

# Sustainability, Prospect and Challenges of Renewable Energy in Bangladesh

Shah Mohazzem Hossain<sup>\*1</sup>, Md. Rokonzaman<sup>2</sup>, Mohammed Hossam-E-Haider<sup>3</sup>

Department of Electrical, Electronic and Communication Engineering  
Military Institute of Science and Technology, Dhaka, Bangladesh

*Abstract—Energy is one of the primary needs for survival of all organisms in the universe. Everything what happens in the surrounding is the expression of flow of energy in one form to another form. In last few decades, energy demand has increased significantly due to the industrialization and increasing standard of living of the human being. But correspondingly energy availability for electricity generation has not kept with demand as yet. To fulfill this huge demand of electricity alternative sources of energy must be used like solar, wind, tide etc. very effectively which are also called renewable energy sources. While non-renewable energy resources will continue to become increasingly scarce, global dependency on them will only continue to grow steadily over the next few years, thereby compounding their scarcity. This paper investigates the prospect, trend, utilization and its technology as well as reviews the policy, institutions and opportunities of renewable energy technology towards sustainable development and climate change mitigation in context of Bangladesh as a country of this subcontinent.*

**Index Terms** —Energy conversion, Solar, Hydro, Biomass, Wind, Renewable energy.

## I. INTRODUCTION

Bangladesh is a small country with a population of 155 million in a land mass of 147,570 sq. km. This country contains floodplains and wetlands with over 300 rivers that sustain rare wildlife, flora and fauna [1]. In this modern era, Energy crisis is one of the severe problems on earth and environmental deterioration because of the lesser availability of energy in 21st century. The increasing rate of energy consumption will be more day by day because of the increasing rate of world population. The high interaction between energy and environment prohibits the use of fossil fuel which causes Green House Gas (GHG) effect on earth's environment, one of the effective ways to solve this huge problem of energy crisis is the use of renewable energy and sustainable energy more and more. In a developing country like Bangladesh, energy source crisis to generate electricity is a major issue which almost hampers all developments. In Bangladesh only about 32% of the total population has access to use electricity and 6% to natural gas. But in rural area only 22% has electricity without gas supply. Because of the high consumption rate of fossil fuel, it will be over near future. Crude oil consumption has increased radically from recent observation which mostly used to generate electricity. Bangladesh imports 3.5-4.0 million tons of petroleum and petroleum products per year that

spent about \$ 5 million in 2011 which is 10% more expense compare to year 2000 [2]. A poor country like Bangladesh can't afford this strong dependence on foreign oil in the near future without thinking any alternative way. For alternative solutions the existing renewable energy sources like biomass, hydro, solar, wind and tidal energy are needed to build up in a more useful manner to minimize the present energy shortage. Though from year 1850-2005 production and use of traditional energy increases more than 50% with a total of approximately 0.2 billion ton to 11.4 billion ton (IEA, 2007) mostly in industrialized nations [3]. In spite of the global financial crisis, Bangladesh is having a macro economic front well enough for its economic growth at an average of 6% per year since 2010 and the economy is still agro-based, with just under 50% of total-labor force employed in the sector and more than 70% of the population involved directly or indirectly in agricultural activities [4]. This results as a huge energy in agricultural sector in a form of biomass energy.

## II. PRESENT ENERGY SCENARIO

Bangladesh's energy infrastructure is quite small, insufficient and poorly managed with a per capita energy consumption of 321 kWh. Non-commercial energy sources, such as wood fuel, animal waste, and crop residues, are estimated to account for over half of the country's energy consumption. Bangladesh has small reserves of oil and coal, but very large natural gas resources. Commercial energy consumption is mostly natural gas (around 78%), followed by oil, hydropower and coal [5].

Electricity is the major source for country's most of the economic activities. But, Bangladesh has been facing electricity shortage for many years. In last few years this problem was not serious but in the year 2010 the problem has exceeded the common people's patient. People are facing heavy load shading problem in the hot summer [6]. Bangladesh is located in tropical region. So, almost all the time is summer except few times in winter. In summer season temperature rises up to 40 degree Celsius. So, it's too hot. People cannot use AC or fan for load shading in this country when the electricity goes away. Like other professional students, businessman, online home worker, computer user, industrialists are badly victim of this problem seriously. In this modern age the electricity is the main and

fundamental demand for common people to the government but the government is failed to meet this demand. Bangladesh's installed electric generation capacity was 10289MW in 2014; only three-fourth of which is considered to be available [7]. Problems in the Bangladesh's electric power sector include corruption in administration, high system losses, delay's in completion of new plants, low plant efficiencies, erratic power supply, electricity theft, blackouts, and shortages of funds for power plant maintenance. Overall, the country's generation plants have been unable to meet system demand over the past decades. Demand with generation of electricity in recent years is depicted in Fig.1.

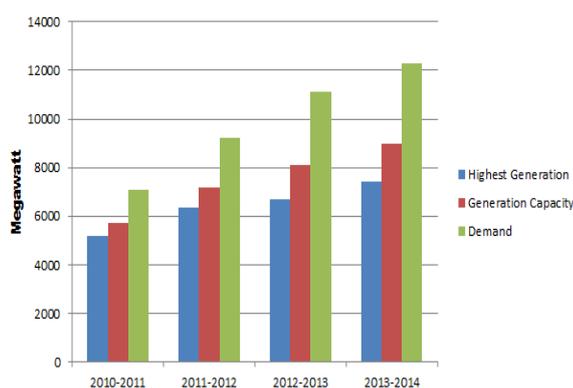


Fig.1. Electricity trend of Bangladesh in recent years [8]

Therefore, we have to investigate some approximate, alternative, new sources for the power generation, which is not depleted by the very few years. It suffers all the living organisms of all kinds as on the land, in aqua and in air. Power stations and automobiles are the major pollution producing places. Therefore, we have to investigate other types of renewable sources, which produce electricity without using any commercial fossil fuels, which is not producing any harmful products. There already existing such systems using renewable energy such as solar, wind etc. for power generation. In Fig.2 shows the utilization percentage of energy sources in recent time of Bangladesh.

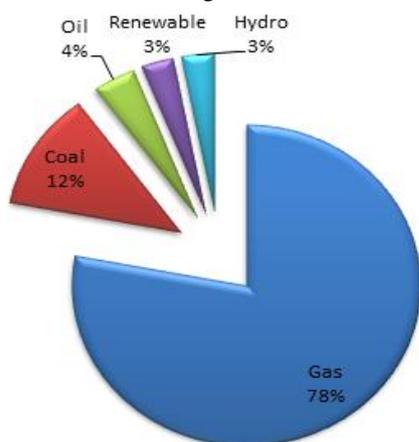


Fig.2. Utilization percentage of energy sources in recent time [8]

### III. RENEWABLE ENERGY STATUS OF BANGLADESH

Bangladesh government has set up the goal of providing electricity to all by 2020 and to ensure reliable and quality supply of electricity at a reasonable and affordable price. Sustainable social and economic development depends on adequate power generation capacity of a country. There is no other way for accelerating development except to increase the power generation by fuel diversification. Development of Renewable Energy is one of the important strategies adopted as part of Fuel Diversification Program. In line with the Renewable Energy policy 2009, the government is committed to facilitate both public and private sector investment in Renewable Energy projects to substitute indigenous non-renewable energy supplies and scale up contributions of existing Renewable Energy based electricity productions. The Renewable Energy Policy envisions that 5% of total energy production will have to be achieved by 2015 and 10% by 2020[9]. To achieve this target, government is looking for various options preferably Renewable Energy resources. Under the existing generation scenario of Bangladesh, Renewable Energy has a very small share to the total generation. The share of Renewable Energy exceeds more than 2% till now [10]. Present energy scenario in renewable sector is depicted in Fig.3

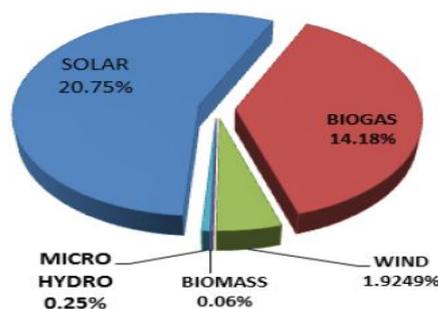


Fig.3. Present renewable energy condition of Bangladesh

#### A. Biomass Energy

Bangladesh is an agriculture-based country and the available biomass is mainly of agricultural residues like rice husk and rice straw from rice plants, Biogases from sugarcane, Jute stick, residues from Wheat, potato, oilseeds, spices etc. In addition to the agricultural wastes the other sources are dry materials such as dry wood, dried leaf, charcoal, coconut shells etc. In Fig.4 Energy Generation from Biomass in recent years is depicted. Over last 30 years, there has been an increasing trend of biomass fuel supply in Bangladesh. The total supply of biomass fuel was 236.08 PJ in 1980 and has increased over next 30 years to 17.3% [11]. The main resource for biomass energy is the biogas plant. Several institutions offer their helps in getting bio-gas plant for own house which is very effective.

Now-a-days people in rural areas are very much interested in those small power generation systems.

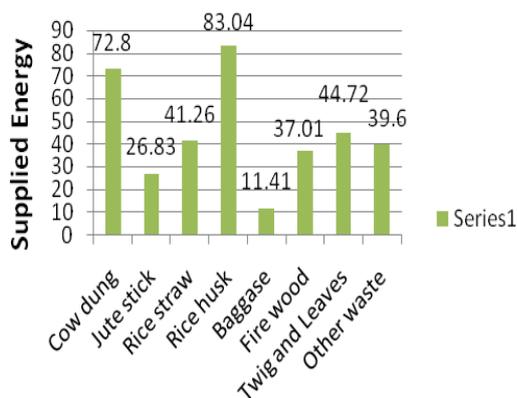


Fig.4. Energy Sources for Biomass in recent years

In Fig. 5 increasing rate of number of Biogas plant is depicted.

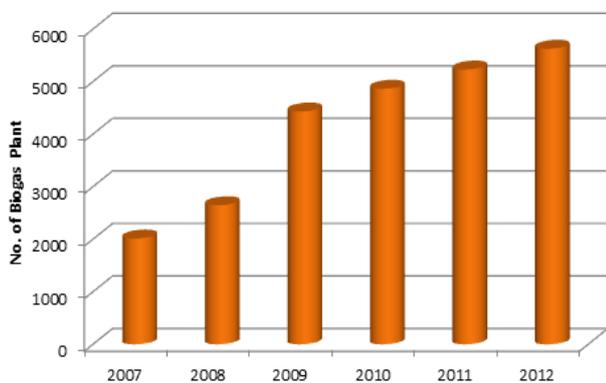


Fig.5. Energy supplied from biomass energy.

**B. Solar Photovoltaic**

Bangladesh is situated between 20.30 and 26.38 degrees north latitude and 88.04 and 92.44 degrees east which is an ideal location for solar energy utilization. Daily average solar Radiation varies between 4 to 6.5 KWh per square meter.

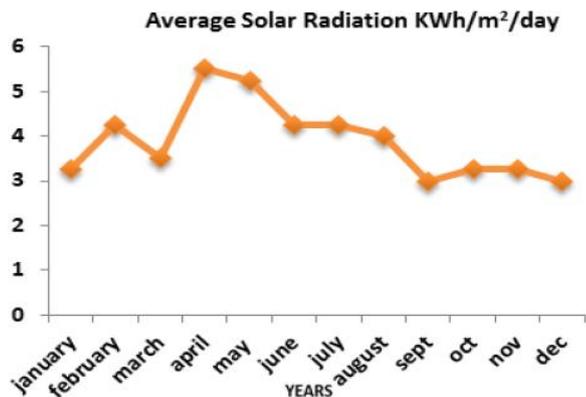


Fig. 6 Average Solar radiation in a year

Maximum amount of radiation are available in the month of March-April and minimum in December-January depicted in Fig.6[12]. According to Infrastructure Development Company Limited

(IDCOL), the total capacity of solar energy based installations in Bangladesh appears to be 20.75 MW[13].The amount is significant considering the upward trend of the number of SHSs (Solar Home System) installations in the country. The Fig.7 shows the approximate division wise SHS's installation. The international community recognizes Bangladesh's SHSs as the fastest growing solar power dissemination program in the world.

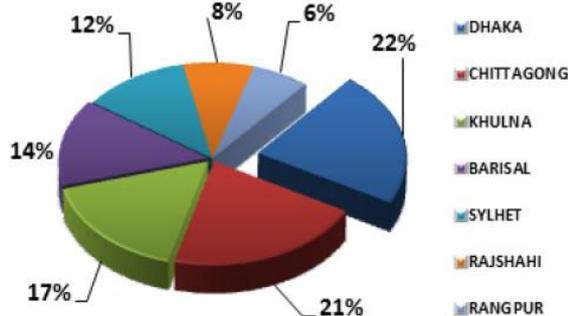


Fig. 7 The approximate division wise SHS's installation [14]

**C. Wind Energy**

The Bangladesh Meteorological department has wind speed measuring stations in towns and cities. Data from earlier measurements and analysis of upper air data by Centre for Wind Energy Technology (CWET) India show that wind energy resource of Bangladesh is not good enough (>7 m/s) for grid connected wind parks [15]. At present, several wind resource assessment program is on-going in the country. From the previous studies it can be inferred that the small wind turbines can be installed in the coastal regions of the country. Several organizations have installed low capacity wind turbines, mainly for battery charging in the coastal region of Bangladesh. However, progress in the wind energy sector of Bangladesh is not impressive. It has been studied that the average wind speed is maximum during the month of April-May which is approximately 5.1 ms<sup>-1</sup> and minimum in the month of December which is around 2.6 ms<sup>-1</sup> in Bangladesh. Fig. 8 shows approximated wind speed in several locations of Bangladesh is shown.

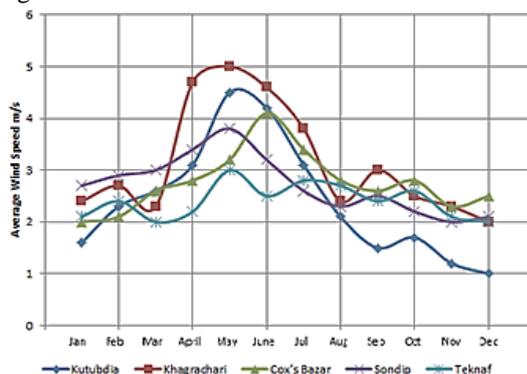


Fig. 8 Average wind speed in several locations of Bangladesh

There is a good opportunity in island and coastal areas for the application of windmills for pumping and electricity generation. A number of small wind generators have been installed by several agencies in coastal areas. In Table I an overall scenario on the wind energy programs undertaken by different organizations of Bangladesh is displayed.

**TABLE I. WIND ENERGY PROGRAMS IN BANGLADESH [16]**

Organization Name	Type of Application	Installed Capacity (Watt)	Location
Grameen Shakti	3 Hybrid	4,500	Grameen Offices in the Coastal Region
	Hybrid	7,500	Cyclone Shelter in the Coastal Region
BRAC	Stand-alone	900	Coastal Region
	Hybrid	4,320	Coastal Region
Bangladesh Army	Stand-alone	400	Chittagong Hill Tracts
IFDR	Stand-alone	1,100	Teknaf
	Stand-alone	600	Meghnaghat
LGED	Wind-PV Hybrid	400	Kuakata
	Total	<b>19,720 W</b>	

**D. Hydro Energy**

Several reconnaissance surveys and studies have been conducted in the past for installing small hydro power plants in the country, but so far only one hydro power plant has been installed at Kaptai having capacity 230MW. Sustainable Rural Energy (SRE) under Local Government Engineering Department (LGED) has successfully demonstrated first micro-hydro power unit at Bamerchara, Chittagong. Its installed capacity was 10KW but due to inadequate water head about 4KW power was generated. SRE has also carried out on prospective micro hydro study in sites of Chittagong Hill Tract reasons and some indigenous technology (wooden waterwheel which is driving procured generator) of micro-hydro power generation unit. A recent study on sustainable rural energy shows that micro hydro power plants are able to provide necessary power supply for rural areas. The study was conducted on the micro hydro power plants of generation capacity starting from 3KW up to 30KW [18]. These plants list are shown in Table II. Recently Bangladesh Power Development Board (BPDB) identified two other sites at Sangu (140 MW) and Matamuhuri (75 MW) for large hydropower plants.

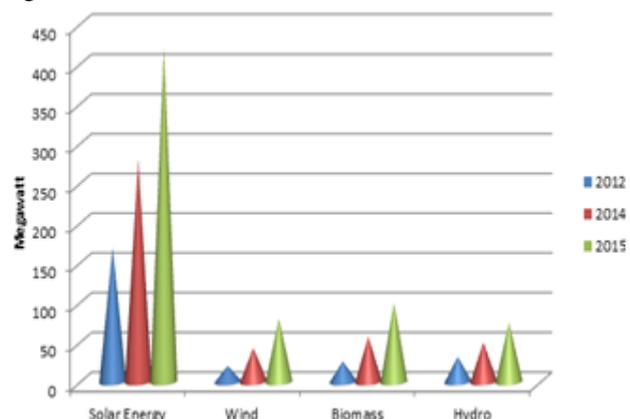
**TABLE II. HYDRO ENERGY PROGRAMS IN BANGLADESH [16]**

Location	Estimated Power Generation (KW)	Socio-economic Infrastructure		
		House hold	School /Mosjid/ Bazaar/ Clinic	Small Industry
Nunchari Tholipara, Khagrachari	3	100	3	1
Chang-oo-Para, Bandarban	30	200	5	2
Bangchhari, Bandarban	25	600	12	5
Liragaon, Bandarban	20	500	8	3
Kamalchar, Rangamati	20	150	8	9
ThangKhrue, Rangamati	30	300	6	3
Monjaipara, Bandarban	7.5	50	3	-

**IV. RENEWABLE ENERGY DEVELOPMENT**

**A. Planning**

To date, most of the initiatives on policy formulation for advancement of renewable have been supported via development assistance from industrialized nations and international organizations rather than being driven by national stakeholders including endusers in Bangladesh [19]. As a consequence, development of renewable has lacked local stakeholders' engagement in decision making. Some institutional reforms have taken place in Bangladesh especially in the energy and power sectors. However, these reforms have failed to bring desired improvements in electricity accessibility and energy supply security [20]. The challenges associated in introducing new energy technologies both in industrialized and developing nations have been acknowledged, for example, wind energy diffusion in Sweden [21] and solar PV in Bangladesh [22]. Several Renewable energy plans for recent years is depicted in Fig. 9.



**Fig. 9 Renewable energy trend in recent years**

The challenge for Bangladesh is to create niche market for such technologies without imposing additional burdens in terms of high investment costs, operation and maintenance costs as well as costs for systems charges to end users. However, the challenge is how such initiatives can be introduced without relying heavily on external financial resources while trends in development assistance also change. Renewable energy technologies, being socio-technological System's when implemented, necessitate a paradigm shift from technology-oriented strategies to market and on the-ground oriented strategies.

### **B. Challenges and Opportunities**

Among many of the underlying issues and barriers, lack of adequate policy frameworks, institutional settings, markets, financing, technological development, human resources and slow diffusion rates of new technologies have constrained deployment of renewable energy technologies in developing nations [23, 24]. Also the externality costs acts as market barriers for advancement of renewable energy technologies [25]. These barriers are often relevant in the context of Bangladesh. In order to further design and implement effective strategies for Bangladesh, appropriate policy mechanisms and institutional settings are necessary for long-term sustainability. Arguably, assistance from international organizations in terms of capacity building, policy learning, and demonstration of successful projects and approaches should enhance the advancement of sustainable energy issues in Bangladesh.

### **C. Climate Change Issues**

Climate change challenges have many other dimensions apart from mitigating impacts via technological input and adaptation. These involve advancing scientific, social, political and ethical learning about the challenges. While the science is known and the impacts are being experienced, many developed nations are not genuinely interested in tackling climate change [26]. However, some national efforts towards short-term and stringent abatement are acknowledged. Among others, climate impacts mitigation via implementation of the Kyoto Protocol is designed to achieve both sustainable developments in developing nations while industrialized nations expect to enjoy emission reduction credits via sustainable energy projects under Clean Development Mechanism (CDM) schemes. It is however too early to assess the effectiveness of such measures in the long-term.

### **D. Global Context**

In global context, climate change is not only a social, an economic and a political issue but also an ethical issue. Therefore, this need to be addressed via a holistic approach while, many developing nations including Bangladesh make insignificant contribution of

greenhouse gases emissions, they possess a strong need for socio-economic development. Bangladesh similarly to the other developing nations requires an allied approach comprised of climate change mitigation and adaptation which also contributes to sustainable development. Such a policy direction has also been recommended for Pacific Island nations [26].

### **E. Bangladesh Perspective**

In the Bangladesh context, sustainable development and climate change are interlinked as climate change influences human life, and society's priorities towards sustainable development can cause rising emissions of greenhouse gases and thus enhance climate impacts and vulnerability. Bangladesh has already demonstrated successful implementation of sustainable energy projects. However, their application is still limited to the demonstration scale and mostly financed by international organizations. In order to make such initiatives sustainable, a more holistic approach is needed. As climate variability is a major concern, an effective strategy that focuses on decentralized and split-home systems as an alternative option needs to be examined for its viability. Also, advancement of renewable energy needs to be supported via effective strategies and institutional settings. Among other initiatives, implementation of CDM under the Kyoto Protocol could facilitate sustainable energy development in Bangladesh via sustainable energy generation and combat adverse effect of climate change in global scale. An immediate priority acknowledged by Bangladesh is the need for development of national adaptation strategies to comprehensively address climate variability risks [27]. Thus a climate-driven energy strategy could lead the nation towards a sustainable energy future. A short, medium, and long-term target oriented approach towards clean energy development could be initial steps towards such strategy. Renewable are slowly finding a niche market in Bangladesh. Still there are lots of barriers and the expected outcomes from the past initiatives are not encouraging as the total utilization level is meager. Time-bound targets for mass dissemination of different renewable energy technology options have to be adopted by the Government of Bangladesh for fulfilling its obligation of universal electrification program by the year 2020 [28].

## **V. CONCLUSION**

Renewable energy is no more an ambitious expensive venture. Because of high research and development cost of renewable energy, it continues to lag in relation to conventional energy.

For sustainable development, every natural resource needs to be judiciously utilized. In order to ensure rural people's access to electricity, both public and private sector of Bangladesh need to concentrate on working

with sustainable energy sources. A united effort in this connection can pave the way for future success of the renewable energy sector in Bangladesh and can establish Bangladesh as a 'sustainable development model' in the world in near future.

### REFERENCES

- [1] National Report on sustainable energy, May 2013.
- [2] Article on "Renewable energy for sustainable Bangladesh (part 1)" by Md. Asrafal Alam on 03 June 2012 under Energy & Environment.
- [3] Dilip Ahuja and Marika Tatsutani," Sustainable energy for developing countries ", S.A.P.I.E.N.S [Online], 2.1 | 2009.
- [4] A review of development trends in the energy sector of Bangladesh by K.A.S. Murshid and Arne Wiig, Report R 2001: 3.
- [5] About electricity sector of Bangladesh available online, 31 Jan, 2015 at [http://en.wikipedia.org/wiki/Electricity\\_sector\\_in\\_Bangladesh](http://en.wikipedia.org/wiki/Electricity_sector_in_Bangladesh).
- [6] Electricity situation of Bangladesh available online, 31 Jan, 2015 at <http://www.articlesbase.com/politics-articles/electricity-shortage-is-a-serious-problem-in-bangladesh-2331901.html>.
- [7] About electricity status of Bangladesh available online, 31 Jan, 2015 at <http://www.powerdivision.gov.bd/user/brec/30/83>.
- [8] Energy and Sustainable Development in Bangladesh, A report by AHSAN UDDIN AHMED, Head of Environment and Development Division Bangladesh Unnayan Parishad (BUP).
- [9] Development of Renewable Energy Technologies by BPDB, January 2014.
- [10] A. K. Hossain & O. Badr, —Prospect of renewable energy utilization for electricity generation in Bangladesh, Renewable and Sustainable Energy Reviews, vol. 11, issue 8, pages 1617-1649, 2007.
- [11] Potentiality of Biomass Energy for Electricity Generation in Bangladesh M. S. Islam & T. Mondal Department of Electrical & Electronic Engineering, Rajshahi University of Engineering and Technology, Rajshahi, BANGLADESH, Asian Journal of Applied Science and Engineering, Volume 2, No 2 (2013) ISSN 2305-915X.
- [12] Renewable Energy Prospects & Trends in Bangladesh Presented by-Mazharul Islam. Bangladesh Power Development Board.
- [13] Present Scenario of Renewable Energy in Bangladesh and a Proposed Hybrid System to minimize Power Crisis in Remote Areas Nahid-ur-Rahman Chowdhury, Syed Enam Reza, TofaeelAhamedNitol, Abd-Al-Fattah-Ibne Mahabub, International Journal of Renewable Energy Research, Vol.2, No.2, 2012.
- [14] ZakariaMahbub, Husnain-Al-Bustam, SuvroShahriar, T.M. IftakharUddin, AbrarSaad, "International Journal of Engineering Research and Applications (IJERA)", Vol. 2, Issue 2,Mar-Apr 2012, pp.896-902.
- [15] How wind turbine works. Available online,20Dec, 2014 at <http://www.energymatters.com.au/renewable-energy/wind-energy/>.
- [16] Md. ZunaidBaten, EmranMd.Amin, AnikaSharin, Raisul Islam, Shahriar A. Chowdhury, "Renewable Energy Scenario of Bangladesh: Physical Perspective", International Conference on the Developments in Renewable Energy Technology (ICDRT) 2009, Dhaka, Bangladesh.
- [17] Potential of micro hydro power units in Bangladesh. Available online, 20Dec, 2014 at <http://www.lged-rein.org/>
- [18] Timilsina, G., T. Lefevre, and S.N. Uddin, New and renewable energy technologies in Asia. Renewable Energy World, 2001(2001-2002): p. 52-67.
- [19] Alam, M.S., E. Kabir, M.M. Rahman, and M.A.K. Chowdhury, Power sector reform in Bangladesh: Electricity distribution system. Energy, 2004. 29(11): p. 1773-1783.
- [20] Soderholm, P., K. Ek, and M. Pettersson, Wind power development in Sweden: Global policies and local obstacles. Renewable and Sustainable Energy Reviews, 2007. 11: p. 365-400.
- [21] Siddiqui, F.A., Linking Innovation and Local Uptake in Rural Development - Potential for Renewable Energy Cooperatives in Bangladesh, in Institute for Sustainability and Technology Policy (ISTP). 2003, Murdoch University.
- [22] Yu, X., Regional cooperation and energy development in the Greater Mekong Sub-region. Energy Policy, 2003. 31(12): p. 1221-1234.
- [23] Painuly, J.P., Barriers to renewable energy penetration; a framework for analysis. Renewable Energy, 2001. 24(1): p. 73-89.
- [24] Owen, A.D., Renewable energy: Externality costs as market barriers. Energy Policy, 2006. 34(5): p. 632-642.
- [25] Taplin, R., Climate change, vulnerability and ethics. Social Alternatives, 2004. 23(4): p. 11-15.
- [26] Yu, X. and R. Taplin, Policy Perspectives: Environmental Management and Renewable Energy in the Pacific Islands. Journal of Environmental Management, 1997. 51(1): p. 107-122.
- [27] Uddin, S.N., R. Taplin, and X. Yu, Advancement of renewables in Bangladesh and Thailand: Policy intervention and institutional setting. Natural Resources Forum, 2006. 30: p. 177-187.
- [28] D.N. Subbukrishna, K.C. Suresh, P.J. Paul, S. Dasappa, N.K.S. Rajan, Precipitated Silica From Rice Husk Ash by IPSIT Process, 15th European Biomass Conference & Exhibition, Berlin, Germany, 7-11 May, 2007.