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## **PHOTOVOLTAIC CHARACTERISTICS OF HYDROGENATED AMORPHOUS CARBON BY PLASMA ENHANCED CHEMICAL VAPOUR DEPOSITION METHOD**

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**Abstract-** The diamond like-carbon (DLC) thin film was deposited by plasma enhanced chemical vapour deposition (PECVD) method using methane and hydrogen composition under different RF power (50, 100 and 150 watt) and working pressure (30, 60 and 90 mTorr). The X-ray diffraction (XRD) spectra showed that the thin films were amorphous nature. The X-ray photoelectron spectroscopy (XPS) analysis showed that the amorphous films were hydrogenated amorphous carbon (a-C:H) characteristics. The optical band gap of the films were tuned from 2.3 to 2.56 eV due to the variation of RF power and working pressure. The optical measurements showed that the optical band gap of the films grown at 50 watt RF power was lower compared with the films grown at 150 watt RF power and constant working pressure 30 mTorr. The optical band gap increases with increasing size of the sp<sup>3</sup> clusters showed better mechanical characteristics. The optical band gap of thin film was 2.56 eV deposited at RF power 150 watt and 30 mTorr working pressure showed as antireflective coating and protective encapsulant to improve stability and cell efficiencies.

## **NANOTECHNOLOGY TO SOLVE POWER PROBLEMS IN THE ENERGY SECTOR: LOW-COST & HIGH EFFICIENCY NANOSTRUCTURED SOLAR CELL**

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**Abstract-** The current global energy problem can be attributed to insufficient fossil fuel supplies and excessive greenhouse gas emissions resulting from increasing fossil fuel consumption. And to reduce the dependency on high-cost imported oil or coal and an urgent need to reduce greenhouse gas emissions, nanotechnology can be a potential solution for solving future needs for energy. The contributions of nanotechnology will be in the field of new generations of low cost solar photovoltaics, the hydrogen economy, more efficient conventional energy production and energy saving for industry as well as consumers. In this paper, some useful contributions of nanotechnology in cheap and efficient energy production has been highlighted and opportunities of nanostructured materials have been studied to design more efficient solar cells has been studied.

## **APPLICATIONS OF RENEWABLE ENERGY IN ARCHITECTURE**

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**Abstract-** The use of renewable energy has been increasing in various applications in Bangladesh, but is concentrated mostly in rural regions. This paper will discuss areas in which renewable energy can be implemented in the architecture of urban Bangladesh. The aim is to point out architectural interventions that reduce dependency on energy consumption. Whereas climatic considerations during building design help in creating low energy architecture, the activities within a building and comfort needs for occupants still require some active energy input. If Architects aim to reduce dependency on conventional fossil energy and try to work in some renewable energy use in the operation of buildings, then savings will act as a bonus under the strained energy situation in Bangladesh. This paper discusses options available for renewable energy use in buildings of Bangladesh in urban areas with particular emphasis on Building Integrated Photo Voltaic systems or BIPVs.

## **SOLAR WATER PUMPING SYSTEM USING LOCAL TECHNOLOGY**

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**Abstract-** In this work a PV-based water pumping system has been developed using local technology. The system can be used for irrigation as well as for pumping water to over-head tank in urban area. In this system a locally developed sine wave inverter has been used to convert the DC electrical power to AC. The inverter is designed using PWM technique with a microcontroller. The efficiency of the inverter is found 80% with very low harmonic distortion. In the system AC pump has been used which is readily available in the local market. It is found that 1kWp PV panel is required to drive a 1HP motor if daily tracking of the panel is used. If the tracking is not used the amount of panel required is 1.2kWp. For performance study the system has been installed at the RERC, DU. The panels (14 panels 75 watt each) have been installed on the roof of the centre building. To study the discharge rate with suitable head, a 40 feet high tower has been made and the discharge pipe has been placed over this tower. To provide the starting surge current and to store the excess energy during the peak hours two 12 volt 120 AH batteries have been used. Although the system was designed to run a 1 HP motor about 10 hours a day, but due to the absence of daily tracking it can run this motor about 4 hours. But it can run a ½ HP motor for 10 hours a day and the discharge rate is 250 l/m. The system can be used for water pumping during irrigation time and it can be used as a mini grid system to provide electricity for the nearby houses. The system becomes economically viable if the mini-grid facility is adopted with it.

## **ENERGY-USE PATTERN IN SELECTED VILLAGES OF BANGLADESH AND SUGGESTIONS ON IMPROVEMENTS TOWARDS SUSTAINABILITY**

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Abstract- In Bangladesh, energy planning is concentrated at the national level and current emphasis is on renewable energy sources along with conventional fuel. Besides, inadequate information about the rural energy sector is an obstacle for solving energy-sector problems. By introducing local level energy planning, it is possible to make self-reliant development through careful uses of the locally available energy sources. By knowing the energy use pattern, energy demand and potential energy resources, necessary decision can be taken for further intervention towards sustainability. From the above point of view, a survey was carried out in three selected villages of Tangail District, Bangladesh and the energy use pattern, energy demand and supply of that locality were studied. The overall objective of the work was to examine the opportunities for application of energy-efficiency and renewable energy measures in the study area for improvements towards sustainability. Primary data were collected by a structured questionnaire, interview. For secondary data, information was collected from the related publications, reports, literatures, studies, as well as web sites of different organizations. All data are analyzed by using different tools of Excel program and analyzed for future demand supply pattern. Probable solutions for improvements towards sustainability have been recommended.

## **PERFORMANCE ENHANCEMENT OF PV SOLAR SYSTEM BY MIRROR REFLECTION**

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Abstract: Bangladesh receives an average solar irradiation of  $3.82\sim 6.42\text{Kwh/m}^2$  and considering the total area of Bangladesh and assuming the efficiency of solar system as 10%,  $5.2\times 10^9$  Kwhr of electricity can be generated annually. Roughly 60% population of the country do not have access to grid electricity and are mostly dependent on bio mass to meet their energy requirement. However, solar home system is becoming popular day by day and even poor households are now becoming interested to purchase solar home system due to its various advantages. Around half a million solar home systems have already been installed in different parts of Bangladesh and the growth rate is around 5%. One of the major limitations of the solar home system is its extremely poor efficiency. Lot of research is going on to improve the performance of the solar panels. Sun tracking is a method frequently adopted for performance enhancement. However sun tracking devices need expensive control and drive equipments and the power for these equipments has to be provided by the solar panel and the battery installed within the solar home system. Due to cost and frequent maintenance requirement, such tracking system is not popular in Bangladesh. Even a slight enhancement of the performance of solar cell will drastically reduce the overall per unit energy cost of the solar home system. In this paper, performance enhancement of solar panel by direct reflection of light has been studied experimentally. In order to make a comparative study, readings of

the output of solar panels were taken under three different conditions simultaneously. The conditions are: i) Output when the panel was inclined at  $23.5^{\circ}$  with the horizontal ii) panel output by tracking the sun and iii) panel output by fixing plane mirrors at the East-West ends of the panel edge with the panel fixed at  $23.5^{\circ}$  with the horizontal. Encouraging results were obtained with such reflectors installed with the solar panel. Results from the practical data show that by using mirrors, an average increase of around 25% in the short-circuit currents, as high as that of sun tracking, can be achieved. And as a result of the reduced complexity and zero power consumption of the mirror system, as compared to that of sun tracking system, use of mirrors will be more economically viable over sun tracking. Moreover, installation of mirrors is cheap, simple and does not require any additional complicated equipments or devices.

## **RESEARCH AND DEVELOPMENT ACTIVITIES ON RENEWABLE ENERGY TECHNOLOGY AT IFRD, BCSIR**

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**Abstract-** Demand for sustainable development leading to higher standard of living, environmental pollution, global warming and increase in world population are the challenges that require efficient energy management at the backdrop of our present dependence on and limitation of fossil fuel reserve. This requires harnessing novel, sustainable, renewable and environment friendly energy sources. Institute of Fuel Research & Development (IFRD) was established in BCSIR to combat these challenges. This institute has been conducting research on alternative, sustainable and renewable energy covering biogas technology, improvement of stove technology, harnessing solar & wind energy and modification of traditional and present day technologies for saving energy. These research activities aim at production of clean bio-fuel, reduction of greenhouse gas emission, reduction of fuel consumption, minimization of environment pollution including indoor air pollution, improvement of efficiency of energy conversion technologies and creation of green Jobs in Bangladesh. Besides, this institute provides testing service of fuel and allied products quality parameters and on energy related technology problems. Research activities of IFRD resulted in designing and development of fixed dome model biogas plant and different models of Improved Stove. This institute disseminated about 22000 biogas plants throughout the country. The installed biogas plants are under surveillance by IFRD, BCSIR. A feasibility study was conducted by IFRD, BCSIR on commercial use of solar, wind and micro-mini hydro energy in Bangladesh. This Institute has developed solar hot box, solar water heater, solar still and solar drier. IFRD also disseminated more than 300,000 ICS units throughout the country. We have, so far, trained around 12,000 people on ICS and biogas technologies in different areas of Bangladesh. The training service on ICS and Biogas technology is available from IFRD. Undertaking and subsequent implementation of a massive Renewable energy technology dissemination program involving government & non-government organizations and other stakeholders including donor agencies is most essential.

## **IMPACT OF UTILIZATION OF SOLAR PV TECHNOLOGY AMONG MARGINALIZED POOR PEOPLE IN RURAL AREA OF BANGLADESH**

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Abstract-Bangladesh is facing serious energy crisis. To combat this adverse situation solar PV technology stands out to be one of the prospective sources. Fortunately Bangladesh is endowed with plentiful supply of solar energy due to its geographical position. This paper investigates on how marginalized poor people in rural area of Bangladesh are benefited by utilization of solar PV technology and also focuses on the collaboration of various governmental and nongovernmental organizations to promote this technology. In Bangladesh, Solar energy utilization has been started since 1980. About 45 governmental and nongovernmental organizations are involved in 20 solar projects are being implemented in different rural areas of Bangladesh. The implementations of different solar projects have revealed that it provides far-reaching economic, environmental and social benefits to people living in remote rural areas in Bangladesh. The utilization of PV technology in rural area is increasing the income as well as the living standard of the rural poor through rural development, increase business opportunities and increases job scope. It is also observed that women empowerment is progressing and education rate is increasing in rural area. It is observed that it has produced a positive impact on the economy of Bangladesh because rural people have reduced their dependence on imported oil such as kerosene, diesel etc. It is revealed that this technology is making a substantial effect in the telecommunication sector in the off grid areas. This technology brings IT to the rural people by establishing computer education, with this education; students improve the quality of their own lives as well as the community. It is also observed that by using this technology instead of dangerous smoke and soot from kerosene lamps, this has reduced their health risk and lessened health related costs.

## **SOCIO-ECONOMIC AND ENVIRONMENTAL IMPACT OF SOLAR HOME SYSTEMS (SHSs) IN BANGLADESH**

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Abstract– Subject to the current energy crisis, the government of Bangladesh has focused more on renewable energies to provide its people with electricity. Especially in rural areas, where the people are deprived from reliable grid electricity, renewable energy is viable solution to their energy crisis. Among the available renewable energy sources the solar energy is the most prominent one. The introduction of Solar Home Systems (SHSs) has lessened the use of expensive non renewable energy options like diesel or Kerosene as well as ensured an environmentally sustainable energy security. This paper investigates the effect of SHSs on the life of people in Bangladesh at the remote localities. Practice of SHSs in the rural areas improves the living standard of people through engaging them to more economic activities. Increase in the working hour allows the rural people to earn more and it also helps village women to participate in profitable activities. The paper also presents environment impact of SHSs to mitigate the threat of global warming through CO<sub>2</sub> reduction from the perspective of Bangladesh.

## **A STUDY ON THE CONTEMPORARY SOLAR ENERGY SCENARIO IN BANGLADESH**

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**Abstract-** The profusion of solar radiation has facilitated the expansion of Solar Energy Technologies (SETs) in Bangladesh. The technologies available here can be classified into two broad categories: solar photovoltaic (PV) systems and solar thermal power/concentrating solar power (CSP) systems. Different government and non-government organizations of Bangladesh have been working towards the dissemination of these SETs in the country for more than a decade. Though this diffusion is yet to assume widespread commercial dimension, the advancement has been significant over the last few years. However as far as the study of solar energy resources in Bangladesh is concerned, an obstacle often faced with is the non-availability of up to date information regarding the actual implementation of SETs, thereby making the task of prospective planning and comprehensive understanding of this viable source of energy all the more difficult. Motivated by this requirement, we present in this paper the contemporary solar energy scenario in Bangladesh with respect to distributions, physical implementations and infrastructural developments. The contributions of different government and non-government organizations in this sector have been studied here from a comparative point of view on the basis of exhaustive literature review and extensive fieldwork, covering discussions with key figures of the public and private sector. The cumulative contribution of solar energy resources in Bangladesh has been calculated as well and has been compared with other renewable energy resources available in the country. Also future areas of expansion in this field have been suggested in compliance with the socio-economic condition of Bangladesh.

## **STUDIES ON THE EFFICIENCY OF SOLAR KILN IN SEASONING OF LAMBU WOOD**

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**Abstract-** Solar kiln developed by the Bangladesh Forest Research Institute (BFRI) was applied for seasoning of Lambu wood. For comparative study of the seasoning efficiency several methods namely air drying, solar kiln augmented with residue burner along with solar kiln were tried. The numbers of planks tested under each trial were 15 having 4'-6' x 1'-1.5' x 1"-2" size. The solar kiln was operated under day light from 9 AM to 5 PM i.e. for about eight hours whereas the solar kiln augmented with residue burner for supplying additional heat was operated for 3 to 5 hours after eight hours of solar kiln drying. For each of the above conditions temperature in the solar kiln was maintained in the range of 40<sup>0</sup>C to 48<sup>0</sup>C. In case of air dry condition the planks were stacked in the laboratory at room temperature. Average data shows that solar kiln alone needs 14 days to attain 12-14% moisture content of Lambu wood. But supplying of additional heat through solar kiln augmented with residue burner, the

seasoning time has been reduced to 5 days. On the other hand, for seasoning of Lambu wood under air dry condition it needs 28 days. From data, it is evident that the solar kiln alone is about 50% and the solar kiln augmented with residue burner is about 80% efficient than the air dry condition in seasoning of Lambu wood. In comparison to solar kiln alone, the solar kiln augmented with residue burner gives maximum effect which accounts for 65% efficiency.

## **ASSESSMENT OF ROLE OF PUBLIC & PRIVATE INITIATIVES IN SOLID WASTE MANAGEMENT IN KHULNA CITY FOR BETTER LIVING ENVIRONMENT**

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**Abstract-** Khulna is an industrial city which situated in the southwest region of Bangladesh. About 1.3 million people live in this city & create 2.4 metric-ton solid wastes every day. The quantity of waste generated in urban areas depends upon a number of factors such as food habit, standard of living, degree of commercial and industrial activity. It is already proved that solid waste is an important factor for environmental pollution. The people who have very little idea about environment are dumping solid wastes here & there and the management process of solid wastes become very complex. The solid waste management system of Khulna city is not up to the standard required for a modern city. The roads, streets & vacant lands remain dirty & unclean, due to haphazard dumping of solid wastes; consequently it is creating serious environmental pollution. Khulna City Corporation (KCC) is trying to manage the solid waste but due to the shortage of manpower and necessary equipments is not able to manage it properly. Through the Public & Private Initiatives in solid waste management, the living environment of Khulna City can be enhanced. Thus the KCC engaged private sectors for solid waste management in Khulna city. This paper deals with the assessment of role public private initiatives to manage the solid waste for better living environment for dwellers of city and ward 29 has been selected as case study area. Prism and Protisruti two NGOs are involved for solid waste management in the study area. They collect waste from door to door. Environment is not polluting with the present waste collection system by the NGOs. Prism takes Tk. 10 and Protisruti takes Tk. 15 from every household for solid waste management. KCC is an autonomous organization. They don't take money for providing social service. Protisruti control 3.15 ton waste in each day and their cost of per unit waste is 3000 taka per ton in a month. Prism control 3.5-ton waste in each day and per unit cost for waste control is Tk. 3500 per-ton per month. KCC control 8.5 ton waste in each day and KCC spend Tk. 2500 for per ton waste in a month. Both of them get financial support from UNDP for solid waste management in Ward 29 and have technical and non-technical persons. The study conducted through (i) questionnaire survey, (ii) data collection from secondary sources, (iii) data processing and analysis, (iv) GIS mapping and (v) drawing conclusion and recommendations. Based the focus group discussion with NGOs and the data analysis result it is found that the solid waste management system has been improved after public-private initiatives and living environment of the city dwellers has also been substantially improved. The studies also identify the problems faced by the households & private sectors for waste management.

## **PROSPECT OF MARINE RETS IN BANGLADESH**

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**Abstract-** To meet the growing energy demands of the global economy, all sources of energy — including conventional and nonconventional fossil fuels, renewable energy, and ameliorated efficiency and conservation — will be needed. One of the challenges of meeting this demand through the increased use of renewable sources is ensuring availability on a very large scale and at an affordable price. At present, Bangladesh is facing acute difficulties in supplying energy to maintain its economic growth. The gap between demand and supply is gradually widening. Although it has some reserves of commercial energy resources (e.g. natural gas and coal), due to economic and technical constraints, it is not being able to supply energy at the desired level. The situation is even worse in the rural areas where supply of energy is still very uncertain. Bangladesh has a good potential for harnessing energy from solar, biomass, etc., it has been experiencing a gradual shift towards exploring new renewable energy resources as a means of driving force for rural development. However, efficient utilization of marine renewable energy technologies (RETs) is yet to assume effective dimensions. Bangladesh has got 710 km long coastal belt along the Bay of Bengal. The ocean immerses as a potential source of renewable energy in the form of Wave, Tidal and Ocean thermal energy conversion (OTEC). Therefore, the country has an immense possibility in harnessing the energy from marine renewable resources. This paper elaborates diverse opportunities of marine RETs and their applications in Bangladesh through different literature review, case study, examples and secondary data analysis. It also contains significant discussions on the possible improvements in the sector of marine RETs in the country. Action plans to enhance commercialization of such technologies have been suggested.

## **BIOGAS IN BANGLADESH: CHALLENGES AND STRATEGIES**

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**Abstract-** The people of Bangladesh are underprivileged from continuous grid electricity. Despite the plentiful supply of renewable sources of energy in Bangladesh, currently their contribution to the electricity supply remains inconsequential. Use of renewable energy is considered an indispensable component of sustainable energy systems, as renewable energy resources emit less greenhouse gas emissions compared to other non-renewable energy systems. Out of the various renewable sources, solar and biogas and to a limited extent, wind and hydro-power are effectively used. Though the biogas production was the leading and most appropriate renewable energy resource in our country, it has become notably insignificant due to the lack of appropriate strategies and institutional settings. To address this, this article examines Bangladesh's current energy strategies and institutional settings and investigates future strategies for the advancement of biogas production. This article argues that further significant efforts could be made toward energy sustainability in Bangladesh and the development for a national sustainable energy policy.

## **WIND RESOURCE ASSESSMENT FOR SOME LOCATIONS OF SOUTHERN PART OF BANGLADESH**

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Abstract- Wind resource assessment is required for wind farm installation at a site. In this study wind energy has been assessed for two off shore, one on shore and two inland hilly areas, which sites are virtually wind energy rich areas. For the estimation of wind energy, measured wind velocity data of Sustainable Rural Energy (SRE) project of Local Government Engineering Department (LGED) for Kutubdia, Sitakunda, Kuakata, Khagrachari, and CUET from June 2005 to December 2006 have been used. The probability density of the Weibull distribution is used for the calculation of the average available wind power per unit area. Analyses on the available data for a few locations has showed that wind farms are opt in the off shore areas/islands or on shores. There is also a great potential of wind energy extraction in the hilly areas with low community land use.