oxidization of organic matter and energy transformation to an electrode. The energy transported by the electrons is used as electrical energy.

The electrons at electrode react with oxygen to produce H_2O [3]. The energy rich electrons carried through a load to the cathode leading in producing 24 hours electricity per day.

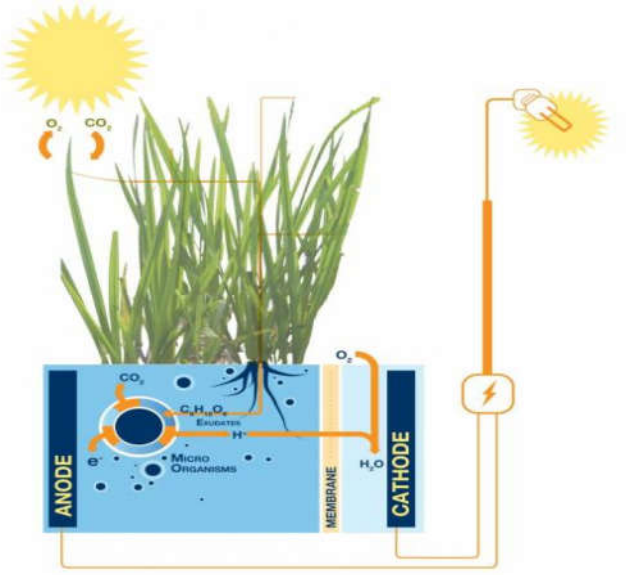

FIGURE. 1 Schematic representation of the proposed scheme

Earlier studies have found that living plants had an ability to produce bioelectricity by transforming solar energy into electrical energy depends on photosynthesis process. This development has the potential to provide a continuous supply of clean energy without depending on nonrenewable energy. This project is unique from all other because graphite electrodes are used for generating electricity, which is inexpensive and safe. Figure.1 shows the schematic representation of the targeted method. The purpose of using actively living plants to harvest energy is ecofriendly, minimal cost and most importantly the source is locally abundant. In-line with such renewable sources, there are also some distinct renewable sources presented by Hinche et al., [4] which uses trees and woody biomass that provide raw materials for pulp, paper, and lumber for power generation. Jamison et al., [5] has presented similar work, where the sources of forest biomass for energy conversion, including manufacturing wastes, post-consumer paper and wood wastes, forest residuals and energy plantations can produce energy. Garcia-Maraver et al [6] presented a contrast of combustion kinetics parameters of agricultural biomass from olive healthy plants which leads to noticeable energy outcome. Zuazo et al., [7] has presented productive usage of renewable energy sources by using Short-rotation woody crops (SRWC) as key point for woody-biomass production and management systems. Biomass potential in Andalusia, from grapevines, olives, fruit trees and poplar, for providing heat in homes is presented as a renewable energy source where heat energy can be converted to electrical source [8]. SR Bull [9] discussed on developments on different renewable energy sources from past to present with pros

and cons of technologies used. Different intelligent methods [11-12] have also been discussed for developing smart agricultural system.

The paper organized as follows: Section. I give the background theory followed by the methodology in the section. II. Third section depicts the implementation of proposed scheme on different plant and final section illustrates the conclusion.

II. METHODOLOGY

The real experimental setup is presented in this paper consists of a pair of graphite electrodes prepared from graphite powder and metallic plate inserted into aloe Vera leaf. The electrodes (anode and cathode) are connected to load of 1MΩ resistor, there are free end wires at both ends of the load made available for voltage measurement using a multimeter. Graphite powder material used for electrode offers good electrical conductivity, strong thermal shock resistance, high mechanical strength. Graphite powder is made in the form of electrodes by applying paste formed by adding water to graphite powder on metallic plate(cu/fe). A copper wire is connected to two electrodes (Anode and Cathode respectively). The electrode placed under the roots of the plants is referenced as anode. During the plant is growing, it produces organic matter(glucose) from photosynthesis process. Part of this organic matter is used in the growth of

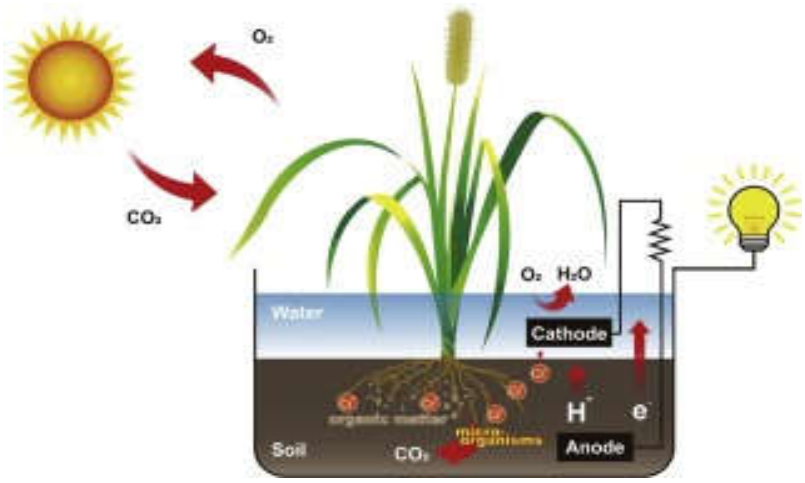

FIGURE. 2 Chemical philosophy of the methodology

plant, and part of it is sent into the soil through the roots. Around these roots bacteria break down this organic matter and, in this process, they release electrons. Figure.2 depicts the chemical philosophy of the methodology.

Anode: $2C_6H_{12}O_6 \rightarrow 2C_6H_{10}O_4+4H+4e-$ (1)

Cathode: $O_2+4H+4e- \rightarrow 2H_2O$ (2)

When the anode is inserted near the roots of the plants and cathode inserted near the stem of the plant, Electrons are attracted towards anode and photons are attracted towards cathode.

Resulting Equation: $2C_6H_{12}O_6+O_2 \rightarrow 2C_6H_{10}O_6+2H_2O$ (3)

III. RESULTS AND DISCUSSIONS

The experimentation is carried out by considering single and multiple plants. When single plant is used, an additional amplifier is used to enhance the voltage but by considering series of plants, there is no requirement of an addition amplifier in this case.

TABLE. 1 Voltage generated using different plants with variable time span

DAY	Plant Name	Day time voltage (DC)	Nighttime Voltage (DC)
DAY -1	Aloe Vera	0.11V	0.10V
	Rose Plant	0.07V	0.07V
Total Voltage:		**0.18V**	**0.17V**
DAY -2	Aloe Vera	0.12V	0.10V
	Rose Plant	0.06V	0.07v
Total Voltage:		**0.18V**	**0.17V**

From the analysis, we have obtained data on the amount of voltage generated from two different plants in day and nighttime. On Day 1, Aloevera plant had harvested around 0.11V(DC) and in the night time around 0.10V & Rose plant had generated around 0.07V(DC) both in day time and night time, but when compared with Rose plant Aloevera had slightly higher voltage both in day and night time. This is due to different root systems in the soil. When we connect the two plants in series, we have obtained output voltage around 0.18V(DC) & 0.17V(DC) in day and nighttime respectively, based on sum of individual voltages. There was slight increase in voltage on Day-2 but overall voltage when connected in series was same in day and nighttime. To get 5V(DC) from two plants we have used amplifier circuit, this lead to advance our methodology by connecting an array of plants to harvest 5V (DC) without any amplifier circuits. Figure.3 depicts the placement of electrodes inside the plant and corresponding circuit.

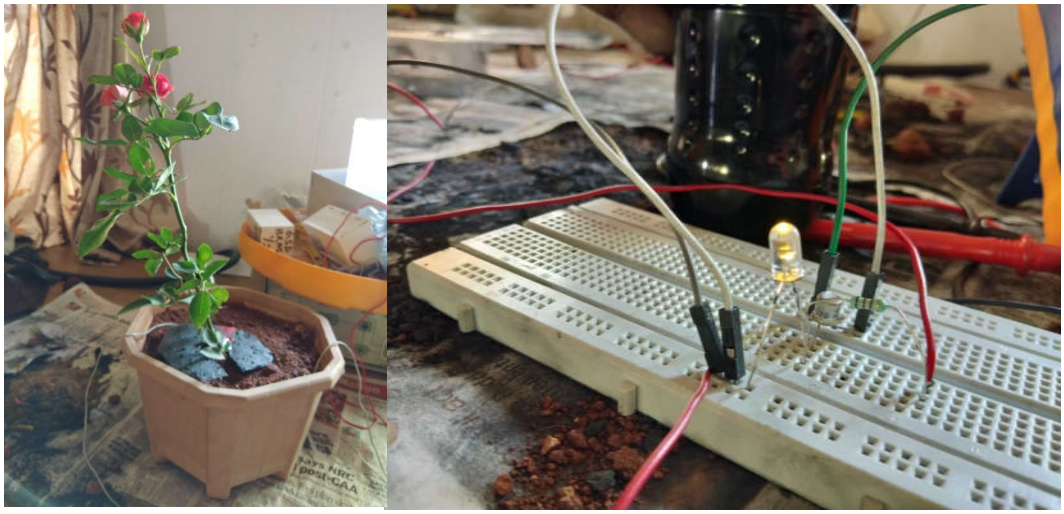

FIGURE. 3 Placing of electrodes inside the plant and connected to the circuit

FIGURE. 4 Connecting plants in series to enhance the voltage

Humans impact the physical environment in many ways: overpopulation, pollution, burning fossil fuels, and deforestation. Changes like these have triggered climate change, soil erosion, poor air quality, and undrinkable water. These negative impacts can affect human behavior and can prompt mass migrations or battles over clean water. To overcome this problem organic energy is used. As a preliminary evaluation on this organic energy, potential application on low electrical consumption appliances was investigated like LEDs. When we obtain 5V DC from the array of plants then we can use that output in charging mobile phones, lighting bulbs, rooftop plantation supplies electricity to the whole building for lightening, this causes more planting of trees and eradicates harmful effects towards environment. This project can be used to provide lighting for performing agricultural activities in the nighttime by producing light from the plants. An important application is highway lightning on the sign boards may keep people conscious about dangers and

warnings, which may prevent accidents. This source can also be extended to use in IOT applications by making use of existing technology [10].

IV. CONCLUSION

In this paper, a novel approach of power generation using plants has been presented. Plants as a renewable source can generate electricity which protects environment based on investigation. Graphite electrodes are used as cathode and anode based on their place of insertion acts as an important factor in producing energy from plants. One Aloevera plant gives around 0.11V, which is obtained due to high rate of photosynthesis. Apart from aloe vera, rose plant also demonstrated voltage around 0.08 voltage. From the results, it is found that when plants are connected in series in the form of an array, power can be generated around 5V DC which can be used for many applications without insertion any external amplifier circuits. This provides society an opportunity in developing cleaner and renewable energy generation resulting in protection of environment.

Acknowledgments

The authors would like to thank the Management of CVR College of Engineering, Hyderabad, India for providing financial support to complete this project.

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