A Sustainable Energy Future in Bangladesh: Current Situation and Need for Effective Strategies

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Abstract: Bangladesh is considered extremely vulnerable to the impacts of climate change. Both adaptation and mitigation measures form a comprehensive national climate change policy approach. Adaptation strategies are crucial for Bangladesh but mitigation can be addressed effectively and provide benefits to the nation. This paper addresses the need for effective mitigation strategies linked with sustainable energy development in Bangladesh. Use of renewable energy, increased energy efficiency and enhancement of energy security constitute a sustainable energy strategy approach. Renewable forms of energy emit far smaller amounts of greenhouse gases (here CO2) compared with fossil fuels and increased energy conservation facilitates the reduction of primary fossil fuel use, thus mitigating climate change impacts while contributing to the provision of energy services and enhancing security of energy supply. In addition, renewable energy sources contribute to provision of other on-site synergistic benefits such as income generation activities, communications and improve human lives, especially in rural and remote locations. Also an allied opportunity exists in Bangladesh via the auspices of the new financing mechanism of Clean Development Mechanism (CDM) under the Kyoto Protocol that could assist in facilitating sustainable energy development. Other initiatives such as advancement of renewable energy technologies under donor driven schemes that foster sustainable energy development in Bangladesh also are discussed.

Keywords: Bangladesh, Sustainable Energy, Renewable, CDM, Energy Policy

1. INTRODUCTION

Bangladesh is located in north-eastern part of South Asia and shares its longest border (4000 km) with India. In the extreme southeast Bangladesh’s neighbour is Myanmar and southern boundary is the Bay of Bengal. With a land area of 147,570 km² and population of over 141.8 million in 2005, Bangladesh is among the world’s most densely populated nations (834 people/km² in 2001) [1]. Bangladesh is the least urbanised nation with 75% people living in rural areas [2]. Bangladesh is one of the poorest nations in the world with GNI per capita of US$ 470 in 2005 and nearly 50% of total population lived below the national poverty line according to the World Bank [2]. Being an agrarian economy, the agricultural sector alone accounts for 20% of GDP and provides employment for more than half of the labour force [1]. Despite slightly lower growth of GDP in recent years (5.4% in 2005 compared with 6.3% in 2004), average annual growth of GDP is expected to be 6.2% during the next five years [2]. Bangladesh is still a developing nation with great potential for development of a strong economy based on human-capital driven industrial sectors. However, development trends in Bangladesh are threatened by a high frequency of extreme climatic events as well as spiralling population growth, scarcity of land and resources, and often administrative instability and discontinuities in development planning. These factors also have had significant impacts on energy infrastructure and energy security which is the particular focus of this paper.

Energy, and more specifically electricity, is a pre-requisite for the entire nation’s economic activities and social development. Bangladesh has modest hydrocarbon resources and rich renewable energy sources especially in the form of traditional energy. Bangladesh lacks efficient electricity generation capacity and electricity grid networks to electrify the whole nation and has never enjoyed 100% electrification. Overall, the nation’s power generation units have been chronically unable to meet system demand over past decade [3]. Often, electricity supply to low-load rural and remote areas is characterised by high transmission and distribution costs and transmission losses, and heavily subsidised pricing [4]. Predominantly, electricity accessibility is limited to urban areas. The provision of uninterrupted power supply has been a challenge over the last decade. Currently energy and specifically an electricity crisis are occurring in Bangladesh. The national Government is finding it difficult to respond to this issue due to insufficient electricity supply compared with demand linked with economic activities due to rapid industrialisation, low levels of power generation from installed capacity due to low efficiency, increased household energy demand specially during the summer season and electricity requirements for agriculture during the dry season, rapid urbanisation, lack of investment in new power generation units, and most importantly limited but diminishing fossil fuel reserves.

Currently, electricity generation per capita in Bangladesh is the lowest in the world, about 154 kWh/per year [1]. The power crisis as mentioned earlier, is likely to persist, despite the addition of new power generation capacity since 1997 [1]. As a result, intermittent power supply and load-shedding are common especially in summer and in the dry season. Also there is a huge unmet commercial demand for energy as the shortfall of power generation capacity is estimated to be around 2500 MW for the next five years [1]. As a result, lack of a reliable electricity service has deterred foreign investment and held back economic growth [1]. While the need for investment in the energy sector, and especially in the electricity sector is a great challenge faced by the Government of Bangladesh, other important issues such as system losses and unpaid-electricity are also major concerns for this sector. For example, only about 55 – 60% of the electricity generated was paid for [1, 5] and system losses of generated electricity were up to 30% in 2004 [1]. The reasons that electricity is not paid for are due to unwillingness of the customer, electricity theft, and mismanagement and petty corruption surrounding electricity metering [5]. These issues have had negative effects on donors’ attitudes towards ongoing and potential investment in large-scale energy schemes in Bangladesh. By acknowledging the potential for renewable energy sources, Bangladesh could possibly meet its unprecedented electricity demand, increase electricity accessibility and enhance energy security via their advancement. The current energy strategy in Bangladesh, which will be discussed in more detail later in the paper, is partially oriented towards the development of the hydrocarbon sector and to a limited extent towards advancement of renewable energy technologies [6]. However, there is a strong need for a holistic approach towards a sustainable energy future for the nation.

This paper begins with reviewing and analysing the existing and potential climate change challenges and environmental concerns associated with energy systems, and the status and challenges of energy accessibility and energy security. Analysis of the current

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energy strategy and institutional settings in Bangladesh then follow. The paper finally focuses on exploring strategies towards a sustainable energy future that contribute to environmental protection and sustainable development.

2. CLIMATE CHANGE AND CLIMATE IMPACTS

Bangladesh is one of the nation’s most likely to suffer extremely adverse impacts from anthropogenic climate change due to the nation’s significant vulnerability to climate impacts and geophysical setting [7, 8]. Approximately a fifth of the nation consists of low-lying coastal zones within 1 metre of high water mark [7]. About 30% of total cultivable land of the nation (out of 67% of total cultivable land of the nation) is classified as low land potentially threatened by flooding [1]. The Intergovernmental Panel on Climate Change (IPCC) projects a high frequency of extreme climatic events (sea level rise, droughts, floods and cyclones) for Bangladesh exacerbated by rapid population growth [9]. Other climate change induced challenges are: scarcity of fresh water, river bank erosion, discharge of wastewater, frequent floods and prolonged and widespread drought, and more widespread salinity in surface water, ground water and soil in the coastal zones [10]. These climate induced impacts, are in fact indirectly affecting security of energy services.

To date climate induced extreme events have been significant driving forces in compelling people to over-exploit natural resources (infrastructure materials, forests) in Bangladesh. This is, in fact, one of the main factors that has contributed to Bangladesh’s large economic deficit and the retarded implementation of planned development schemes over past decades. Other factors with regard to lack of climate adaptation measures include institutional capacity and economic resources to address adaptation, and strategies towards combating climate induced poverty and development challenges. In fact, unlike developed nations with high adaptive capacities, developing nations including Bangladesh have low adaptive capacities and are therefore identified as being the most vulnerable to the adverse effects of future climate change [11]. Many anticipated adverse impacts of climate change will in fact reinforce existing stresses on the energy-environmental sectors that already pose a serious impediment to the nation’s development agenda [12]. Strategically, Bangladesh needs a national level policy approach to comprehensively address foreseen climate related risks.

3. ENVIRONMENTAL IMPACTS FROM ENERGY SYSTEMS

Bangladesh possesses a number of environmental problems in common with other nations such as a decrease of agricultural land due to soil erosion and land used for residential purpose, water pollution and salinity, loss of biodiversity and natural disasters [10]. Also negative environmental and social impacts associated with the large-scale hydropower (>40 MW) generation have occurred as resettlements of a large numbers of people and loss of agricultural lands and habitats. The nation has a high dependency on natural gas and hydropower for electricity generation but, as mentioned previously, low per capita energy consumption. Social acceptance of long-term environmental impacts from the planned 500 MW coal-fired power plant using coal obtained from open-cut mining at Phulbari (in northern-eastern part of Bangladesh) are yet to be confirmed. However, this project already received environmental clearance from the Government of Bangladesh [13] notwithstanding emissions including those of greenhouse gases. However, Bangladesh’s contribution to global climate change via emissions of CO2 from energy systems is insignificant compared with many industrialised nations. Bangladesh shares less than 0.1% of global emissions of CO2 compared with 24% of the USA [7] and emits about 0.19 t of CO2 per capita [14].

Due to lack of energy access for cooking and small industrial applications, traditional energy meets these important energy demand [15]. However, burning of wood, dung and crop residues results in indoor air pollution and causes severe human health impacts directly to the users especially rural women [16]. Traditional energies also impose both personal and social costs to end-user as the time spent for collecting traditional fuels by family members, the considerable quantity of fuel and associated labour needed and the distance of fuel-sources from home often travelled by foot [15, 16]. Thus, improving the energy supply situation and, in particular, increasing access to clean electricity and facilitating more sustainable use of traditional energies, are important in addressing energy related social health impacts.

4. ENERGY ACCESSIBILITY AND ENERGY SECURITY

Energy services are fundamental to development and economic growth [17] and in fact, at the level of the individual, modern energy services can transform people’s lives for the better [18]. Though a large percentage on average 20% of total public sector investment has been allocated for the development of Bangladesh’s energy sector [19], the achievements made in the energy sector have not been able to cope with sharp growing demand for energy either in quantity or quality of energy service. Supply of electricity is frequently interrupted in urban areas due to the low electricity generation capacity available compared with the high electricity demand and regulated power supply by load-shedding. Energy/electricity accessibility is also threatened in rural, remote and coastal areas by extreme climatic events. In 2002, about 26% of the total population had access to electricity and electricity consumption was only 96 kWh per capita for all sectors [20]. Electricity access was limited to only about 30% of total households and only 4% households had access to the natural gas network nationwide [16]. However, the demand in electricity has increased at an alarming rate in recent years in Bangladesh. This rapid increase in electricity consumption is due to high growth trends in economic development and population growth (2% in 2003) [21] and partially due to the revolution in communications technology.

Energy security is a part and parcel of sustainable development for both industrialised and developing nations. In Bangladesh, security of energy supply is threatened due to number of reasons including lack of domestic energy resources, high dependence on imported transportation fuels and poor energy infrastructure. Bangladesh has substantial natural gas reserves (424 – 909 Gm3) [22] which provide more than two-thirds of the nation’s commercial fossil fuel supply, with a production of 11 Gm3 in 2002 [23]. According to latest available information, Bangladesh has over 2 billion t of low-sulphur coal reserves [1]. However, the economic potential for this coal is yet to be confirmed. Even though Bangladesh has these natural gas reserves and recently discovered coal resources, efficient use of these resources is limited due to lack of exploitation and distribution facilities. Also, though its proven oil reserves are estimated to be 56.9 million barrels, Bangladesh meets over 90% of its oil demands through
imports [22]. Out of the 3.6 GW of electricity generated annually, 94% comes from thermal (natural gas and oil-fired) and the remainder from large-scale hydropower [23]. Due to the nation’s flat terrain and potentially large social and environmental impacts, further exploitation of hydropower is expected to be limited to small and mini-sized hydropower plants with an estimated potential of about 250 MW [24].

5. APPLICATION AND POTENTIAL FOR SUSTAINABLE ENERGY DEVELOPMENT

In Bangladesh, utilisation 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 [16, 25]. Biomass accounted nearly 50% of total energy supply in 2004 [26] and supplied 98% of total renewable energy [27]. Compared to other renewable energy technologies, such as improved cooking stoves and biomass briquetting, initiatives involving the installation of solar home systems are flourishing [28]. This is largely due to the initial initiative of the micro-credit program of Grameen Shakti [29] 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 organisations [30]. A more detailed status of renewable energy applications in Bangladesh is given in [31]. 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 [30]. 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 organisations 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 [16, 28, 30]. 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 [32]. 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 [33] and manufacturing of battery operated lamps by rural women has been initiated under the Coastal Electrification and Women’s Development Micro-Enterprise project (CEWDM) [34, 35]. 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 [31]. 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 [36]. 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 [37].

6. CURRENT ENERGY STRATEGIES

Development of the energy sector has been prioritised via the Five-Year Development Plans of Bangladesh. Development of the energy sector appears to be a major constraint for continued development of the nation. However, the energy sector received strong impetus only during 5th Five-Year Development Plan (1997-2002), when three designated areas were focussed on in development planning: energy (electricity); oil, gas and mineral resources; and renewables. The 5th Five-Year plan also facilitated investment in the energy sector via encouraging private sector participation. In line with this energy planning, the Ministry of Finance took an important step by exempting import duties and value added tax (VAT) on solar PV modules and wind turbines [16]. Financial measures in the form of subsidies played an important role in promoting solar PV and biogas technologies. Currently, under the National Program of Domestic Biogas in Bangladesh, the Government of Bangladesh is providing a US$ 120 subsidy for installing family-sized biogas plants with average capacity of 2.8 m³ of gas production daily [38] which can be used for cooking and lighting purposes [30]. However, gradual phasing out of energy subsidies has been recommended as an energy policy option, in the context of Pacific Islands developing nations [39].

6.1 National energy policy

The Bangladesh National Energy Policy was introduced in 1996 and emphasized environmentally sound energy development [6]. Also, realising the rising national electricity demand and the need for associated investments, the Government of Bangladesh amended the 1991 Industrial Policy during mid 1990s in order to facilitate private sector investment for installing new power generation units on a build-own-operate basis [28]. These policies focussed on broad energy infrastructure development for Bangladesh rather than small-scale local level projects. The current legal and policy frameworks in Bangladesh that encompass reference to the development of renewable energy include the National Policy Statement on Power Sector Reform 2000; the Private Sector Power Generation Policy 1996 to encourage private sector participation in the electricity generation; Remote Area Power Supply Systems; Policy Guidelines for Small Power Plants in Private Sector 2001 to encourage small-scale (<10 MW) electricity generation; and the Energy Regulatory Commission Act 2003 [30, 40]. However, Bangladesh still lacks a dedicated renewable energy policy. A draft Renewable Energy Policy was released in 2002 [41]. This draft policy provided modalities and procedures for financing arrangements, tariff regulations, fiscal and other incentives for implementation of renewables and guidelines for establishment of an independent renewable energy institution, a Renewable Energy Development Authority [40, 41]. This draft renewable energy policy has not been finalised or implemented to date. The provision for an independent renewable energy institution is discussed below.
6.2 Environmental policy and framework

Another policy framework that refers to renewable energy is the Bangladesh National Environment Policy which was approved in 1992 [42]. Though this policy does not have a specific section on the development of renewables, policy guidelines concerning renewables are specified under the Conservation of Natural Reserves and Renewables, and in the Reduction of Use of Wood and Agricultural Wastes as Fuel and Enhanced Use of Alternative Sources of Energy. The implementation program for the National Environmental Policy 1992 recommended increasing rural energy supply through the installation of renewable energy projects [42]. The National Environment Management Action Plan 1995 [43] also stresses the importance of renewables in rural areas, and further emphasizes the exploitation of renewables for a cleaner environment. At the international level, in response to global climate change concerns, Bangladesh has signed and ratified the Kyoto Protocol. In order to facilitate the CDM under the Kyoto Protocol and in relation to Bangladesh’s participation in the United Nations Framework Convention on Climate Change (UNFCCC), the Department of Environment acts as the designated national authority (DNA). The DNA is responsible for approval of greenhouse gas emission reduction projects including renewables [44].

6.3 Institutional settings

The Ministry of Power, Energy and Mineral Resources (MEMR) of Bangladesh is the sole authority administering all activities related to the nation’s hydrocarbon sector and energy including the rural and renewable energy. Although institutionalisation of a Renewable Energy Development Authority (REDA) was proposed 2002, by the end of 2005, the Government of Bangladesh decided to establish an alternative independent unit, the Sustainable Energy Development Authority (SEDA) for expediting the use of renewable and alternative sources of energy for power generation [45]. In addition to focusing on advancement of renewable energy, SEDA is to also facilitate energy saving measures via installation of energy efficient lighting [45]. Power Cell, the planning and research unit under the MEMR was given the responsibility to form SEDA with immediate effect; however, implementation has not been as rapid as was anticipated [45]. Currently, the Director of Power Cell heads SEDA and the full organisational structure and mandate are yet to be established by Power Cell [45]. Notwithstanding this, the decision for establishing SEDA was an important step in acknowledging the need for sustainable energy development in Bangladesh. A number of other government and non-government organizations are currently involved in renewables. Government-controlled power utilities, the Bangladesh Power Development Board (BPDB) and semi-autonomous government utility the Rural Electrification Board (REB), both run programs on renewables. Other government organizations involved in renewables include: the Bangladesh Centre for Scientific and Industrial Research (BCSIR); the Bangladesh Atomic Energy Commission (BAEC); and the Local Government Engineering Department (LGED). In addition, an institution mentioned previously, IDCOL, a state-owned non-banking financial institution, that was established in 1997, administers the financing for the Rural Electrification and Renewable Energy Development Project (REREDP) with ten participating national NGOs and newly initiated National Program on Domestic Biogas in Bangladesh [30]. With regard to the private sector, renewable energy industry investment is very young in Bangladesh. A few industries are involved as importers and systems integrators of renewable technologies [31]. However, since their engagement is limited to promoting renewable energy technologies, their participation has not been included in policy formulation and decision making. A number of research and development centres for renewable energy technologies are also functioning in Bangladesh [46].

7. RELEVANCE OF EFFECTIVE STRATEGIES

7.1 Renewable energy development planning

To date, most of the initiatives on policy formulation for advancement of renewables have been supported via development assistance from industrialised nations and international organisations rather than being driven by national stakeholders including end-users in Bangladesh [29]. As a consequence, development of renewables 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 [47]. The challenges associated in introducing new energy technologies both in industrialised and developing nations have been acknowledged, for example, wind energy diffusion in Sweden [48] and solar PV in Bangladesh [28]. 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 systems when implemented, necessitate a paradigm shift from technology-oriented strategies to market and on-the-ground oriented strategies.

7.2 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 [49, 50]. Also the externality costs acts as market barriers for advancement of renewable energy technologies [51]. 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. Research findings reveal that lack of energy accessibility is a major concern in both rural and urban areas of Bangladesh. Among other viable options, use of on-site renewables potentially could increase energy accessibility and could offer other synergistic benefits including socio-economic development. However, the challenge is to harness further adequate and affordable energy services from renewables in sustainable ways. Decentralized energy systems in rural, remote and coastal areas as well as split-home systems (based on renewables) could facilitate accessibility of electricity. Increased efficiency of energy conversion systems, especially addressing efficient cooking stoves could potentially reduce environmental pollution and health risks. In fact, energy requirements for cooking purposes are more significant than for lighting. Thus a holistic approach towards meeting total energy demand is important for
communities either in rural or urban areas. In particular, the national energy policy should have explicit target on renewable energy via decentralised renewable energy application as well as target for energy conservation in household and industrial sector. Such a strategy could broadly encompass providing subsidies for the advancement of renewables especially for remote and rural locations and gradually removal of subsidies from conventional energy consumption. In addition, integration with local people and stakeholders’ is important in initiating community based renewable energy applications and mobilising financial resources. These, however, will direct national development planning towards sustainable development.

7.3 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 [8]. 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 development in developing nations while industrialised nations expect to enjoy emission reduction credits via sustainable energy projects under CDM schemes. It is however too early to assess the effectiveness of such measures in the long-term.

7.4 Global context
In global context, climate change is not only a social, an economic and a political issue but also an ethical issue [8]. Therefore, this need to be addressed via an 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 [39].

7.5 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 renewables needs to be supported via effective strategies and institutional settings [31]. 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. 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.

8. CONCLUDING REMARKS
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 decentralised systems where applicable) could enhance both electricity accessibility and energy security in Bangladesh.

To summarise, Bangladesh already has experience with sustainable energy projects and certain renewable energy project approaches. Though these initiatives are at initial stage of development and implementation, the potential of these initiatives is high. Viable approaches need to be amplified to a broader context under a national sustainable energy strategy. In particular, the pilot schemes of sustainable energy development in Bangladesh need be scaled up to take a greater share in nation’s energy mix. Mobilization of finance, realization of niche markets for sustainable energy and strengthening relevant institutions to implement sustainable energy policy direction are possible avenues to assist with this.
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