Solar Water Pump for Vegetable field under the Climatic Condition in Bangladesh

K.A.Khan[1] and Farhana Yesmin[2]

[1]Department of Physics, Jagannath University, Dhaka-1100, Bangladesh
[2]Department of Civil Engineering, Dhaka Polytechnic Institute, Bangladesh

ABSTRACT

A solar water pump has been used for vegetable field under the Climatic Condition in Bangladesh. The solar cell which has been used for this water pump the I-V characteristics of those solar cell has been studied. The variation of Fill Factor (FF) and the conversion efficiency (η_c) have been observed in this research work. Furthermore, it has been found the different results for various solar cells under the Bangladeshi climatic conditions. The observable parameters were: Short circuit current, Open circuit voltage, Maximum useful power, Maximum useful current, Maximum useful voltage, Fill Factor, Conversion efficiency, Cell Area, Diode Series resistance, Shunt resistance.

Keywords: *Short circuit current, open circuit voltage, Maximum useful power, Maximum useful current, Fill Factor, Conversion efficiency.*

Introduction

Bangladesh is a agricultural dependent country. After completion the paddy cultivation, farmers are cultivating the vegetables to meet up the double crops systems in a year. To keep it in mind, a solar water pump has been set up at Saver area under Dhaka district of Bangladesh. A solar big solar panel has been set up to run the water pump connected to a cannel to bring water to the vegetable field. The effect of the solar panel has been studied for use in double crops in the almost whole month of the year.

II. Methods and Materials

II A Practical application of solar cell for irrigation and Vegetable field:

Fig.1 Solar panel set-up for vegetable field cultivation after paddy cultivation.

Fig.1 shows an solar array made by some solar panels. It is under open sun condition. The beam radiation falls on the solar panel and the electricity is produced in the day time. An electric pump is operated using this produced electricity. There is a pump house where the pump is maintained during night time from the unsafe condition (Fig.1).

Fig.2 A cannel is connected to the solar panel to water for vegetable field.

A long circular long pipe is connected with the electric pump. The pump needs some specific power (watt) to turn the water pump. The one end of the pipe is inside the water and the other end is used as an output of the watering system.

Fig.3 A control room for maintaining the liaison among solar panel, water pump and loads.

It is the control room of the watering system (Fig.3). It does the function of the starting and closing the machine timely. It has an indicator giving the indication of the proper function.

Fig.4 A water pump for use in solar system

Fig.4 shows the solar water pump for irrigation and vegetative field. It indicates the flow of the water flow by a flow meter.

Fig.5 Collected water from the cannel using solar water pump.

It is shown (Fig.5) the out let water collected from a cannel to provide a vegetative field. It operates from morning to evening nicely but it does not work at all at the night.

Fig.6 Vegetable field where provided water by the solar system

Farmers and researchers are visiting the vegetative fields (Fig.6) cultivated by the solar water pump. By the help of the solar system people can get double more crops by the help of solar photovoltaic electricity.

Fig.7 Vegetables field where provided water by the solar photovoltaic system

Fig.7 Vegetable field beside the solar panel
Visitors and researchers are waiting to see the vegetables field. It can be cultivated further any vegetative and fruits as per our necessity.

II. B. Define different Parameters:

i) Open circuit Voltage : The voltage without load is called Open circuit Voltage. Generally, it is denoted by V_{oc}.

ii) Short circuit current: The current without load is called short circuit current. Generally, it is denoted by I_{sc}.

iii) Fill Factor (FF):

It **is** defined as **,** FF **=** $(V_mI_m) / (V_{oc}I_{sc})$, where, V_m = Useful voltage
I_m = Useful current
V_{oc} = Open circuit Voltage
I_{sc} = short circuit current

iv) Convesion efficiency (η_c):

It is defined as,
Convesion efficiency, $\eta_c = (V_mI_m) / A_cI_b$,where,
V_m = Useful voltage
I_m = Useful current
Ac = Collector area(m^2)
I_b = Beam radiation (w/m^2)

II.C Description of solar cell, module, panel, array:

Solar Cell: It is the building block of a solar cell. In a solar cell some rectifier diodes are in parallel connection. The standard open circuit voltage of the solar cell is 0.5 volt. The short circuit current of a solar cell = 0.5 A. The standard temperature of a solar cell= 25^0C. The standard pressure= 1 atm pressure= 760 mm Hg pressure

Solar module: One or more than two cells make a solar module.

Solar Panel: One or more than two modules make a solar panel

Solar Array: One or more than two panels make a solar array. A SPV Array is made up of PV modules, which are environmentally-sealed collections of SPV Cells — the devices that convert sunlight to electricity. The most common SPV module that is 5-to-25 square feet in size and weighs about 3-4 lbs./ft^2. Often sets of four or more smaller modules are framed or attached together by struts in what is called a panel. This panel is typically around 20-35 square feet in area for ease of handling on a roof. This allows some assembly and wiring functions to be done on the ground if called for by the installation instructions.

Balance of system equipment (BOS): BOS includes mounting systems and wiring systems used to integrate the solar modules into the structural and electrical systems of the home. The wiring systems include disconnects for the dc and ac sides of the inverter, ground-fault protection, and over current protection for the solar modules. Most systems include a combiner board of some kind since most modules require fusing for each module source circuit. Some inverters include this fusing and combining function within the inverter enclosure.
Dc-ac inverter: This is the device that takes the dc power from the PV array and converts it into standard ac power used by the house appliances.
Metering: This includes meters to provide indication of system performance. Some meters can indicate home energy usage.
Other components: utility switch (depending on local utility).

II D SPV Electrical System Types:

There are two general types of electrical designs for PV power systems for homes; systems that interact with the utility power grid and have no battery backup capability; and systems that interact and include battery backup as well.

II E Grid-Interactive Only (No Battery Backup):

This type of system only operates when the utility is available. Since utility outages are rare, this system will normally provide the greatest amount of bill savings to the customer per dollar of investment. However, in the event of an outage, the system is designed to shut down until utility power is restored.

II F Standard solar cell condition: The standard state condition of a solar cell is: The standard open circuit voltage of the solar cell is 0.5 volt. The short circuit current of a solar cell = 0.5 A. The standard temperature of a solar cell = 25^0C. The standard pressure = 1 atm pressure = 760 mm Hg pressure.

III. Results and Discussion with Graphical Analysis:

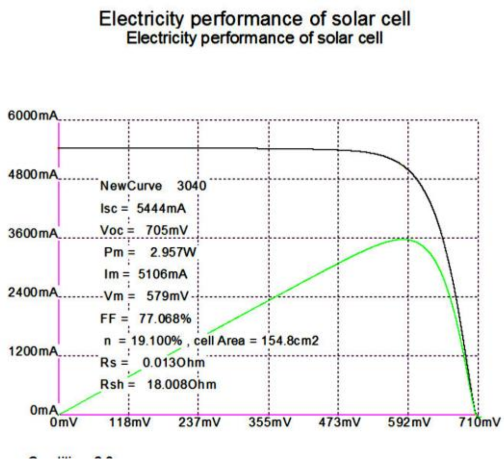

Fig.7 Ideal I-V curve for ideal solar cell-1

Fig.7 shows the I-V curve for a solar cell under Bangladeshi climatic condition. It is shown the following experimental results:
Curve Number = 340
Short circuit current, I_{sc} = 5444mA,
Open circuit voltage, V_{oc} = 705 mV,
Maximum useful power, P_m=2.957W,
Maximum useful current, I_m = 5106mA,
Maximum useful voltage, V_m= 579 mV,

Fill Factor, FF= 77.068% ,
Conversion efficiency, η_c = 19.10% ,
Cell Area = 154.8cm^2,
Diode Series resistance, R_s = 0.013 ohm,
Diode Shunt resistance, R_{sh} = 18.008 ohm.

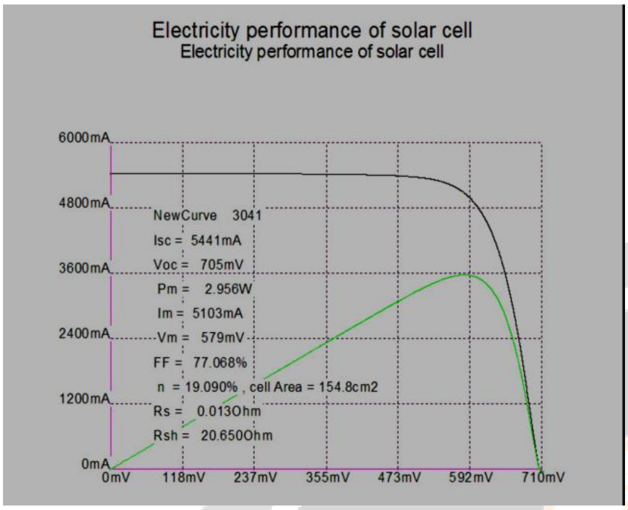

Fig.8 Ideal I-V curve for ideal solar cell-2

Fig.8 shows the I-V curve for a solar cell under Bangladeshi climatic condition. It is shown the following experimental result:
Curve Number = 3041
Short circuit current, I_{sc} = 5441mA,
Open circuit voltage, V_{oc} = 705 mV,
Maximum useful power, P_m = 2.956 W, Maximum useful current, I_m = 5103 mA, Maximum useful voltage, V_m= 579 mV,
Fill Factor, FF = 77.068% ,
Conversion efficiency, η_c = 19.210% ,
Cell Area = 154.8cm^2,
Diode Series resistance, R_s = 0.013 ohm,
Diode Shunt resistance, R_{sh} = 19.049 ohm.

Finally, it is shown that where FF increases, the conversion efficiency also increases. Therefore it can be said that FF and conversion efficiency (η_c) is almost proportional.

IV. Conclusion

Solar photovoltaic electricity depends on solar radiation. Bangladesh is located in fine places where solar radiation falls nicely for solar Photovoltaic system. It is concluded that SPV system can be utilized for all months of the whole year. So that SPV system is feasible and viable for the agricultural activities under Bangladeshi climate.

Acknowledgement

The authors are grateful to the PKL electricity research group named Md. Abdus Samad (Ex-Joint Secretary), Dr. M A Latif, Dr. Md. Sajjad Hossain, Dr. Md. Fakrul Islam, Dr. Bapy Guha, Md. Mehdi Hassan, Md. Shamsul Alam and Dr. Jesmin Sultana for their valuable suggestions and whole hearted cooperation during research work.

References

[1] K.A.Khan, Lovelu Hassan, A K M Obaydullah, S. M. Azharul Islam, M.A. Mamun, Tanjila Akter, Mehedi Hasan, Md. Shamsul Alam,M. Ibrahim, M Mizanur Rahman and M. Shahjahan , Bioelectricity: A new approach to provide the electrical power from vegetative and fruits at off-grid region, Published in the journal of Microsystem Technologies of Springer, manuscript number: 2018MITE-D-17-00623R2, Received: 14 August 2017/Accepted: 3 February 2018, Volumes-24,Issues-3, Impact Factor: 1.195, ISSN: 0946-7076 (Print) 1432-1858 (Online), Springer-Verlag GmbH Germany, Part of Springer Nature, DOI: 10.1007/s00542-018-3808-3, 2018.

[2] Mehedi Hasan and K A Khan, Dynamic Model of Bryophyllum pinnatum Leaf Fueled BPL Cell: A Possible Alternate Source of Electricity at the Off-grid Region in Bangladesh, Published in the Microsystem Technologies (2018), Springer, manuscript number, MITE-D-18-00800R1, DOI: https://doi.org/10.1007/s00542-018-4149-y, Publisher Name: Springer Berlin Heidelberg,Print ISSN: 0946-7076,Online ISSN: 1432-1858, First Online: 28 September 2018

[3] K A Khan, M.S.Bhuyan,M. A. Mamun, M. Ibrahim, Lovelu Hassan and M A Wadud, Organic Electricity from Zn/Cu-PKL Electrochemical Cell, Published in the Springer Nature, Series Title: Advs in Intelligent Syst., Computing, Volume Number:812, Book Title: Contemporary Advances in Innovative and Applicable Information Technology,ISBN:978-981-13-1539-8, https://doi.org/10.1007/978-981-13-1540-4, 2018

[4] K A Khan, A. Rahman, M. S. Rahman, A. Tahsin, K. M. Jubyer, and S. Paul, “Performance analysis of electrical parameters of PKL electricity (An experimental analysis on discharge rates, capacity & discharge time, pulse performance and cycle life & deep discharge of PathorKuchi Leaf (PKL) electricity cell),” In Innovative Smart Grid Technologies-Asia (ISGT-Asia), 2016 IEEE, pp. 540-544. IEEE, 2016.

[5] M. K. A. Khan, S. Paul, M. S. Rahman, R. K. Kundu, M. M. Hasan, M.Moniruzzaman, and M. A. Mamun, “A study of performance analysis of PKL electricity generation parameters:(An experimental analysis on voltage regulation, capacity and energy efficiency of pathorkuchi leaf (PKL) electricity cell),” In Power India International Conference (PIICON), 2016 IEEE 7th, pp. 1-6. IEEE, 2016.

[6] M. K. A. Khan, M. S. Rahman, T. Das, M. N. Ahmed, K. N. Saha, and S. Paul,“Investigation on Parameters performance of Zn/Cu Electrodes of PKL, AVL, Tomato and Lemon juice based Electrochemical Cells: A Comparative Study,”In Electrical Information and Communication Technology (EICT), 2015 3rd International Conference on, pp. 1-6. IEEE, 2017.

[7] K A Khan, Akhlaqur Rahman, Md Siddikur Rahman, Aniqa Tahsin, Kazi Md Jubyer, and Shuva Paul. "Performance analysis of electrical parameters of PKL electricity (An experimental analysis on discharge rates, capacity & discharge time, pulse performance and cycle life & deep discharge of Pathor Kuchi Leaf (PKL) electricity cell)." In Innovative Smart Grid Technologies-Asia (ISGT-Asia), 2016 IEEE, pp. 540-544. IEEE, 2016.

[8] M K A Khan, Shuva Paul, Md Siddikur Rahman, Ripon Kumar Kundu, Md Mahmudul Hasan, Mohammad Moniruzzaman, and Mohammad Al Mamun. "A study of performance analysis of PKL electricity generation parameters:(An experimental analysis on voltage regulation, capacity and energy

efficiency of pathor kuchi leaf (PKL) electricity cell)." In Power India International Conference (PIICON), 2016 IEEE 7th, pp. 1-6. IEEE, 2016.

[9] M K Alam Khan, "Copper Oxide Coating for use in Linear Solar Fresnel Reflecting Concentrating Collector",Published in the journal. of Elsevier, Renewable Energy, An International Journal, WREN(World Renewable Energy Network), UK, RE: 12.97/859,1998

[10] Muhammad Riazul Hamid, Characterization of a Battery cell fueled by Bryophyllum Pinnatum sap, International Journal of Scientific & Engineering Research, Volume 4, Issue 3, ISSN 2229-5518, March-2013.

[11] Muhammad Riazul Hamid, Akib Yusuf, Abu Md. Abdul Wadud, and Md. Mosfiqur Rahaman, Design and Performance Test of a Prototype of a 12 Volt DC Battery Fueled by Bryophyllum Pinnatum Sap and Improvement of Its Characteristics, Department of Electrical and Electronic Engineering, Ahsanullah University of Science and Technology, Dhaka, Bangladesh, Email: {drhamidbd, shohan933}@gmail.com, {akib147, sshaon95}@yahoo.com, International Journal of Electronics and Electrical Engineering Vol. 4, No. 5, October 2016.

[12] K A Khan, " Electricity Generation form Pathor Kuchi Leaf (Bryophyllum pinnatum) " , Int. J. Sustain. Agril. Tech. 5(4): 146-152, July 2009.

[13] K A Khan and Md. Eyashir Arafat, "Development of Portable PKL (Pathor Kuchi Leaf) Lantern", Int. J. SOC. Dev. Inf. Syst. 1(1): 15-20 January 2010.

[14] K. A. Khan and Ranen Bosu, "Performance study on PKL Electricity for Using DC Fan", Int. J. SOC. Dev. Inf. Syst. 1(1): 27-30, January 2010

[15] K A Khan and Md. Imran Hossain," PKL Electricity for Switching on the Television and Radio",Int. J. SOC. Dev. Inf. Syst. 1(1): 31-36, January 2010

[16] Shuva Paul, K A Khan, Kazi Ahad Islam, Baishakhi Islam and Musa Ali Reza, "Modeling of a Biomass Energy based (BPL) Generating Power Plant and its features in comparison with other generating Plants ",IPCBEE vol. 44 (2012) @ (2012) IACSIT Press, Singapore DOI: 10.7763/ IPCBEE. 2012. V44. 3

[17] K. A. Khan, Shuva Paul, Md. Adibullah, Md.Farhat Alam, Syed Muhammad Sifat, Md. Rashed Yousufe, " Performance Analysis of BPL/PKL Electricity module ", International Journal of Scientific & Engineering Research Volume 4, Issue3, March-2013 1 ISSN 2229-5518

[18] K A Khan, Shuva Paul,Asif Zobayer,Shiekh Saif Hossain, A Study on Solar Photovoltaic Conversion, International journal of Scientific and Engineering Research ,Volume-4,Issue-3,March-2013,ISSN2229-5518, 2013

[19] Tania Akter, M H Bhuiyan, K A Khan and M H Khan, "Impact of photo electrode thickness and annealing temperature on natural dye sensitized solar cell", Published in the journal. of Elsevier. Ms. Ref. No.: SETA-D-16-00324R2, 2017

[20] K A Khan, Inventors, Electricity Generation form Pathor Kuchi Leaf (PKL), Publication date 2008/12/31, Patent number BD 1004907,2008

[21] K A Khan, Technical note "Copper oxide coatings for use in a linear solar Fresnel reflecting concentrating collector", Publication date 1999/8/1, Journal Renewable energy, Volume 17, Issue 4, Pages 603-608, Publisher – Pergamon, 1999

[22] K A Khan, Shuva Paul, A analytical study on Electrochemistry for PKL (Pathor Kuchi Leaf) electricity generation system, Publication date 2013/5/21, Conference- Energytech, 2013 IEEE, Pages 1-6, Publisher, IEEE,2013

[23]T.A.Ruhane, M.Tauhidul Islam, Md. Saifur Rahaman, M.M.H. Bhuiyan, Jahid M.M. Islam, M.K.Newaz, K A Khan, Mubarak A. Khan, "Photo current enhancement of natural dye sensitized solar cell by optimizing dye extraction and its loading period" , Published in the journal of Elsevier : Optik - International Journal for Light and Electron Optics, 2017.

[24] K A Khan, M S Alam, M A Mamun, M A Saime & M M Kamal, Studies on electrochemistry for Pathor Kuchi Leaf Power System, Ppublished in the Journal of Bangladesh J. Agric. And Envirin. 12(1): 37-42, June 2016

[25] Mehedi Hasan, Lovelu Hassan, Sunjida Haque, Mizanur Rahman, K A Khan, A Study to Analyze the Self-Discharge Characteristics of Bryophyllum Pinnatum Leaf Fueled BPL Test Cell, Published in the Journal of IJRET, Vol-6 Iss-12, Dec-2017

[26] J. Sultana, K A Khan, and M.U. Ahmed. "Electricity Generation From Pathor Kuchi Leaf (PKL) (Bryophillum Pinnatum)." J.Asiat Soc. Bangladesh Sci., 2011, Vol. 37(4): P 167-179

[27] M. Hasan, S. Haque and K A Khan, "An Experimental Study on the Coulombic Efficiency of Bryophyllum pinnatum Leaf Generated BPL Cell",IJARIIE, ISSN(O)-2395-4396, Vol-2, Issue-1, 2016

[28] MM Hasan, MKA Khan, MNR Khan and MZ Islam, "Sustainable Electricity Generation at the Coastal Areas and the Islands of Bangladesh Using Biomass Resources", City University Journal, Vol. 02, Issue. 01, P. 09-13, 2016.

[29] M Hasan and K A Khan, "Bryophyllum pinnatum Leaf Fueled Cell: An Alternate Way of Supplying Electricity at the Off-grid Areas in Bangladesh" in Proceedings of 4th International Conference on the Developments in Renewable Energy Technology [ICDRET 2016], P. 01, 2016. DOI: 10.1109/ICDRET.2016.7421522

[30] M Hasan, KA Khan, MA Mamun, "An Estimation of the Extractable Electrical Energy from Bryophyllum pinnatum Leaf", American International Journal of Research in Science, Technology, Engineering &Mathematics (AIJRSTEM), Vol. 01, Issue. 19, P. 100-106, 2017.

[31] M K A Khan, M. S. Rahman, T. Das, M. N. Ahmed, K. N. Saha, and S. Paul, "Investigation on Parameters performance of Zn/Cu Electrodes of PKL, AVL, Tomato and Lemon juice based Electrochemical Cells: A Comparative Study,"In Electrical Information and Communication Technology (EICT), 2017 3rd International Conference on, pp. 1-6. IEEE, 2017. DOI: 10.1109/EICT.2017.8275150,IEEE, Khulna, Bangladesh, Bangladesh, 7-9 Dec. 2017.

[32] Md. Afzol Hossain, M K A Khan, Md. Emran Quayum,''Performance development of bio-voltaic cell from arum leaf extract electrolytes using zn/cu electrodes and investigation of their electrochemical performance'', International Journal of Advances in Science Engineering and Technology, ISSN: 2321-9009, Vol-5, Iss-4, Spl. Issue-1, Nov-2017

[33] K A Khan , M. A. Wadud , A K M Obaydullah and M.A. Mamun, PKL (Bryophyllum Pinnatum) electricity for practical utilization, IJARIIE-ISSN(O)-2395-4396, Vol-4, Issue-1, Page: 957-966

[34] M. M. Haque, A.K.M.A. Ullah, M.N.L Khan, A.K.M.F. F. Kibria and K A Khan,"Phyto-synthesis of MnO2 Nanoparticles for generating electricity," In the International conference on Physics-2018, Venue-Department of Physics, University of Dhaka, Dhaka-1000,Bangladesh, Organizer-Bangladesh Physical Society(BPS, 08-10 March, 2018.

[35] Lovelu Hasan,Mehedi Hasan, K A Khan and S.M. Azharul Islam, "SEM Analysis of Electrodes and measurement of ionic pressure by AAS data to identify and compare the characteristics between different bio-fuel based electrochemical cell, " In the International conference on Physics-2018, Venue-Department of Physics, University of Dhaka, Dhaka-1000,Bangladesh, Organizer-Bangladesh Physical Society(BPS, 08-10 March, 2018.

[36] Mehedi Hasan and K A Khan, "Identification of BPL Cell Parameters to Optimize the Output Performance for the Off-grid Electricity Production, " In the International conference on Physics-2018, Venue-Department of Physics, University of Dhaka, Dhaka-1000,Bangladesh, Organizer-Bangladesh Physical Society(BPS, 08-10 March, 2018.

[37] K A Khan, M.S.Bhuyan,M. A. Mamun,M.Ibrahim,Lovelu Hassan and M A Wadud, "Organic electricity from Zn/Cu-PKL electrochemical cell ", Published in the Souvenir of First International Conference of Contemporary Advances in Innovative & Information Technology(ICCAIAIT) 2018,organized by KEI, In collaboration with Computer Society of India(CSI), Division-IV(Communication). The proceedings consented to be published in AISC Series of Springer,2018

[38] M K A Khan , A K M Obaydullah, M.A. Wadud and M Afzol Hossain, "Bi-Product from Bioelectricity", IJARIIE-ISSN(O)-2395-4396, Volume-4, Issue-2, Page-3136-3142 , 2018

[39] M K A Khan and A K M Obaydullah , "Construction and Commercial Use of PKL Cell", IJARIIE-ISSN(O)-2395-4396, Volume-4, Issue-2, Page-3563-3570, 2018

[40] M K A Khan, "Studies on Electricity Generation from Stone Chips Plant (Bryophyllum pinnatum)", International J.Eng. Tech 5(4): 393-397, December 2008

[41] K A Khan, M Afzol Hossain, A K M Obaydullah and M.A. Wadud, "PKL Electrochemical Cell and the Peukert's Law ", Vol-4 Issue-2, 2018 IJARIIE-ISSN(O)-2395-4396,Page: 4219 – 4227

[42] K A Khan, M.A.Wadud, M Afzol Hossain and A.K.M. Obaydullah, "Electrical Performance of PKL (Pathor Kuchi Leaf)Power", Published in the IJARIIE-ISSN(O)-2395-4396,Volume-4, Issue-2, Page-3470-3478 ,2018.

[43] K A Khan, M Hazrat Ali, M. A. Mamun, M. Mahbubul Haque, A.K.M. Atique Ullah, Dr. Mohammed Nazrul Islam Khan, Lovelu Hassan, A K M Obaydullah, M A Wadud, "Bioelectrical Characteristics of Zn/Cu- PKL Cell and Production of Nanoparticles (NPs) for Practical Utilization'' , 5th International conference on 'Microelectronics, Circuits and Systems', Micro2018, 19th and 20th May,2018,Venue: Bhubaneswar, Odisha, India, Organizer: Applied Computer Technology, Kolkata, West Bengal, India, Page: 59-66, www.actsoft.org , ISBN: 81-85824-46-1, In Association with: International Association of Science, Technology and Management, 2018

[44] M.M. Hassan, M. Arif and K A Khan, "Modification of Germination and growth patterns of Basella alba seed by low pressure plasma", Accepted in the " Journal of Modern Physics", Paper ID: 7503531,2018

[45] K.A.Khan, S.M.Maniruzzaman Manir, Md. Shafiqul Islam, Sifat Jahan, Lovelu Hassan, and M Hazrat Ali. "Studies on Nonconventional Energy Sources for Electricity Generation" Internation Journal of Advance Research And Innovative Ideas In Education , Volume 4 Issue 4 2018 Page 229-244

[46] K A Khan, Mahmudul Hasan, Mohammad Ashraful Islam, Mohammad Abdul Alim, Ummay Asma, Lovelu Hassan, and M Hazrat Ali. "A Study on Conventional Energy Sources for Power Production" Internation Journal Of Advance Research And Innovative Ideas In Education, Volume 4 Issue 4 2018 Page 214-228

[47] M K A Khan ; Md. Siddikur Rahman ; Tanmoy Das ;Muhammad Najebul Ahmed ; Kaushik Nandan Saha ; Shuva Paul, Investigation on parameters performance of Zn/Cu electrodes of PKL, AVL, Tomato and Lemon juice based electrochemical cells: A comparative study, Publication Year: 2017, Page(s):1-6, Published in: 2017 3rd International Conference on Electrical Information and Communication Technology (EICT), Date of Conference: 7-9 Dec. 2017, Date Added to IEEE Xplore: 01 February 2018, ISBN Information: INSPEC AccessionNumber: 17542905,DOI: 10.1109/EICT.2017.8275150,Publisher: IEEE,Conference Location: Khulna, Bangladesh

[48] K A Khan and M. M. Alam, " Performance of PKL (Pathor Kuchi Leaf) Electricity and its Uses in Bangladesh", Int. J. SOC. Dev. Inf. Syst. 1(1): 15-20, January 2010.

[49] K A Khan, M. H. Bakshi and A. A. Mahmud, "Bryophyllum Pinnatum leaf (BPL) is an eternal source of renewable electrical energy for future world", American Journal of Physical Chemistry 2014;3(5):77-83,published,online,November10,2014(http://www.sciencepublishinggroup.com/j/ajpc)doi:10.11648/j.ajpc.20140305.15,ISSN:2327-2430 (Print); ISSN: 2327-2449(Online),2014.

[50] M K A Khan, An Experimental Observation of a PKL Electrochemical Cell from the Power Production View Point, Presented as an Invited speaker and Abstract Published in the Conference on Weather Forecasting & Advances in Physics, 11-12 May 2018, Department of Physics, Khulna University of Engineering and Technology (KUET), Khulna, Bangladesh.

[51] Bapy Guha, Fakhrul Islam and K A Khan ,Studies on Redox Equilibrium and Electrode Potentials, IJARIIE-ISSN(O)-2395-4396, Volume-4, Issue-4, Page-1092-1102 , 2018

[52] Fakhrul Islam, Bapy Guha and K A Khan , Studies on pH of the PKL Extract during Electricity Generation for day and night time collected Pathor Kuchi Leaf , IJARIIE-ISSN(O)-2395-4396, Volume-4, Issue-4, Page-1102-1113 , 2018

[53] K A Khan, Mohammad Lutfor Rahman, Md. Safiqul Islam, Md. Abdul Latif, Md. Afzal Hossain Khan, Mohammad Abu Saime and M Hazrat Ali, Renewable Energy Scenario in Bangladesh, Published in the journal of IJARII, Volume-4,2018, Issue-5, page : 270-279, ISSN(O)-2395-4396.

[54] K A Khan and Salman Rahman Rasel, Prospects of Renewable Energy with Respect to Energy Reserve in Bangladesh, Published in the journal of IJARII, Volume-4,2018, Issue-5, page : 280-289, ISSN(O)-2395-4396.
[55] K A Khan, Md.Shahadat Hossain, Md.Mostafa Kamal,Md.Anisur Rahman and Isahak Miah ,Pathor Kuchi Leaf : Importance in Power Production, IJARIIE-ISSN(O)-2395-4396 , Vol-4 Issue-5, 2018
[56] K A Khan, M.Hazrat Ali, M. A. Mamun, M. Ibrahim,A K M Obaidullah, M. Afzol Hossain and M Shahjahan, PKL Electricity in Mobile Technology at the off-grid region, Published in the proceedings of CCSN-2018, 27-28 October, 2018 at Kolkata, India.2018
[57] K A Khan and Afzol Hossain, Off-grid 1 KW PKL Power Technology: Design, Fabrication, Installation and Operation, Published in the proceedings of CCSN-2018, 27-28 October, 2018 at Kolkata, India,2018
[58] K A Khan, M. A. Mamun, M. Ibrahim, Mehedi Hasan, Md. Ohiduzzaman A K M Obaidullah, M.A Wadud and M Shajahan, PKL electrochemical cell for off-grid Areas: Physics, Chemistry and Technology, Published in the proceedings of CCSN-2018, 27-28 October, 2018 at Kolkata, India.2018
[59] K A Khan, and Salman Rahman Rasel. "Studies on Wave and Tidal Power Extraction Devices" International Journal of Advance Research And Innovative Ideas In Education Volume 4 Issue 6 2018 Page 61-70
[60] K A Khan, Sultan Mahiuddin Ahmed , Mousumi Akhter , Md Rafiqul Alam , and Maruf Hossen . "Wave and Tidal Power Generation" Internation Journal Of Advance Research And Innovative Ideas In Education Volume 4 Issue 6 2018 Page 71-82
[61] K A Khan, Md. Atiqur Rahman, Md. Nazrul Islam, Mahmuda Akter, and Md. Shahidul Islam. "Wave Climate Study for Ocean Power Extraction" Internation Journal Of Advance Research And Innovative Ideas In Education Volume 4 Issue 6 2018 Page 83-93
[62] K A Khan, Md.Sujan Miah, Md. Iman Ali, Sujan Kumar Sharma, and Abdul Quader. "Studies on Wave and Tidal Power Converters for Power Production" Internation Journal of Advance Research And Innovative Ideas In Education Volume 4 Issue 6 2018 Page 94-105
[63] K.A.Khan , and Farhana Yesmin. "PKL Electricity- A Step forward in Clean Energy" Internation Journal Of Advance Research And Innovative Ideas In Education Volume 5 Issue 1 2019 Page 316-325
[64] K.A.Khan, M Hazrat Ali, A K M Obaydullah, M A Wadud, "Candle Production Using Solar Thermal Systems ",1st International Conference on 'Energy Systems, Drives and Automations', ESDA2018, Page: 55-66.
[65] K.A.Khan and Farhana Yesmin, "Cultivation of Electricity from Living PKL Tree's Leaf" International Journal Of Advance Research And Innovative Ideas In Education Volume 5 Issue 1 2019 Page 462-472
[66] S. J. Hassan & K. A. Khan, "Determination of Optimum Tilt angles of Photovoltaic panels in Dhaka, Bangladesh."International J. Eng. Trach 4 (3): 139-142, December 2007. Webiste : www. Gsience. Net , 2007
[67] S.J.Hassan & K. A. Khan, "Design, Fabrication and performance study of Bucket type solar candle machine", International J. Eng. Trach 4 (3), December 2007. Webiste : www. Gsience. Net, 2007
[68] Md. Kamrul Alam Khan, "Studies on Electricity Generation from Stone Chips Plant (Bryophyllum pinnatum)", International J.Eng. Tech 5(4): 393-397, December 2008
[69] Saiful Islam, K.A. Khan, A.K. Sadrul Islam & M. Junab Ali, "Design, Fabrication & performance study of a Paraboloidal Solar Medical Sterilizer" , Bangladesh J.Sci. Res. 18(2): 211-216, 2000 (December)
[70] Md Shahidul Islam and Md. Kamrul Alam Khan, Performance Studies on Single Crystal Solar PV Modules for Practical Utilisation in Bangladesh, International J.Eng. Tech 5(3): 348-352, September 2008
[71]Md.Kamrul Alam Khan, Studies on Fill Factor(FF) of Single Crystal Solar PV Modules For Use In Bangladesh, International J.Eng. Tech 5(3): 328-334, September 2008
[72] Md. Kamrul Alam Khan, Performance Studies of Monocrystallinne PV module considering the shadow effect, International J.Eng. Tech 5(3): 342-347, June 2008
[73] Md Shahidul Islam and Md.Kamrul Alam Khan, Study the Deterioration of a Monocrystal Solar silicon PV module Under Bangladesh Climate, International J.Eng. Tech 5(2):26 3-268, June 2008