



The Renewable Energy and Sustainable Development: A Case Study of Bangladesh

K. M. Anwarul Islam¹, Umme Salma²

¹Department of Business Administration, the Millennium University, Dhaka, Bangladesh

²Department of Computer Science and Engineering, Bangladesh University, Dhaka, Bangladesh

Email address:

ai419bankingdu@gmail.com (K. M. A. Islam), ummesalma.cse@gmail.com (U. Salma)

*Corresponding author

To cite this article:

K. M. Anwarul Islam, Umme Salma. The Renewable Energy and Sustainable Development: A Case Study of Bangladesh. *International Journal of Finance and Banking Research*. Vol. 2, No. 4, 2016, pp. 139-146. doi: 10.11648/j.ijfbr.20160204.13

Received: January 23, 2016; **Accepted:** May 17, 2016; **Published:** June 30, 2016

Abstract: Bangladesh is facing daunting energy challenges. Security concerns over growing fuel imports, limited domestic energy resources for power generation, and projected demands for electricity that will exceed domestic supply capabilities within a few years. By acknowledging the potential of renewable energy resources, the country could possibly meet its unprecedented energy demand, thus increasing electricity accessibility all and enhancing energy security through their advancement. The integration of renewable energy technologies in the power sector through national energy planning would, therefore, is a step in the right direction, not only for sustainable development of the country but also as part of Bangladesh's responsibility toward the global common task of environmental protection. This research paper examines the potential of renewable energy sources for power generation in Bangladesh from the viewpoint of different promising available technologies. The analysis shows a substantially higher implementation of renewable energy technologies compared to the base scenario. Renewable energy technologies, especially solar photovoltaic, play an important role in achieving acceptable energy security.

Keywords: Sustainable Energy, Renewable, Bangladesh, Power, Solution, Electricity

1. Introduction

Electricity is a very important factor in developing the economy and the standard of living of a country. It must be generated using the national resource of that country. Bangladesh largely depends on natural gas and hydro power stations to generate major portion of power. The country lags behind than its expected production capacity. Though many power generation units have been added to the national grid to solve the power crisis issue, it is not enough. High demand and increasing need of power have created challenge for the power stations to meet the demand. In our country, a major portion of total population still does not have the access to electricity. Only 10% of the rural households have electricity connection and there are some parts of Bangladesh which will not get the access of electricity connection from the national grid within next 30 years [1]. To solve this energy crisis we can use different form of renewable energy to

generate power. Renewable energy is the energy that comes from different types of natural resources mainly from sunlight, wind, rain, tides, and geo thermal heat, biodiesel, bio fuel etc.

1.1. Problem Statement

The measure of development in any society of today is synonymous with the level of energy consumption. Energy is therefore recognized as a critical input parameter for national economic development. Modern day energy demands are still met largely from fossil fuels such as coal, oil and natural gas. In 1980, the global primary energy demand was only 7228 million tons of oil equivalent (mtoe) but this had increased to 11429 mtoe by 2005 (WEO 2007). Further increases can be expected, mostly in connection with increasing industrialization and demand in less developed countries, aggravated by gross inefficiencies in all countries. Fossil fuels provide energy in a cheap and concentrated form, and

as a result they dominate the energy supply. In the worldwide total energy demand, the share of fossil energy is around 80%, while the remaining 20% are supplied by nuclear and renewable energy (Rout 2007). In 2005, a total of 26.6 billion tons of CO₂ emissions were generated world-wide of which more than 41% was from power generation based on fossil fuels (WEO 2007). The CO₂ emissions from power generation are projected to increase 46% by 2030 (WEO 2007). In 1980, total global electricity generation was 8027 terawatt hour (TWh), which had increased to 17363 TWh by 2005. The installed capacity of power generation was 1945 gigawatt (GW) in 1980 and had increased to 3878 GW by 2005 (EIA 2010) of which almost 69% was from conventional fuels. The main problem is that in the next 20 years the expected demand for electricity would require the installation of the same power generation capacity that was installed over the entire 20th century. This translates to the stunning number of one 1000 megawatt (MW) power station installed every 3.5 days over the next 20 years (Lior 2008). The concentration of greenhouse gases (GHGs) in the atmosphere has been increasing for a variety of reasons. CO₂ in the atmosphere is increasing as a result of the burning of fossil fuels. Global warming and mitigation of GHGs is presently the major issues of international concern. The Intergovernmental Panel on Climate Change (IPCC) was set up in 1988 to study different aspects of climate change. One aspect is the progressive gradual rise of the earth's average surface temperature, thought to be caused in part by increased concentrations of GHGs in the atmosphere. This so-called global warming is commonly described as climate change, although it is only one of the changes that affect the global climate.

Sustainable development can be broadly defined as living, producing and consuming in a manner that meets the needs of the present without compromising the ability of future generations to meet their own needs (Twidell and Weir 2006). Energy development is increasingly dominated by major global concerns of air pollution, fresh water pollution, coastal pollution, deforestation, biodiversity loss and global climate deterioration. To prevent disastrous global consequences, it would increasingly be impossible to engage in large-scale energy-related activities without insuring their sustainability, even for developing countries in which there is a perceived priority of energy development and use and electricity generation over their impact on the environment, society, and indeed on the energy resources themselves. The long-term control of global climate change and holding the climate at a safety levels requires a connection of policies for climate change to sustainable development strategies in all nations.

Over the last few decades, a decline in fossil fuels reserves has been observed worldwide. Alternately, fossil fuels are not being newly formed at any significant rate, and thus present stocks are ultimately finite. If the current rate of energy consumption is continued, the limited reserves of coal, oil and natural gas may last only for 122, 42 and 60 years, respectively (BP 2009; Lior 2008). The amount of uranium in the world is insufficient for massive long-term deployment of

nuclear power generation (BP 2009; Lior 2008). Therefore, the sustainable development issue is more than ever raised, stimulating the need to search for a sustainable development path.

1.2. Literature Review

Since the 1980s, sustainability and environmental responsibility attracted considerable academic research (Deegan, 2002; Gray, 2002; Mathews, 1995). Research on voluntary disclosure has attempted to examine the nature and patterns of sustainability and environmental disclosure and investigates the determinants of these disclosure such as size, profit, and industry affiliation (Cormier and Magnan, 2003). The literature recognizes that sustainability and environmental practices across countries (Adams et al., 1998b) and between developed and developing countries (Imam, 2000). Further, the nature and patterns of sustainability and environmental disclosure vary between industry sectors (Gray et al., 2001). Surveys of sustainability and environmental disclosure practices in western developed countries reveal that companies place the greatest emphasis on human resources disclosures (Gray et al., 2001) such as employee numbers and remuneration, equal opportunities, employee share ownership, disability policies, and employee training. Moreover, the vast majority of disclosures are qualitative in nature.

In a study of 150 companies in the US, UK and Australia Guthrie and Parker (1990) found that 85% of US, 98% of UK, and 56% of Australian companies made some social disclosures in their annual reports. This study indicated that more than 40% of these companies reported human resource issues, 31% reported community involvement, 13% reported environmental activities, and 7% reported energy and product related issues. It also revealed the average number of pages that organizations in these countries allotted for social disclosures. Companies in the US used 1.26 pages while 0.89 and .70 pages were used in the UK and Australia respectively.

However, it would be inappropriate to generalize the results of studies of developed nations to newly developed countries because the stage of economic development is likely to be an important factor affecting sustainability and environmental disclosure practices. In the context of emerging economies, a few studies have focused on companies in countries such as Malaysia, Singapore, and Hong Kong. For example, a study of 100 public companies in Malaysia showed that 66% of the companies made some kind of social reporting (Kin, 1990). Of these, 64 companies reported human resource issues and 22 companies disclosed community involvement issues. A similar study in Hong Kong revealed that 6% companies disclosed social activities with an emphasis on staff development and community relations (Lynn, 1992). The number of pages dedicated to such disclosures ranged from 0.25 to 3 pages. Ng (2000) found that 9% of the 200 HK listed companies reported environmental information in published accounts. However, no company disclosed financial data concerning environmental performance. Disclosures appeared in the

directors' report or the chairman's statement. Such disclosures were general statements indicating company support for environmental protection and describing projects to reduce pollution and save energy and resources.

There are multiple theoretical reasons why the companies should do sustainability reporting, some companies' still not doing this because of not having that information; it signals bad performance; or because of the expense. However, worldwide there is an increasing trend of sustainability and environmental reporting. An international survey of corporate sustainability reporting conducted by KPMG in 2008 found that 70 per cent of the world's 250 largest companies issued separate reports on sustainability and environmental responsibility in 2008 compare to their finding of 52 per cent in 2005. At national level, the two top countries in terms of separate sustainability and environmental reporting are Japan (88% in 2008; 80% in 2005) and the United Kingdom (84% in 2008; 71% in 2005). There were 8 and 13 percentage point increases in stand-alone reports in Japan and UK respectively in last 3 years. This escalation signals the significance of sustainability and environmental disclosure (KPMG, 2008). However, South East Asian countries such as India, Pakistan, and China are still low in these practices.

Nevertheless, there is a change in the way companies report sustainability and environmental practices. From using a section in the annual report, companies are now moving to stand-alone reports (KPMG, 2008). Global Reporting Initiative (GRI) has elaborated guidelines for preparing social or sustainability reports. Many companies use this guideline as a framework to build their social reports (Raman, 2006).

As expectations for disclosure of information on environmental and social performance have grown, so have demands for information in a standardized way that allows readers to compare company performance. A number of broadly recognized standards are particularly relevant to sustainability and environmental disclosure including the GRI Sustainability Reporting Guidelines, Accountability Assurance Standard 1000 & 1000S, and the ISO 14001 Series. The GRI Guidelines focus on issues that should be reported (Maitland 2002a,b). GRI develops these reporting guidelines using a global consensus-seeking process that involves reporting organizations such as companies, as well as report readers and users like employees, investors, and non-governmental organizations. GRI issues its first set of guideline in 2000, the second in 2002 (known as G2 guideline) and the third in late 2006 (G3 Guideline) (KPMG, 2008); AAS 1000 & 1000S focus on the processes of reporting and auditing. A focus on processes, and, in particular, the involvement of stakeholders through a robust process of dialogue, is likely to result in a company properly discharging accountability rather than simply complying with a list of disclosure items (Adams, 2004).

2. Objectives of Research

- To examine the potential contribution of renewable energy to the power supply in Bangladesh.

- To identify the Sustainable Development of energy system for the Bangladesh power sector.

3. Research Methodology

Annual reports, in general, are considered appropriate documents for studying sustainability and environmental disclosures as they are common and popular means of communication to stakeholders and command credibility (Guthrie and Parker, 1990; Singh and Ahuja, 1983; Adams, 2004; Gray et al., 1995a, 1995b; Raman, 2006). As this is argument is also valid in Bangladesh, to analyze the extent of sustainability and environmental reporting by Bangladesh companies, annual reports were used as a primary sources document. Separate corporate sustainability and environmental disclosure reports by public listed limited companies published between 1 July 2007 and 30 June 2008 were also reviewed. Taking 2007-2008 as the target year, 263 companies were listed on the Dhaka Stock Exchange (DSE). The unavailability of 17 reports reduced this number to 246. This represents 93.53% of listed companies.

According to the findings, 25 companies or 10.16% of companies made disclosures relating to corporate sustainability and environmental performance. Therefore, 221 companies or 89.83% of companies made no information available in their annual report. These 25 reporting companies were systematically analyzed using the technique of content analysis. This technique is defined _as a method of copying the text (or content) of a piece of written work into various categories on the basis of selection criteria' (Krippendorf, 1980, p. 21). This technique has been used in other studies (Guthrie and Parker, 1990; Raman, 2006). Content analysis employs a three-step process (Raman, 2006). First, an appropriate document is chosen. For this study, Director's report, Chairman's report, Separate section of annual report and separate sustainability reports were chosen.

The second step is to determine the unit for measuring contents. Different researchers use different units of measure. For example, Zeghal and Ahmed (1990) used the number of words, Hackston and Milne (1996) the number of sentences, and Gray et al., (1995b) the number of pages. Indeed there has been considerable debate about these different measures (Gray et al., 1995; Milne and Adler, 1999; Unerman, 2000). For example, in the case of pages, some researchers do not consider font size, line spacing, and page margins. Others argue that words would have no meaning unless they are part of a sentence. Raman (2006) argues that pages are a preferable measure since they can be easily counted and involve less judgment. Thus, in this study the unit of measure is number of pages. As different companies use different measurement size, line spacing, and page margins, to be consistent we typed them in a different word file and measure the portion of pages use by them. Previous sustainability and environmental researches (such as, Imam, 2000; Belal, 2000, 2001; Hossain et al., 2006) did not take this fact into consideration.

The third step of content analysis involves identification of themes or categories into which blocks of content can be classified. The earlier work of Ernst and Ernst (1978), Guthrie and Parker (1990), and Gray et al., (1995a) is used to categorize information into four dimensions: Theme, Form, Amount and Location. Theme was based on categories such as environment and energy. The form of disclosure includes quantified data, either monetary or non-monetary, and qualitative or declarative data. Amount measures the proportion of pages devoted to sustainability and environmental responsibility issues. Location refers to directors' report, Chairman's report, Separate section of annual report and separate or stand alone report.

The relevant 25 annual reports from DSE are examined to identify the type and extent of disclosures in relation to corporate sustainability and environmental disclosure. (Mohammad I. Azim and Samina Rahman, 2012).

4. Present Energy situation in Bangladesh

Electricity is a pre-requisite for the technological development and economic growth of a nation. The future economic development of Bangladesh is likely to result in a rapid growth in the demand for energy with accompanying shortages and problems. The country has been facing a severe power crisis for about a decade. Known reserves (e.g., natural gas and coal) of commercial primary energy sources in Bangladesh are limited in comparison to the development needs of the country (Islam 2001a). Power generation in the country is almost entirely dependent on fossil fuels, mainly natural gas, that accounted for 81.4% of the total installed electricity generation capacity (5248 MW) in 2006 (BPDB 2006). By that year, only about 42% of the total population had been connected to electricity (Jamaluddin 2008), with vast majority being deprived of a power supply. The government of Bangladesh has declared that it aims to provide electricity for all by the year 2020, although at present there is high unsatisfied demand for energy, which is growing by more than 8% annually (PSMP 2005). Demand-supply gaps and load shedding have increased.

Coal is expected to be the main fuel for electricity generation. The government of Bangladesh has planned to generate 2900 MW power from coal in the next 5 years (Khan 2009), although coal power has adverse environmental effects and coal reserves are limited. The government has also focused on furnace-oil-based peaking power plants. As a result, the share of CO₂ emissions coming from fossil-fuel-based power plants in the national CO₂ inventory is expected to grow, and there is a growing dependency on imported fossil fuels for power generation.

Increasing the use of fossil fuels to meet the growing worldwide electricity demand, especially in developing countries, not only counteracts the need to prevent climate change globally but also has negative environmental effects locally. In Bangladesh, the power sector alone contributes 40%

to the total CO₂ emissions (ADB 1998; Shrestha et al. 2009). In this case, it is necessary to develop and promote alternative energy sources that ensure energy security without increasing environmental impacts.

Bangladesh is facing daunting energy challenges: Security concerns over growing fuel imports, limited domestic energy resources for power generation, and projected demands for electricity that will exceed domestic supply capabilities within a few years.

By acknowledging the potential of renewable energy resources, the country could possibly meet its unprecedented energy demand, thus increasing electricity accessibility to all and enhancing energy security through their advancement. The integration of renewable energy technologies in the power sector through national energy planning would be, therefore, the right direction, not only for sustainable development of the country but also as the responsibility of Bangladesh toward the global common task of environmental protection. In order to avoid long-term impacts, it is necessary to conduct energy planning by generating transient scenarios for demand and the corresponding requirement of energy sources under the constraints of availability, cost and pollution. The present study is one of the first efforts in this direction. It concentrates on the Bangladesh power sector only, as this has become one of the most critical sectors in the country's economy and is a major bottleneck with respect to development.

5. Contribution of Renewable Energy to the Power Supply in Bangladesh.

5.1. Solar Energy

The energy from sunlight reaching the earth is a huge potential that can be exploited and used for generating electricity. Among several available technologies, solar PV is the most promising. PV technology converts sunlight into direct current (DC) electricity. When light falls on the active surface of the solar cell, electrons become energized and a potential difference is established, which drives a current through an external load. The central issue with PV technology is cost. The unit cost of PV has sunk in several orders of magnitude while the efficiency is continuously being improved (Brown and Hendry 2009; Gottschalg 2001; Green 2004; Ramana 2005; Van der Zwaan and Rabl 2003). Solar PV is becoming more and more popular owing to high modularity, no requirement for additional resource (e.g., water and fuel), no moving parts and low maintenance required.

Over the last two decades, the cost of manufacturing and installing solar PV system has decreased by about 20% for every doubling of installed capacity (Brown and Hendry 2009). The solar industry has grown at a rate of 35% per year over the last ten years (BP 2010).

5.2. Solar Home System

The system consists of a 20-100 watt peak (Wp) PV array¹,

a rechargeable battery and a charge controller. Both the array size and sunlight availability determine the amount of electricity available for daily use (WB 1996). With an appropriate sunlight regime, the system has proven to be competitive for remote households. The SHS is thus implemented in many developing countries. In Bangladesh, by the end of 2008 a total of about 350,000 SHSs had been installed (IDCOL 2008).

5.3. Hybrid System

When renewable energy technologies are used in decentralized and remote areas, they can be coupled with diesel generators to improve the total system reliability. Wind diesel generator-battery, wind-solar PV-diesel generator-battery, PV-diesel generator battery hybrid can be used for generating electricity in the rural areas of Bangladesh.

5.4. Wind Energy

The energy from continuously blowing wind can be captured using wind turbines that convert kinetic energy from wind into mechanical energy and then into electrical energy. Electricity generated by wind turbines can feed to the central grid or be locally consumed using small stand-alone wind turbines.

5.5. Biomass

Biomass covers all kinds of organic matter from fuel wood to marine vegetation. Biomass is the fourth largest source of energy worldwide and provides basic energy requirements for cooking and heating of rural households in developing countries. Energy generation using biomass offers a promising solution to environmental problems by reducing the emission of common greenhouse gases. A wide range of options exists for conversion of biomass into energy such as heat energy and electrical energy. Two widespread technologies are direct combustion and gasification.

Direct combustion involves the oxidation of biomass with excess air, producing hot flue gases which in turn produce steam, which is used to generate electricity. In a condensing steam cycle only electricity is produced, while in an extracting steam cycle both electricity and steam are generated (DOE 1997).

Gasification involves conversion of biomass to produce a medium or low calorific gas. The gained gas is then used as fuel in combined cycle power generation plants. Being produced in combined cycle power plants, electricity from this technology has higher efficiency and is more competitive than that from a steam turbine. Biogas is a mixture of CH₄ (40 – 70%), CO₂ (30 – 60%) and other gases (1 – 5%) produced from animal dung, poultry droppings and other biomass wastes in specialized bio-digesters (Rehling 2001). This gas is combustible and can be used to generate electricity.

5.6. Hydro Energy

Kinetic energy from flowing or falling water is exploited

in hydropower plants to generate electricity. Hydropower plants are divided into two categories: 1) Large hydropower plants (>10 MW), usually with reservoirs, that cannot 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. Hydropower technologies are mature and widely available.

6. Sustainable Development of Energy System for the Bangladesh Power Sector

In Bangladesh, utilization of renewable energy in remote and isolated areas could enhance electricity accessibility and hence lift peoples' living and social standards. Bangladesh has considerable potential for using renewable energy sources including biomass, solar photovoltaic (PV), wind and to a limited extent, small hydropower (Sarkar, M.A.R., M. Ehsan, and M.A. Islam, 2003) (Islam, A.K.M.S., M. Islam, and T. Rahman, 2006). Biomass accounted nearly 50% of total energy supply in 2004 (Hossain, I. and M. Tanim, 2005) and supplied 98% of total renewable energy (IEA/OECD, *Renewables Information* 2004). Compared to other renewable energy technologies, such as improved cooking stoves and biomass briquetting, initiatives involving the installation of solar home systems are flourishing (Siddiqui, F.A., 2003). This is largely due to the initial initiative of the *micro-credit* program of *Grameen Shakti* (Timilsina, G., T. Lefevre, and S.N. Uddin, 2001) and recent initiatives of the Infrastructure Development Company Limited (IDCOL) to promote solar home systems (SHS) under the Rural Electrification and Renewable Energy Development Project (REREDP) with financing from both government and international organizations [IDCOL, 2005]. A more detailed status of renewable energy applications in Bangladesh is given in (Uddin, S.N., R. Taplin, and X. Yu, 2006). IDCOL's solar energy program is one of the fastest growing renewable energy programs in the world as it had already installed 50,000 SHSs by 2005, which was much faster than the expected completion schedule by 2008. IDCOL expects to finance an additional 200,000 SHSs by 2009 under the same program (IDCOL, 2005). These initiatives are expected to change the living standard in remote rural locations of Bangladesh through providing access to electricity. Intervention from Government institutions, international organizations and the private sector has facilitated dissemination of renewable energy technologies on-the-ground in Bangladesh since early 1980s. Pilot programs and schemes have been initiated to implement solar PV, SHSs, biogas technology and improved cooking stoves (Sarkar, M.A.R., M. Ehsan, and M.A. Islam 2003), (Siddiqui, F.A., 2003), (IDCOL, 2005). Unfortunately, most of these initiatives have not continued after the completion of the pilot schemes. This has been due to a lack of local

stakeholders' interest (Biswas, W.K., P. Bryce, and M. Diesendorf, 2001). However, some steps have been taken to integrate local communities and other stakeholders in decision-making processes to address this problem. Local business entrepreneurs and local population of both genders have been encouraged to actively participate in these programs. For example, IDCOL's National Program on Domestic Biogas is focusing on engagement of multi stakeholders (Ghimire, P.C., 2005) and manufacturing of battery operated lamps by rural women has been initiated under the Coastal Electrification and Women's Development Micro-Enterprise project (CEWDM) (ESMAP, 2004), (Khan, H.J, 2003). As such, there has been mixed success with certain projects and most renewable energy development and promotion schemes have been confined to demonstration or pilot scale implementation stage to date in Bangladesh (Uddin, S.N., R. Taplin, and X. Yu, 2006). Bangladesh has considerable potential for Clean Development Mechanism (CDM) schemes under the Kyoto Protocol and, in particular, sustainable energy projects. To date, only two CDM projects have been registered from Bangladesh and several projects are in the pipeline (Fenhann, J., 2006). However, the process of developing CDM schemes has been slow as only few projects are at different stages of CDM project cycles. Reasons for this include: a lack of understanding of CDM modalities and procedures; a lack of human capacity; a lack of understanding of the new investment scheme under CDM; high transactional costs for CDM activities; and significant uncertainties with regard to the future of CDM and the Kyoto Protocol after the first commitment period from 2008-2012 [Muller, A., 2005].

7. Conclusion

In Bangladesh, diffusion of renewable energy technologies has gained momentum in recent years via evolution of relevant policies, institutional facilitation and learning-by-doing experience. However, current policy measures and institutional structures that have been put in place should be considered only as initial steps towards further development of sustainable energy. Mechanisms to enhance the participation of stakeholders including the private sector, non-governmental organizations and to mobilize financial resources need to be addressed. Also Bangladesh still lacks a strong policy framework and appropriate measures in order to enhance sustainable energy development. A number of innovative and practical approaches have been examined in this paper for a sustainable energy future in Bangladesh. Superiority of any kind of policy measures and approaches is yet to be confirmed. This is because the success of any policy measure or approach will depend on the political, administrative and socio-economic conditions in Bangladesh on the one hand, and the specific support mechanisms on the other. It is important to note that, introduction of new technologies requires concrete strategies and mechanisms before any benefits can be obtained or niche markets realized. Current policy and institutional settings should be taken as a

basis for steps towards this process. Also, implementation of sustainable energy projects under the Clean Development Mechanism (CDM) of the Kyoto Protocol could contribute to a sustainable energy future in Bangladesh. Implementation of CDM under the Kyoto Protocol may overcome many barriers and may facilitate the advancement of sustainable energy projects in Bangladesh. Since Bangladesh is at the initial stage of CDM development, it is however, too early to draw any definite conclusion regarding achievements to date. On-the-ground experience and learning-by-doing with CDM projects, formulation of nation-specific policies for CDM, and further institutional development should help Bangladesh in advancing towards a sustainable energy future. Further, nationwide development of electricity and natural gas infrastructure (transmission and distribution networks as well as decentralized systems where applicable) could enhance both electricity accessibility and energy security in Bangladesh.

References

- [1] Adnan Jamil, "Biogas and Cattle Organs: An Alternative Significant Source of Energy for Sustainable Development in Rural Bangladesh", Student Thesis, Institutionen för livsvetenskaper, 2008. Available at: <http://urn.kb.se/resolve?urn=urn:nbn:se:sh:diva-1617>
- [2] WEO (2007) World energy outlook, 2007, International Energy Agency
- [3] Rout UK (2007) Modelling of endogenous technological learning of energy technologies-an Analysis with a Global multiregional energy system model. Dissertation, University of Stuttgart
- [4] Lior N (2008) Energy resources and use: The present situation and possible paths to the future. *Energy* 33: 842-857
- [5] Twidell J and Weir T (2006) Renewable energy resources, Taylor & Francis, USA
- [6] BP (2009) British Petroleum statistical review of world energy, June 2009. http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2008/STAGING/local_assets/2009_downloads/statistical_review_of_world_energy_full_report_2009.pdf. Cited 10 Sep 2009
- [7] Mohammad I. Azim and Samina Rahman (2012), Renewable Energy, Sustainability and Environment: Are We There Yet?, *World Journal of Social Sciences*, Vol. 2(3), Pp. 168 – 181.
- [8] Guthrie, J and Parker, LD 1990, 'Corporate social disclosure practice: A comparative international analysis', *Advances in Public Interest Accounting*, vol. 3, pp. 159-175.
- [9] Adams, CA 2004, 'The ethical, social and environmental reporting performance portrayal gap', *Accounting, Auditing and Accountability Journal*, vol. 17(5), pp 731-757.
- [10] Singh, DR and Ahuja, JM 1983, 'Corporate social reporting in India', *International Journal of Accounting*, vol. 18(2), pp. 151-169.

- [11] Mathews, MR 1995, 'Social and environmental accounting: A practical demonstration of ethical concern?', *Journal of Business Ethics*, vol. 14, pp. 663-71.
- [12] Gray, R 2002, 'The social accounting project and accounting, organizations and society—privileging engagement, imaginings, new accountings and pragmatism over critique?', *Accounting, Organizations and Society*, vol. 27, pp. 687-708.
- [13] Deegan, C 2002, 'The legitimising effect of social and environmental disclosures—A theoretical foundation', *Accounting, Auditing and Accountability Journal*, vol. 15, pp. 282-311.
- [14] Cormier, D and Magnan, M 2003, 'Environmental reporting management: A continental European perspective', *Journal of Accounting and Public Policy*, vol. 22, pp. 43-62.
- [15] Adams, CA, Hill, WY and Roberts, CB 1998b, 'Corporate social reporting practices in Western Europe: Legitimizing corporate behavior?', *The British Accounting Review*, vol. 30, pp 1-21.
- [16] Imam, S 2000, 'Corporate social performance reporting in Bangladesh', *Managerial Auditing Journal*, vol. 15, pp. 133-141.
- [17] Gray, RH, Javad, M, Power, DM and Sinclair, CD 2001, 'Social and environmental disclosure and corporate characteristics: A research note and extension', *Journal of Business Finance and Accounting*, vol. 28, pp. 327-356.
- [18] Guthrie, J and Parker, LD 1990, 'Corporate social disclosure practice: A comparative international analysis', *Advances in Public Interest Accounting*, vol. 3, pp. 159-175.
- [19] Kin, HS 1990, 'Corporate social responsibility disclosures in Malaysia', *Akauantanb Nasional*, Issue. January, pp. 4-9.
- [20] Lynn, M 1992, 'A note on corporate social disclosure in Hong Kong', *The British Accounting Review*, vol. 2, pp. 105-110.
- [21] Ng, AY 2000, 'Going green: More cause than concern', *Australian CPA*, vol. 70, pp. 64-65.
- [22] KPMG 2008, *KPMG International Survey of Corporate Responsibility Reporting 2008*. Amsterdam: KPMG international.
- [23] Raman, SR 2006, 'Corporate social reporting in India – A view from the top', *Global Business Review*, vol. 7, pp. 313-324.
- [24] Maitland, A 2002a, 'Pressures mount for greater disclosure: Social reporting: To win trust, companies are responding to Government influences, campaigners, investors and consumers', *Financial Times*, 10 December.
- [25] Maitland, A 2002b, 'Rise in environmental reporting: Corporate disclosure pressure to reveal non financial performance', *Financial Times*, 29 July.
- [26] KPMG 2008, *KPMG International Survey of Corporate Responsibility Reporting 2008*. Amsterdam: KPMG international.
- [27] Adams, CA 2004, 'The ethical, social and environmental reporting performance portrayal gap', *Accounting, Auditing and Accountability Journal*, vol. 17(5), pp 731-757.
- [28] Gray, R, Kouhy, R and Lavers, S 1995a, 'Corporate social and environmental reporting: A review of the literature and a longitudinal study of UK disclosure', *Accounting, Auditing and Accountability Journal*, vol.8, pp. 47-77.
- [29] Gray, R, Kouhy, R, and Lavers, S 1995b, 'Methodological themes: Constructing a research database of social and environmental reporting by UK companies', *Accounting, Auditing and Accountability Journal*, vol. 8, pp. 78-101.
- [30] Krippendorff, K 1980, *Content Analysis: An Introduction to its Methodology*. Newbury Park, CA: Sage Publications.
- [31] Guthrie, J and Parker, LD 1990, 'Corporate social disclosure practice: A comparative international analysis', *Advances in Public Interest Accounting*, vol. 3, pp. 159-175.
- [32] Raman, SR 2006, 'Corporate social reporting in India – A view from the top', *Global Business Review*, vol. 7, pp. 313-324.
- [33] Zeghal, D and Ahmed, SA 1990, 'Comparison of social responsibility information disclosure media used by Canadian firms', *Accounting, Auditing and Accountability Journal*, vol. 3(1), pp. 38-53.
- [34] Hackston, D and Milne, MJ 1996, 'Some determinants of social and environmental disclosures in New Zealand companies', *Accounting, Auditing and Accountability Journal*, vol. 9, pp. 77-108.
- [35] Milne, MJ and Adler, RW 1999, 'Exploring the reliability of social and environmental disclosures content analysis', *Accounting, Auditing and Accountability Journal* vol. 12(2), pp. 237-56.
- [36] Unerman, J 2000, 'Methodological issues-reflections on quantification in corporate social reporting content analysis', *Accounting, Auditing and Accountability Journal*, vol. 13(5), pp. 667-81.
- [37] Hossain, M, Islam, K and Andrew, J 2006, 'Corporate social and environmental disclosure in developing countries: Evidence from Bangladesh', working paper, Faculty of Commerce, University of Wollongong.
- [38] Belal, AR 2000, 'Environmental reporting in developing countries: Empirical evidence from Bangladesh', *Eco-Management and Auditing* vol. 7, pp.114-121.
- [39] Belal, AR 2001, 'A study of corporate social disclosures in Bangladesh', *Managerial Auditing Journal*, vol. 16, pp. 274-289.
- [40] Imam, S 2000, 'Corporate social performance reporting in Bangladesh', *Managerial Auditing Journal*, vol. 15, pp. 133-141.
- [41] Ernst and Ernst 1978, *Social Responsibility Disclosure: Surveys of Fortune 500 Annual Reports*, Ernst and Ernst, Cleveland.
- [42] Guthrie, J and Parker, LD 1990, 'Corporate social disclosure practice: A comparative international analysis', *Advances in Public Interest Accounting*, vol. 3, pp. 159-175.
- [43] Islam MN (2001a) Energy context in Bangladesh. In: Islam AKMS and Infield DG (ed), *Photovoltaic technology for Bangladesh*. Bangladesh University of Engineering and Technology, Dhaka, Bangladesh and Loughborough University, UK, pp 1-18
- [44] Jamaluddin M (2008) Draft SAARC regional trade study: Country report-Bangladesh, p 91.

- [45] Khan S (2009) PDB plans big for six coal-fired power plants In: The Daily Star, Tuesday, June 9, 2009.
- [46] Shrestha RM, Anandarajah G, and Liyanage MH (2009) Factors affecting CO₂ emission from the power sector of selected countries in Asia and the Pacific. *Energy Policy* 37: 2375-2384.
- [47] Brown J and Hendry C (2009) Public demonstration projects and field trials: Accelerating commercialisation of sustainable technology in solar photovoltaics. *Energy Policy* 37: 2560-2573.
- [48] Gottschalg R (2001) Future prospects for PV technologies. In: Islam AKMS and Infield DG (ed) *Photovoltaic technology for Bangladesh*. Bangladesh University of Engineering and Technology, Dhaka and Loughborough University, UK, pp251-264.
- [49] Green MA (2004) Recent developments in photovoltaics. *Sol. Energy* 76: 3-8
- [50] Ramana PV (2005) SPV technology dissemination-A Global review In: Eusuf M. (ed), *Solar photovoltaic systems in Bangladesh, experiences and opportunities*. The University Press Limited, Dhaka, Bangladesh, pp 119-138
- [51] Van der Zwaan B and Rabl A (2003) Prospects for PV: A learning curve analysis. *Sol. Energy* 74: 19-31.
- [52] BP (2010) British Petroleum official website under renewable energy, June 2010.
- [53] <http://www.bp.com/sectiongenericarticle.do?categoryId=9023789&contentId=7044135>. Cited 22 Jun 2010.
- [54] Brown J and Hendry C (2009) Public demonstration projects and field trials: Accelerating commercialization of sustainable technology in solar photovoltaic. *Energy Policy* 37: 2560-2573.
- [55] IDCOL (2008), Infrastructure Development Company Limited, Dhaka, Bangladesh.
- [56] http://www.idcol.org/news_detail.php?id=90. Cited 24 Nov 2009
- [57] DOE (1997) Renewable energy technology characterizations, TR-109496, Technical Report, Electric Power Research Institute, U.S. Department of Energy, Washington, DC 20585, p 275.
- [58] Sarkar, M.A.R., M. Ehsan, and M.A. Islam, *Issues relating to energy conservation and renewable energy in Bangladesh*. Energy for Sustainable Development, 2003. II(2): p. 77-87.
- [59] Islam, A.K.M.S., M. Islam, and T. Rahman, *Effective renewable energy activities in Bangladesh*. *Renewable Energy*, 2006.31(5): p. 677-688.
- [60] Hossain, I. and M. Tanim, 2005, *Energy and Sustainable Development in Bangladesh*, HELIO International, Dhaka.
- [61] IEA/OECD, *Renewables Information 2004*. 2004, Paris: International Energy Agency.
- [62] 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.
- [63] Timilsina, G., T. Lefevre, and S.N. Uddin, *New and renewable energy technologies in Asia*. *Renewable Energy World*, 2001(2001-2002): p. 52-67.
- [64] IDCOL, 2005, IDCOL Renewable Energy Program, Infrastructure Development Company Limited, Dhaka.
- [65] 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.
- [66] Biswas, W.K., P. Bryce, and M. Diesendorf, *Model for empowering rural poor through renewable energy technologies in Bangladesh*. *Environmental Science & Policy*, 2001. 4(6): p. 333-344.
- [67] Ghimire, P.C., 2005, *Technical Study of Biogas Plants Installed in Bangladesh*, Development Partners, Dhaka.
- [68] ESMAP, 2004, *Opportunities for Women in Renewable Energy Technology Use in Bangladesh (Phase I)*, World Bank Energy Sector Management Assistance Program, New York
- [69] Khan, H.J., *Case-study: battery-operated lamps produced by rural women in Bangladesh*. *Energy for Sustainable Development*, 2003. VII(3): p. 68-70.
- [70] Fenhann, J., 2006, *CDM Project Pipeline*, UNEP Riso Centre, Roskilde.
- [71] Muller, A., 2005, *How to Make Clean Development Mechanism Sustainable-The Potential of Rent Extraction*, Environmental Economics Unit (EEU), Goteborg.