Unveiling the New Source of Green Energy - A plant

Amey Vitthal Kardile[1]
[1] *Student, III-BE Department of Mechanical Engineering, PVG's COET, Pune.*

Abstract: **Living-plants take CO_2 and H_2O and capture the light energy. This energy is stored in plats as sugars produced. Some part of this stored energy, transferred to the roots of the plants. This transferred energy is in form of electrons as a by-product [1]. 40% or more energy can be released into the soil which is renewable & transform of solar energy. Hence by embedding pairs of electrodes into it to allow flow of ions and hence generate electricity. Multiple tests using different type of electrodes and plants suggested that voltages are produced to greater or lesser extents where combination of copper (Cu)-zinc (Zn) and Bauhinia racemosa L. produces the highest voltage output. The obtained result confirmed that the natural process is responsible for production of clean, renewable, sustainable, efficient plant produced electricity as a future renewable bio-energy source.**

***Keywords* - Renewable energy; weak energy source; electrodes; living-plants; bio-energy .**

1. INTRODUCTION

All the Non-Renewable resources are being exhausted and are getting vanished day by day, and coal which contributes about a major portion in electricity generation is at the stage of extinction and also has many drawbacks of polluting the environment **[2]**. This paper presents how to harvest renewable green electricity by simple method from the living plants using the by-product formed during the process of photosynthesis i.e. electrons.

2. TESTING & METHODOLOGY

In this section, the experimental work is divided into two parts - discovery of green energy sources and selection of best pair of electrodes.

2.1 Discovery of green energy source: The light reactions [3]

The light harvesting (LH) system i.e. chlorophyll used to identify the particular centre. This is called P680 for PS2, and P700 for PS1, since the respective molecules absorb distinctively at 680±10nm (1.82 eV) and 700±10nm (1.77 eV) respectively. Note that both these molecules absorb at the red end of the spectrum indicating their position at the lower potential energy end of the LH system.

2.1.1 Cyclic photo phosphorylation

It is a type of light energised ATP synthesis in which e- expelled by excited photo-centre is returned after a one chain cycle (fig.1).

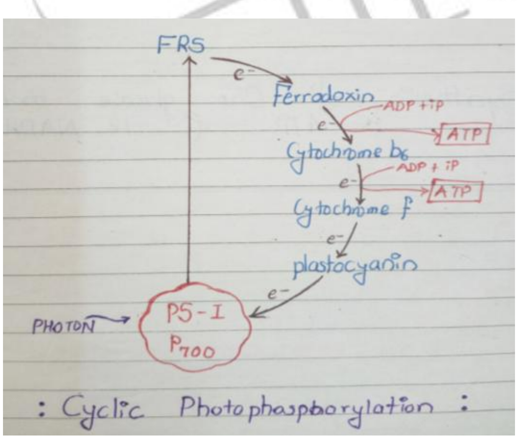

Fig-1: Cyclic photo phosphorylation

1) PS-1 absorbs energy and get excited and expels energy rich e-.
2) The e- are accept by ferrodoxin via an unknown e- acceptor called ferredoxin reducing substance(FRS).
3) This e- is roll down from cytocrome B6 , plastocyanin & cytocrome F.
4) From plastocyanin e- are transferred back to P_{700}. Thus flow of e- is in closed circuit.

5) ATP formation takes place when e- are transferred from ferrodoxin to cytocrome B6 & cytocrome B6 to cytocrome F.

2.1.2 Non cyclic photo-phosphorylation

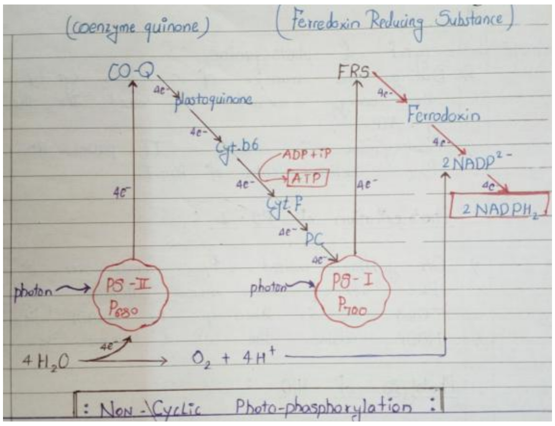

Fig-2: Non cyclic photo-phosphorylation

This involves continuous unidirectional flow of e- & photolysis of H_2O.Electron flow from PS-2 to PS-1 via cytocrome(fig.2).

2.1.2.1 Photo-excitation of PS-2

1) The pigment in PS 2 absorbs energy, get excited & transfer e-.
2) After loosing e- P_{680} become a strong oxidant.
3) This e- is taken up by plastoquinone (PQ) through co-enzyme quinine (CO-Q) leaving reaction centre ionized.
4) Plastoquinone (PQ) donates e- downstreme to cytocrome B6 to cytocrome F to plastocyanin.
5) During the transfer of e- from cytocrome B6 to cytocrome F the energy released is used in synthesis of ATP.
6) Plastocyanin is mobile. It passes it's e- to P_{700} reaction centre of PS-1.

2.1.2.2 Photo-excitation of PS-1

1) On getting excited P_{700} hands over e- to FRS i.e. ferredoxin reducing substance.
2) Then e- is taken up by NADP from FRS.
3) NADP retains the e- and become –ve charged.

2.1.2.3 Photolysis of H_2O

1) P_{680}^+ acts as strong oxidizing agent and brings about splitting of H_2O.
2) The light dependent splitting of H_2O molecule is called photolysis of H_2O.
3) Mg, Ca & Cl^- ions are important role in photolysis of H_2O.

$$4H_2O \longrightarrow 2H_2O+O_2+4H^++4e^-$$

4) $4e^-$ is accepted by P_{680}, $4H^+$ is reacting with $2NADP^{2-}$ to form $2NADPH_2$.

2.2 Dark reactions (calvin cycle / c_3 cycle)

The reactions – the Calvin cycle – occur in the stroma outside the thylakoid structures, but within the chloroplast (fig.3) [4].

1) RUMP is phospolated into RUBP by using ATP molecules.
2) This RUBP converted into additive unstable 6C compound by using CO_2.
3) This unstable 6C compound is dissociated into 3C of PGA & forms the first stable compound in cycle.
4) This PGA is phospolated into 1-3-PGA & it again condensed into PGAL by using $NADPH_2$.
5) This PGAL is phospolated into fructrose-1-6-diphospate then fructose-6-phosphate then glucose-6-phosphate and finally glucose id formed.
6) Thus the main initial inputs for the Calvin cycle are NADPH, ATP and H+ from the photo systems, and CO_2 and H_2O from the environment.

7) The enzyme RUBISCO i.e. ribulose biphosphate-carboxylase-oxygenase).

$$3CO_2 + 9ATP + 6NADPH + 5H^+ \longrightarrow C_3H_5O_3P + 9ADP + 8P_i + 6NADP^+ + 3H_2O + e^-$$

Thus two NADPH are required per C fixed from reduced CO2. Each NADPH requires two electrons from two operations of PS1 to be reduced again to NADP. Thus the Calvin cycle is powered by four photon absorptions in PS1 **[4]**. **Synthesis of one glucose molecule required 18 ATP & 12 NADPH$_2$ (**nicotinamide adenine di-nucleotide hydrogen phosphate**).**

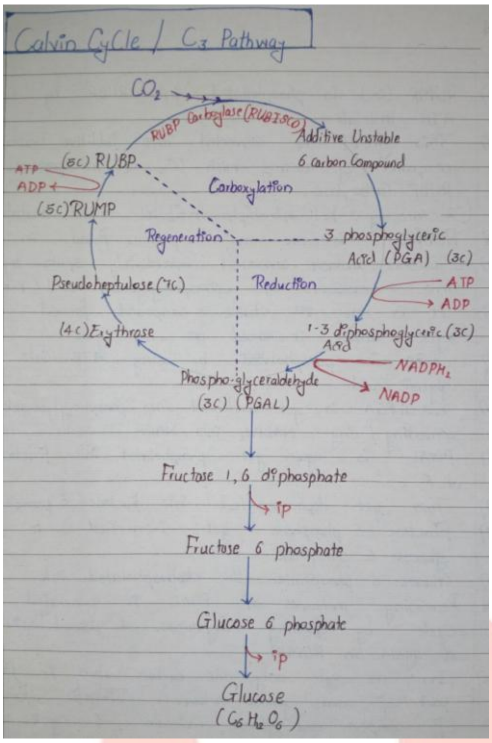

Fig-3: Dark reactions (Calvin cycle / c$_3$ cycle)

2.3 INVESTIGATION ON THE TYPE OF ELECTRODES

The present study was aimed to explore the utility of the one of the plant *Bauhinia racemosa L* for green electricity synthesis & to investigate the types of electrodes, the best pair that produces the highest power output has to be tested & selected for future optimization attempts. In the present work, four electrodes of different materials had been selected as they are easily available. They consist of copper (Cu), lead/carbon (Pb/C); zinc (Zn) and aluminium (Al). The electrode terminal either positive or negative is determined according to its electrochemical potential. Therefore, the electrode with higher potential (anode) and lower electrode potential (cathode) was selected.

Scientific Classification of	Plant
Kingdom	Plantae
Order	Fabales
Family	Fabaceae
Genus	Bauhinia
Species	B.racemousm
Biological name	Bauhinia racemosa L

Fig-4: Tree of *Bauhinia racemosa L.* **Table-1: Scientific classification of plant**

Electrode Combination (*Bauhinia racemosa*)	**Voltage produce**
Cu (+) & Zn (-)	0.94
C(Pb) (+) & Al (-)	0.76
Cu (+) & Al (-)	0.51
Zn (+) & Al (-)	0.42

Table-2: Voltage output with different electrodes on *Bauhinia racemesa L.* (Apta Plant) (Bidi leaf tree)

Fig-5: Actual testing on *Bauhinia racemosa L.* *with Cu-Zn pair of electrodes*

Fig-6: Actual testing on *Bauhinia racemosa* L. with (Pb) - Al pair of electrode

Fig.7: Actual testing on *Bauhinia racemosa L.* with Cu-Al pair of electrodes

Fig.8: Actual testing on *Bauhinia racemosa* L. with Zn-Al pair of electrodes

From above experiment, copper (Cu)-zinc (Zn) pair produces the highest stable voltage approximately 0.94V (**fig.5**). This is followed by C (Pb)-Al (0.76V) (**fig.6**), Cu-Al (0.51V) (**fig.7**) and Al-Zn is at lowest (0.42V) (**fig.8**) (refer table 2).In all the combination, the gained voltage is stable up to 50 minutes.

3. WORKING

Green plants are harvesting the energy from the sunlight and transforming it into food and oxygen by photosynthesis. In photosynthesis the photons from the sun hit molecules inside the chloroplasts causing the emission of an electron. This electron travels from one molecule to another through a series of cytochromes called photosystems I and II and it travels into the soil as a by-product [4].

Hence by putting the electrodes into the soil electrons flows linearly by the principle of density variation. Hence it proves trees generate a tiny stream of electricity - a few hundred millivolts. This tiny flow of electricity may also be due to the difference in PH levels between tree and the soil but the major source is from tree photosynthesis which remains the constant for long time.

4. PROOF OF PRINCIPLE, FUTURE PERSPECTIVES AND APPLICATIONS

An Experimental setup is shown in the figure 7&8. The electrode used is copper (Cu)-zinc (Zn) pair. Unlike electricity produced in the MFC (Microbial Fuel Cell) [5], the electricity produced from trees is purely out of the nature of the tree

Fig-9: One electrode is stuck in the xylem and other to the ground.

Fig-10: Both electrodes is stuck in the xylem

The voltage measured is in millivolts but using the various electrical or electronic boosters' device we can easily increase voltage up to 3 to 5 volts. This voltage is sufficient to run a wireless low power sensor in monitoring environmental conditions such as forest fires, smuggling of radioactive materials etc. It can also be made possible to charge a smart phone in future, by just plug in an electrode into a tree. The above described 'embodiment' is just one possibility the system/method can be actually used for numerous such applications.

5. CONCLUSIONS

This paper presented origin of green electricity from ***Bauhinia racemosa L.*** along with selection of the best combination of electrode pairs. Taking different species of plants basic principle will remains the same hence, it doesn't limited to the specific plant and/or species. From the tested species of plants ***Bauhinia racemosa L.*** produced the highest voltage when electrodes of Cu-Zn were used. It also proves that plant-growth isn't compromised by harvesting electricity, so plants keep on growing while electricity is concurrently produced.

Paper also reveals the new ways of using tree power hence our dependence on non-renewable energies can be reduced to a great extent. All this will eventually lead to a pollution free green globe. The discovery of tree power opens up new possibilities of looking into the global environmental issues. It will inspire everyone to plant trees in surroundings for costless green energy. Further research aimed at increasing the efficiency of energy, up-scaling of the technology and further integration of electrode & plant should allow higher yields and a technology closer to practical implementation.

6. REFERENCES

[1]. Gudrun Hoffmann-Thomaa, Anton Arij Schriera, Andreas Fangmeierd, Hans-Ju¨rgen Ja¨gerb, Aart J.E. van Bela, Increase of photosynthesis and starch in potato under elevated CO2 is dependent on leaf age, Journal of Plant Physiology 162 (2005) 429—438.

[2]. Ying Ying Choo, Jedol Dayou, Noumie Surugau Origin of Weak Electrical Energy Production from Living-Plants, International journal of renewable energy research jedol dayou, vol.4, no.1, 2014

[3]. Agepati S. Raghavendra1, Prafullachandra Vishnu Sane2 & Prasanna Mohanty3, Photosynthesis research in India: transition from yield physiology into molecular biology, Photosynthesis Research 76: 435–450, 2003.

[4]. Information on http://mhhe.com/biosci/genbio/raven6b/graphics/raven06b/other/raven06b_10.pdf

[5]. Shentan Liu,1 Hailiang Song,1 Xianning Li,1 and Fei Yang2, Power Generation Enhancement by Utilizing Plant Photosynthate in Microbial Fuel Cell Coupled Constructed Wetland System, Hindawi Publishing Corporation International Journal of Photoenergy Volume 2013, Article ID 172010.