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Present Situation of Renewable Energy in Bangladesh: Renewable Energy Resources Existing in Bangladesh

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I. Introduction

Bangladesh is a developing and a probabilities country. In Bangladesh, there are many natural resources such as coal, gas, petrol. The main source of energy in Bangladesh is Natural gas (24%) which is likely to be depleted by the year 2020[32]. Then Bangladeshis people will be faced some problem. In these case renewable energy helps the people of Bangladesh. People have a large unsatisfied demand of energy, which is growing by 10% yearly[1]. Bangladesh has a vast potential for renewable energy and the natural availability of alternative energy creates opportunities of Growth in power sector. Not only the technologies should be developed to produce energy in an environment friendly manner but also enough importanceshould be given to conserve the energy in most efficient form. The government has issued its vision and policy statement in February 2000, to bring the entire country under electricity service by the year 2020[2]. Recently it has the lowest per capita consumption of commercial energy in south Asia.

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Presently total generation capacity is 6727 MW. In this capacity 3534 MW is from the public sector which is 53% and 47% respectively of the total generation capacity. To meet the cumulative demand of electricity coal, gas, diesels, are being used to produce electricity. But it is also insufficient. In order to lessen the pressure of power demand on our conventional power plant, renewable energy like wind and solar power can be used[3]. The potential non-exhaustive source of energies, available in the form solar, biogas, hydropower and wind can be harnessed to provide an environmentally sustainable energy security, as well as an affordable power supply to the off-grid rural areas of the country . To this end, effective utilization of renewable energy resources has been adopted as a policy of the Government of Bangladesh.[4]. Different government and nongovernment organizations working separately or jointly to disseminate renewable energy technologies (RET) throughout the reported in the recent literature [5,6] however, prospective planning and comprehensive understanding of this dynamic field requires as well as regressions, in this sector should be continually scrutinized. Motivated by these objectives, we present in this paper a present scenario of the renewable energy related activities in Bangladesh. Based on fieldwork, covering discussions with key figures of the public and private sector, and exhaustive literature review, we demonstrate here the advancement in this field with respect to physical progress, research activities and infrastructural development. Also a comparison of these forms of renewable energy resources in Bangladesh has been drawn on the basis of the output power calculation of each sector.

II. Solar Energy in Bangladesh

Bangladesh is a subtropical country, 70% of year sunlight is dropped in Bangladesh. For this reason, we can use solar panels to produce electricity largely. Solar radiation varies from season to season in Bangladesh. Bangladesh receives an average daily solar radiation of 4-6.5 kWh/m2. Maximum amount and minimum on November-December-January in the following figure1 [7]. Renewable Energy Research Centre (RERC), Dhaka University is the only source which has got long term measured data of Dhaka Solar

Energy can be a great source for solving the power crisis in Bangladesh. 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.

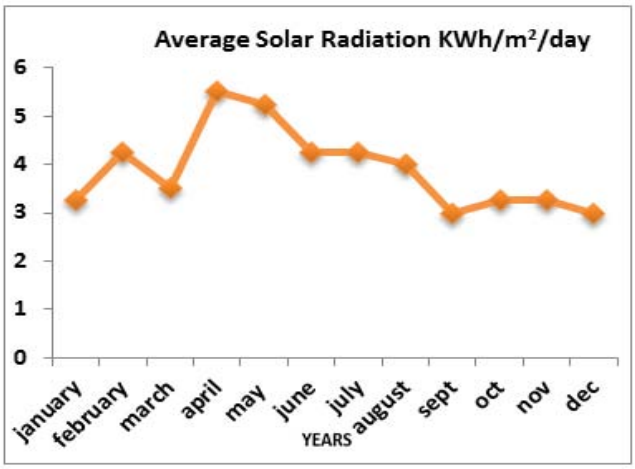

Fig. 1 : Monthly average solar radiation profile in Bangladesh

At this position, the highest and the lowest intensity of direct radiation in W/m^2 are also shown in the following figure2 [8]. So Bangladesh is in a perfect location. In fact, the Bangladesh government has recently taken many steps to encourage people to use photovoltaic energy. Almost every newly built apartment buildings are now using solar panels along with the grid connection to get support during the load shedding period. Even in the rural areas, some NGO's have been working to provide solar panels to the villagers at a cheap price.

Figure-3[9]. Shows that the approximate division wise SHSs installation. The figure3.illuminates that the distribution of the SHSs is highest in Dhaka district whereas lowest in the Sylhet. Now solar power can be calculated from the following equation: Solar power, P_{solar} = (Area per sq- ft × watts per sq-ft).

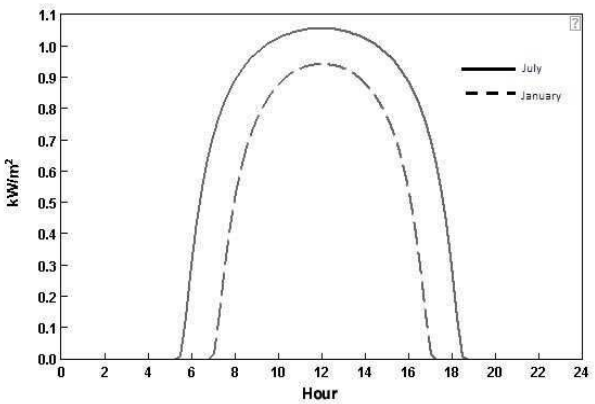

Fig. 2 : The highest and lowest intensity of direct radiation in W/m^2

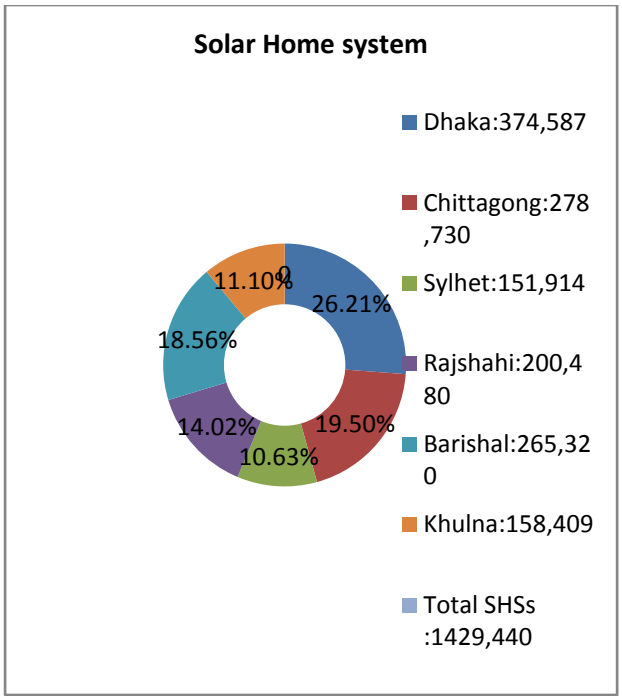

Fig. 3 : Distribution of solar Home system in six divisions of Bangladesh to January2013 [9]

III. Present Condition of Wind Energy

Wind power is the conversion of wind energy by wind turbines into a useful form, such as electricity or mechanical energy. The power is directly proportional to the velocity of the wind. Large scale wind farms are connected to the local power transmission network with small turbines used to provide electricity to isolated areas. Bangladesh is in the midst of a severe energy and power supply crisis, one of the worst in South Asia. Bangladesh has a 724km long coastline and many small islands in the Bay of Bengal, where strong southwesterly trade wind and sea-breeze blow in the summer months and there is a gentle northeasterly trade wind and land breeze in winter months [11]. Along the coastal area of Bangladesh, the annual average wind speed at 30m height is more than 5 m/s [10]. Wind speed in northeastern parts in Bangladesh is above 4.5 m/s while for the other parts of the country wind speed is around 3.5 m/s [10,12]. Some measurements were made by F. Rahman in some coastal areas followed by a year's measurement in Patenga (Chittagong) at a height of 20 m in 1995. It was found that wind speed is higher than the values obtained by the meteorological department. This led to a year-long systematic wind speed study at seven coastal sites in 1996-1997 at a height of 25 m. Bangladesh power development board (BPDB) installed a 160feet tower at the Muhuri Dam site in the Feni district in May 2003. Two high resolution anemometers were installed on this tower, one anemometer at 80 feet and the anemometer at 160 feet height. One wind vane has been installed at 80feet height. The average wind

speed, till to date, at the Muhuri Dam areas is found to be as 6.50 m/s and the wind power density varies from 100 to 250 Watt/m2 in the coastal regions of Bangladesh. For the financial viability of the grid connected wind turbines, the required annual average wind speed is 6 m/s. So, the wind speeds aren't charging for the grid connected wind energy projects in the areas of the Muhuri Dam, Feni. This site is large enough for the larger wind energy projects. Bangladesh Power development board (BPDB) implemented a 1000kW capacity wind battery hybrid power project on the kutubdia island (Bay of Bengal) in the Cox's bazaar district. Under this project, total 50 nos. Of 20 kW capacity stand-alone type wind turbines are being installed. The total capacity of all the wind turbines being stored in a battery bank. WBHPP was officially started on March 30,2008[14]. In another project, Bangladesh power development board (BPDB) has implemented a 0.90MW capacity of the grid connected wind energy (GCWE) at the Muhuri Dam areas in the Feni district in 2004. This is the first ever GCWE project in Bangladesh. Thus generating electricity from wind in the coastal areas can be transmitted to other regions of the country through the high voltage transmission lines. Very little operation and maintenance will be required during the whole life time of wind turbines and no fuel will be required for generating electricity from wind [15].

Table 1 : Feasibility of wind condition at different places of Bangladesh [13]

Site	Reference height(m)	Annual average wind speed(m/s)
Cox's Bazar	10	2.42
Sandip Island	5	2.16
Teknaf	5	2.16
Patenga Airport	5	2.45
Comilla Airport	6	2.21
Khepupara	10	2.36
Kutubdia Island	6	2.09
Bhola Island	7	2.44
Hatia Island	6	2.08

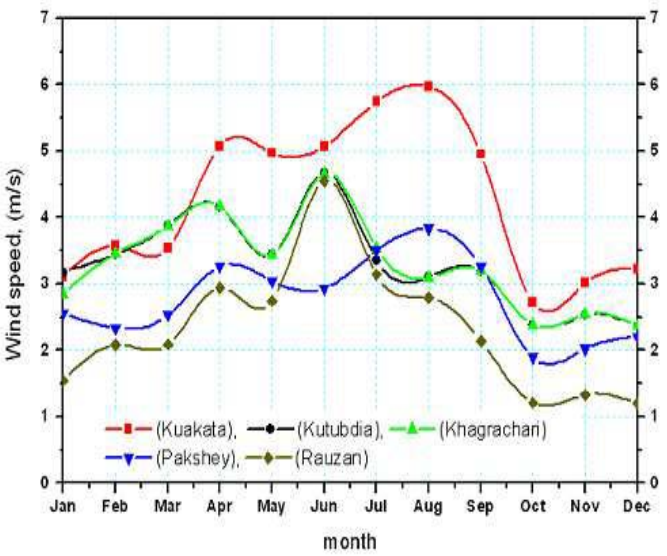

Fig. 4 : Monthly variation of wind speed in five selected sites

From the above figure4, we can see that maximum velocity (5.98 m/s) in the month of August in the place of Kuakata and the minimum velocity (1.20m/s) in the month of December in the place of Rauzan.

Wind power will be calculated from the following equation: $P = (1/2) \times \rho \times A \times V^3$ (in Watts)

Where,

A=area perpendicular to the direction of flow (in m2),

V=wind velocity (ms-1), ρ =density of air (in Kgm-3) and

P=power generation.

Figure 5 : Wind turbines of 1000kw capacity WBHPP at Kutubdia Island, Cox's Bazaar district (Bay of Bengal)

IV. Biogas Energy

Biogas is one kind of a gas which produced by the biological breakdown of organic matter in the

absence of Oxygen. Organic wastes such as dead plant and animal material. Animal dung, and Kitchen waste can be converted into a gaseous fuel called biogas. Biogas originates from biogenic material and is a type of biofuel [16]. Major components of biogas are 40-70% methane (CH4), 30-60% carbon dioxide (CO2) and other gases (1-5%) [17]. It also contains several trace gases like Hydrogen sulfide (H2S), Nitrogen (N2), Ammonia (NH3). and Carbon monoxide (CO) [18]. A biogas based electricity generation system consist of a digester, a biogas collection tank, a generator as well as the piping and controls required for successful operation. The biogas is produced in the anaerobic digester, where anaerobic fermentation takes place which is provided every day with livestock manure in the form of cattle dung. Poultry droppings etc. Grameen Shakti is one of the most uttered NGO in the field of biogas. They have completed 13,500 biogas plants [19]. Recently Seed Bangla Foundation has proposed a 25 KW Biogas based Power plant in Rajshahi [20]. IDCOL. A Government owned investment Company fixed a target to set up 37,669 biogas plants in Bangladesh by 2012, under its National Domestic Biogas and Manure Programmers (NDBMP). It has also set a target of 25% of the total target of biogas plants in the northern region which is yet to be brought under the national gas grid [21]. Besides working in partnership with IDCOL. Some organizations have constructed domestic biogas plants with their own funds. These are Greameen Shakti (3,664 plants), BRAC (3,664 plants of their own), and some other private organizations which promote biogas plants independently [23]. Moreover, since May 2011, IDCOL along with its partner organizations has installed 18,713 biogas plants in different parts of Bangladesh [22].

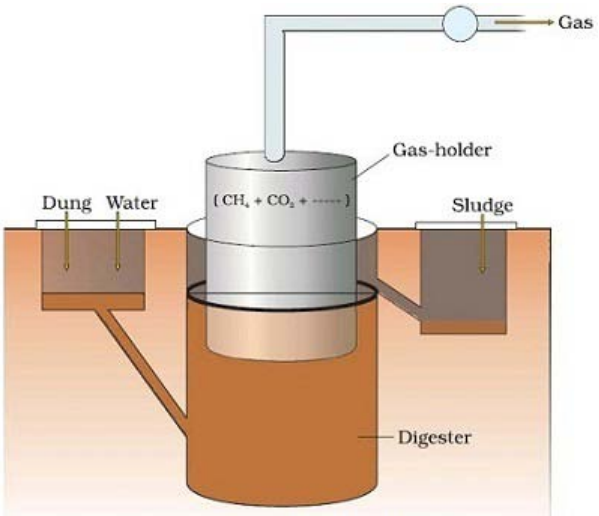

Fig. 6 : Construction of a Typpical Biogas Plant

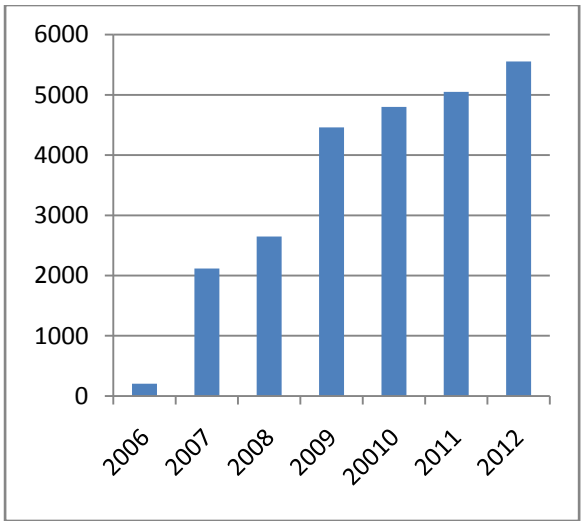

Fig. 7 : Biogas plants constraction in Bangladesh under NDBMP[33]

Graph details:
In 2006: Total biogas plants installed in BD=205.
In2007: Total biogas plants installed in BD =2116.
In2008: Total biogas plants installed in BD =2648.
In2009: Total biogas plants installed in BD =4459.
In2010: Total biogas plants installed in BD =4800.
In2011: Total biogas plants installed in BD =5049.
In2012: Total biogas plants installed in BD =5555.

V. Ocean Wave Energy

Ocean wave energy is generated directly from the waves of the oceans. It is another special type of renewable energy which helps to decrease the harmful emissions of greenhouse gases associated with the generation of power. It can be potentially a significant source of electricity in Bangladesh. Though the main purpose of ocean wave energy is electricity generation, it can also be used for the pumping of water, water desalination etc.[24]."The oscillating Water Column method is technically feasible and becoming economically attractive in this purpose. This type of wave energy harnessing device is being commissioned by several countries such as the United Kingdom (500KW), Ireland (3.5MW), Norway (100KW), India (150 KW) etc. Bangladesh has ocean wave energy from the Bay of Bengal.

VI. Tidal Power

Tidal power can be generated in two ways, 1. Tidal stream generators 2. Barrage generation. The power created though tidal generators are generally more environmentally friendly and causes less impact on established ecosystems. Similar to a wind turbine, many tidal stream generators rotate under water and is driven by the swiftly moving dense water Tidal power or Tidal energy is a form of hydropower that converts the energy of tides into electrical power. As the tides are

more predictable than wind and sunlight, tidal energy can easily be generated from the changing sea levels. The coastal area of Bangladesh has a tidal rise and fall of between 2 to 5 meters [25]. Among these coastal areas, with 5 meter tides experienced, sandwip has the best prospect to generate tidal energy [25]. Bangladesh can generate tidal power from these coastal tidal resources by applying Low head tidal movements and Medium head tidal movements, Low head tidal movements which uses tides of height within 2m to 5m can be used in areas like Khulna, Barisal, Bagerhat, Satkhira and Cox's Bazaar regions and the height tidal movements which use a more than 5m of tides can be mainly used in Sandwip. So we can say that with suitable tidal height available, this can be a great source of energy for Bangladesh.

VII. Geothermal Energy

Geothermal energy is a very powerful and efficient way to extract a renewable energy from the earth through natural process. This can be performed on a small scale to provide heat for a residential unit, or on a very large scale for energy production through a geothermal power plant. Geothermal power is cost effective, reliable and environmentally friendly but it has previously been geographically limited to areas near tectonic plate boundaries. With this technology, we can use the steam and hot water produced inside the earth's surface to generate electricity. Geothermal energy is generated about 4,000 miles below the surface, in the earth's core [26]. The process takes place due to the slow decay of radioactive particles, the high temperature produced inside the earth and it happens in all rocks [26]. About 10,715 megawatts (MW) of geothermal energy is generated in 24 countries worldwide [26]. The northern districts of Bangladesh show the prospect to explore the geothermal resources. The demand for electricity in urban as well as in the rural areas is increasing, but our production of electricity is not increasing. The rural demand for electricity can be covered by the production of electricity through geothermal energy.The electricity demand of urban areas can be met then by these saved electricity which is supposed to be provided in the rural areas. Geothermal energy can balance the electricity consumption in these two areas. According to Reference [27], a Dhaka based private company namely Anglo MGH Energy has initiated a project to set up the country's first geothermal power plant with a capacity to produce 200 MW of electricity close to Saland in Thakurgaon district. They have planned to set up 28 deep tube wells to lift hot steam and the lifted steam will be used to run a turbine and the turbine is connected to the generator to generate electricity [27]. From the above discussion it is clear that geothermal energy can also be a great source of harnessing electrical energy in Bangladesh.

VIII. Hydro Power

Kinetic energy from flowing or falling water is exploited in hydropower plants to generate electricity. Hydropower plants are classified into two categories: 1. Large hydropower plants (>10 MW), usually with reservoirs, that can not only produce electrical energy Continuously, but also are able to adjust their output according to electricity demand and 2. Small hydropower plants (<10 MW) that are less flexible with respect to load or demand fluctuation due to their dependence on the water resource [28]. In Bangladesh about 1.4 trillion cubic meters (m^3) of water flows through the country in an average water year. Major rivers of the country have a high rate of water flow of about 5 to 6 months during monsoon season, which is substantially reduced in winter season. More than 90% of Bangladesh's rivers originate outside the country, due to which proper planning of water resource is difficult without neighboring countries' cooperation. Downstream water sharing with India is a highly contentious issue in Bangladesh. The annual average rainfall is about 2,300 mm, which varies from 1,200 mm in the north-west to 5,800 mm in the northeast. Most of the rainfall (about 80%) occurs during the months of May/June to September/October [29]. At present only 230 MW of hydro power is utilized in Karnaphuli, Rangamati hydro station, which the only hydroelectric power plant operated by BPDB [30]. Micro-hydro and mini-hydro have limited potential in Bangladesh, with the exception of Chittagong and the Chittagong hill tracts. Hydropower assessments have identified some possible sites from 10 kW to 5 MW but no appreciable capacity has yet been installed [31].

IX. Calculation of the Total Power

The individual power equations and total power equation are given below:

Solar power, Psolar = (Area per sq- ft × watts per sq-ft)

Wind power, $Pwind = (1/2) \times \rho \times A \times V^3$

Where,

A=area perpendicular to the direction of flow (m^2),

V=wind velocity (in ms-1),

ρ =density of air which is about 1.2 Kgm-3.

Biogas generator power, $P_{biogas}(W) =$

$$\frac{50\% \text{ of } 100 \text{ kgs pes day animal waste} \times 1000}{2 \text{ kgs animal waste per kwh} \times 5 \text{ hours operation a day per year}}$$

Hydro power, P_{hydro} (W) = H × Q × g × 1000
Where, H=Gross water head (in meter),
Q=Flow of water (in m3/sec) and
g=Gravitation force i.e. 9.81 (in ms-2)
Now,
The total power, PT (W) $=P_{solar} + P_{wind} + P_{hydro} + P_{biogas}$

X. Conclusion

The summary of this paper exhibits that, there is a considerable opportunity of Bangladesh to meet its future power demand and thus economic growth through renewable resources. Renewable energy sources discussed above can help Bangladesh to produce more power in order to reduce Load-shedding problem. Time has come to look forward and work with these renewable energy fields to produce electricity rather than depending wholly on conventional method. With the help of these resources Bangladesh can generate electricity &May able to meet the required demand in the future. Therefore, the Government and the Private sector should work hand to hand to emphasize more on renewable energy sources to produce electricity to solve our power crisis problem.

References Références Referencias

1. http://en.wikipedia.org/wiki/Bangladesh.
2. "Bangladesh Gazette: Renewable Energy Policy of Bangladesh 2008", published in November 06, 2008. http://lib.pmo.gov.bd/.pdf
3. http://www.powerdivision.gov.bd/index.php?page_id=263
4. Ministry of Power, Energy and Mineral Resources, Govt. of the People's Republic of Bangladesh, *Renewable energy policy of Bangladesh*, Dhaka, Bangladesh, Nov. 2008.
5. A.K.M. Sadrul Islam, M. Islam and Tazmilur Rahman, "Effective renewable energy activities in Bangladesh," *Renewable Energy*, vol. 31, no. 5, pp. 677-688, Apr. 2006.
6. M.A.R. Sarkar, M. Ehsan and M.A. Islam, "Issues relating to energy conservation and renewable energy in Bangladesh," *Energy for Sustainable Development,* vol. 7, no. 2, pp. 77-87,Jun. 2003.
7. KhairulAnam, Husnain-Al-Bustam, "Power Crisis & Its Solution through Renewable Energy in Bangladesh", Cyber Journals: Multidisciplinary Journals in Science & Technology, Journal of Selected Areas in Renewable and Sustainable Energy (JRSE), and September-2011.
8. KazyFayeenShariar, Enaiyat Ghani Ovy, Kazi Tabassum Aziz Hossainy, "Closed Environment Design of Solar Collector Trough is using lenss and reflectors", World Renewable Energy Congress 2011, Sweden.
9. Renewable energy projects, IDCOL solar energy program, (2012, March). URL: http://www.idcol.org/prjshsm2004.php.
10. M.J. Khan, M.T. Iqbal, S. Mahboob, "A wind map of Bangladesh," Renewable Energy (2004),Volume: 29, Issue: 5, Publisher: Elsevier, Pages: 643-660, ISSN: 09601481, DOI: 10.1016/j.Renene.2003.10.002.
11. Dr. A. Hossain, "Wind Energy in Bangladesh," Sustainable Development Networking Program.
12. T.V. Ramachandra, B.V. Shruti, "Wind energy potential mappings in Karnataka, India, using GIS," Energy Conversion and Management 46 (2005) 1561-1578, doi:10.1016/j.enconman.2004.07.009.
13. M. S. Kaiser, M. A. Rahman, M. M. Rahman, and S. A. Sharna, "Wind energy assessment for the coastal part of Bangladesh," Journal of Engineering and Applied Sciences, vol. 1, no. 2, pp. 87-92, **(for feasible chart).**
14. Islam, A., M. Islam, and T. Rahman, "Effectiverenewable energy activities in Bangladesh. Renewable Energy", **31**(5): p. 677-688, 2006.
15. M. S. Kaiser, M. A. Rahman, M. M. Rahman, and S. A.Sharna, "Wind energy assessment for the coastal part of Bangladesh," Journal of Engineering and Applied Sciences, vol. 1, no. 2, pp. 87-92, 2006..
16. Website of Wikipedia on biogas. Available at: http://en.wikipedia.org/wiki/Biogas.
17. U. Rehling, Small biogas plants. Sustainable energy systems and management (SESAM), University of Flensburg, Germany, 2001.
18. Description of the biggest production in an agricultural biogas plant. Available at:http://www.bios-bioenergy.at/en/electricity-from-biomass/biogas.
19. A successful Renewable Energy Program in Bangladesh, "International Conference on Conservation, Energy Efficiency & Solar," Organized by Pakistan Engineering Council and USAID October 25-29, 2010, Islamabad, Pakistan.
20. Seed Bangla website. Available at: http://www.seedbangla.com.
21. The Financial Express. Available at:http://www.thefinancialexpressbd.com/more.php?date=2011-02-06&news_id=125260.
22. Infrastructure Development Company Limited (IDCOL). Availableat: http://www.idcol.org/biogass_installation.php.
23. M. ZunaidBaten, E.M. Amin, A. Sharin, R. Islam, S. A. Chowdhury, "Renewable Energy Scenario of Bangladesh: Physical Perspective," International Conference on the Developments in Renewable Energy Technology (ICDRT) 2009, Dhaka, Bangladesh.
24. Banglapedia, National Encyclopedia of Bangladesh. Available at: http://www.bpedia. org/R_0175.php

25. Md. Mahbubuzzaman, M. Shahidul Islam, Md. Mahfuzar Rahman, "Harnessing tidal power", News Paper Article, The Daily Star. Available at: http://www.thedailystar.net/newDesign/print_nes.php?nid=146470.
26. Ingvar B. Fridleifsson, RuggeroBertani, Ernst Huenges, John W. Lund, ArniRagnarsson, RybachLadislaus (2008-02-11), O. Hohmeyer and T. Trittin, ed., *The possible role and contribution of geothermal energy to themitigation of climate change*, Luebeck, Germany, pp. 59–80, retrieved 2009- 04-06.
27. Anglo MGH Energy Plans to set up Bangladesh's first geothermal power plant. Available at: http://www.powereng.com/articles/2011/03/anglo-mghenergy- plans.html
28. M. A. H. Mondal, "Implications of renewable energy technologies in the Bangladesh power sector: long-term planning strategies," Ph.D. dissertation, Dept. of Ecology and Natural Resources Management, ZEF, University of Bonn, Germany, Jul. 2010.
29. A. K. Azad (2011), "A Review on Renewable Power Sources: Prospects of Bangladesh and Scotland," EBook, St. Andrew's University, Scotland, UK. Available:http://pdfmio.com/download/renewablepower.
30. S. Moury, and R Ahshan, "A feasibility study of an on-grid solar home system in Bangladesh," Proc. of the IEEE ICDRET, Dhaka, Dec. 2009.
31. Renewable Energy Policy of Bangladesh, Power Division, Ministry of Power, Energy and Mineral Resources, Bangladesh, Nov. 2008.
32. Prospect of solar energy in Bangladesh prepared by Dhaka University.
33. SNV Domestic biogas news letter, issue 4, January 2011.