

PROSPECTS OF RENEWABLE ENERGY IN NBANGLADESH

**A Thesis submitted in partial fulfillment of the requirements for the
Award of Degree of Bachelor of Science in Electrical and Electronic
Engineering**

by

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Certification

This is to certify that this thesis entitled “**Prospects of renewable energy in Bangladesh**” is done by the following students under my direct supervision and this work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering. The presentation of the work was held on December 2019.

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Dedicated to

**Our Parents
And
Teachers**

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List of Abbreviations

CDM	Clean Energy Mechanism
LED	Light Emitting Diode
RET	Renewable Energy Technology
SHS	Solar Home System
GHG	Green House Gas
PV	Photovoltaic
SPPA	Small Power Purchase Agreement
IDCOL	Infrastructure Development Company Limited
SWERA	Wind Energy Resources
UNDP	United Nations Development Program
MOEF	Ministry of environment and Forest
SEMP	Sustainable environment Management Program
SRE	Sustainable Rural Energy
BRAC	Bangladesh Rural Advancement Committee
CMES	Centre for Mass Education in Science
GS	Grameen Shakti
IFRD	Institute of Fuel Research Development
IERD	Bangladesh Council of Scientific and Industrial Research
RED	Rural Electrification Board
CSP	Concentrating Solar Power
MSW	Municipal Solid Waste

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Abstract

Electric energy security is essential, yet the high cost and limited sources of fossil fuels and need to reduce greenhouse gasses emission, have made renewable resources attractive in world energy based economics. The potential for renewable energy sources is much because they can in principle, exponentially exceed the world's energy demand, these types of resources will have a significant share the future global energy as always. Accordingly this paper, presents how renewable energy resources are currently being used and scientific development to improve their utilization. And how renewable energy technology towards sustainable development and climate change mitigation, what are the opportunities and challenges in the context of Bangladesh of a country of this subcontinent.

Chapter 1

Introduction

1.1 Introduction

Renewable energy is an energy which is raised out of renewable resources, which the energy get naturally like this, daylight, wind, rain, tides, waves and geothermal warm. Renewable vitality gives vitality in four vital zones; Power era, discuss and water cooling, transportation, rustic (off-grid) vitality administration [1]. The current renewable energy comes from biogas, hydro power, wind and solar. Bangladesh is a progressive country that have much options and benefits use of renewable vitality sources because of producing electric power. Bangladesh have numerous normal assets as coal, gas and petroleum. Bangladesh the major source of vitality is common gas (24%) that is consumed by the year 2020. Government emerged its prospect and arrangement in February 2000with provide electricity service the whole country by the year 2020. In 2015 and 2016 renewable energy contributed 19.3% for the sake of worldwide energy consumption and produce of electricity on 24.5%. In 2015 global investments renewable accounted more than US\$286 Billion. Worldwide, allotted 7.7 billion jobs are connected the renewable energy industries with solar and photovoltaics. 2019 globally, new electricity was installed capacity renewable of all two-thirds [2].

1.2 Worldwide renewable energy sources

Renewable vitality sources that are restocked through nature and formed direct the sun like as warm, photo-electric, indirect to the sun like hydro power, wind and photosynthetic energy gatherer biomass in. Renewable vitality innovations turning common vitality source within usable that is energy-power, warm and powers. Represent the capability of renewable vitality source to give above the times 3000 recent worldwide vitality heads.

1.2.1 Biomass energy

The term of the biomass used vital material making out of plants, trees and crops that is basically collect and capacity the sun's vitality by photosynthesis. Is bioenergy transformation of biomass to useful energy as warm, power and fluid fills. Bioenergy for biomass through specifically by the arrive as devoted crops or created the preparing of crops for nourishment. Biomass vitality is renewable and feasible much characteristics with fossil fills. Can be biomass direct consumed to acquire vitality, it feedstock to transformed to several liquid or gas fuel. Biofuels can be gathered and transported for warm and control era of request which is necessary for vitality blend by a large reliance on irregular sources as wind. The major role of biomass is hoped to play in future vitality scenarios. Currently developing technique to improve bio-refinery and biotransformation advances to transform biomass through clean vitality fills. The utilization the biomass-executed fuels which generally assuage present and vitality surety and commerce adjust exposure and cherish socio-economic improvements. Biomass powers have moo vitality consistence and transportation and collection that can be taken a toll obstructive. Produce electricity by using biomass technologies founded but cost paid for power rarely embranchment the total taken a toll of biomass fuel.

1.2.2 Geothermal Energy

Geothermal vitality is strong and proficient to way extraction renewable vitality to the soil through characteristic processes. This process can be completed on a little scale to supply warm for a private unit by using a geothermal heat pump for vitality generation by geothermal control plant. Geothermal control is deliberated a cost efficient, dependable and naturally neighborly vitality sources. This vitality assets structure of warm vitality come from interior the earth's gathered in shake and entrapped water of steam. This systems happen where the temperatures and profundities of the supplies shift according to in various geological environments. High-temperature aqueous frameworks more prominent than 180 degree Celsius which are connected intermediated-temperature between 100 and 180 degree Celsius and low temperature less than 100 degree Celsius systems are establish in continental placing. High, low and intermediate temperature areas of geothermal can be exploit power manufacture and coordinate utilize of warm. Energy source of geothermal are serial as like aqueous frameworks, conductive frameworks and profound aquifers. Fluid and vapor are managed types that are include hydrothermal systems. Hot shake and magma

above wide extend temperature that are include conductive systems. Deep aquifers disclosing fluids in creak zones depths larger than 3 km, although magnetic heat source. Energy sources of geothermal technologies utilization gathered beneath classified for electrical control era, straight utilize of warm, or joint warm and control of cogeneration. Power generation and straight utilize are hydrothermal only commercially fulfill geothermal systems. Geothermal power plants, projected installed retention is hoped between 140 GW_e, 160 GW_e, whilst useful install retention reach 800 GW_{th} for straight use by 2050.

1.2.2 Hydropower energy

Hydropower refers that is convert energy from moving water through electricity. By using turbines, captured and changed over into power by moving water that creates energy. Dams, harnessing wave and tidal power the most prevalent from hydropower that are getting to be more common. Generated of the hydropower from of water flowing within the hydrological cycle that is driven by sun based radiation. Generated hydropower the stream of rivers water is driven by constrain of gravity to step from higher to lower heights. A very large scales hydropower plant, get few to various GW. Taipu in Brazil largest projects 14000 MW and gorges of three in china 22400 MW both creating 80 to 100 Tw per year. Five countries make the world's half of the hydropower generation: China, Brazil, Canada, USA and Russia. According to three categories of hydropower plants by operation and flow of water. Hydropower plants alter from little to huge scale terms in, the watersheds depends on hydrology and geology Run-of-river (ROR), Reservoir and pumped storage. Now globally available pumped storage is the largest retention from grid energy storage. Hydropower technology is demonstrated and well- progressed. based more than a century of involvement. Today hydropower is amazingly adaptable control innovation among the leading. efficiencies of all vitality sources 90% of due to wire of water straight conversion of pressure driven vitality to power. Still development by cathartic operation, loss of environmental impacts, adapting new social and environmental requirements and improving more strong and cost-effective mechanical arrangements.

1.2.3 Solar energy

Sun based vitality is one of the foremost helpful alternative forms energy of. Generation of solar energy includes the use of sun's energy to provide through such as water of

thermal systems, sun powered photovoltaic and concentrating sun powered control (CSP) frameworks. These categories of innovations are well demonstrated much frameworks placed all over the world final few decades.

1.2.4.a Photovoltaic

Directly convert solar energy into electricity by the solar photovoltaic (PV). This systems PV cells that is semiconductor devices which is changes over sun based vitality into straight current power.

Interconnected PV cells from a PV module up to 50 to 200W. From PV systems of PV module joint with a set of components inverters, batteries, electrical components and mounting systems. Most of the solar PV technologies established are silicon based systems. Highly modular to supply control ranges a couple of to tens of megawatts. Classification of photovoltaic systems two major sorts: off lattice and network associated.

1.2.4.b Concentrating solar power

Technologies of concentrating solar power (CSP) produce electricity used in a downstream process by direct-beam sun based irradiance to warm a fluid, strong or gas for power generation. Range of little dispersed frameworks of tens KW, huge centralized control of hundreds of MW. Concentrating solar power plants were 354 MW solar electric producing stations in California that was earliest commercial that proceed to function commercially now a days. Beginning 2009, more than 700 MW that's network associated CSP plants were introduced globally, under construction other 1500MW. In 2012, entire global retention up more than 60% to about 2550 MW.

1.2.4.c Solar thermal heating and cooling

This advances gather warm vitality get the sun and usage warm give hot water, space warming, cooling and warming for private, commercial and mechanical applications. Global solar thermal capacity estimated 282 GW_{th} by the end of 2012.

1.2.5 Wind energy

Electricity generation by wind turbines firstly were created at the starting of 20th century. Gradually has moved forward this technology as shortly 1070s. Sustainable energy sources of wind vitality has re-emerged mostly at the end of 1990s.

Characterized of Wind control is the change of wind vitality by wind turbines through a beneficial frame like as produce power by wind turbine, mechanical control by wind mills pumping water by wind pumps. Generation of electricity from wind turbine requires active vitality of moving discuss is changed over to mechanical and electrical vitality [3].

1.2.4 Ocean energy

Ocean energy outlined to change over active wave control into power. It's prepared with kinetic-energy gatherers called drifts. The wave move up and down with dynamic movement of the waves. The floats of motion is transferred through hydraulic to rotate power generation. Upgrade the facility to utilize wind and solar power. Each power station will be produce 6 MW of energy. Able to provide electricity a single machine for 4000 homes [4].

1.3 Renewable energy Source in Bangladesh

Bangladesh is one of the foremost populated nation of the World's. Net Residential Item (GDP) in Bangladesh was 7.05% in 2016. Financial growth in 2017 presage will be more than 7%. Financial growth grown large need of electricity. Energy plays a crucial part in financial grown, economical advancement and security of any other nation. Bangladesh, power is mostly utilized from of vitality as future financial development relay on the power [5]. Laudable the progress the renewable vitality division in few a long time. In recent, 404 MW electricity comes from renewable energy sources. Renewable vitality in Bangladesh is exceptionally hopeful the case of sun powered vitality. Renewable energy will stay comprise the running energy procreation by non-renewable conventional. The energy sector is rising day by day, entire electricity produced capacity is 15351 MW of February 2017. Need of electricity coal, diesel, gas founded power produced process being utilized. Various agencies, government and non- government organizations acts generally or in itself to proclaim renewable energy technologies (RET) throughout reported the current literature. The most source of renewable vitality in Bangladesh is takes after:

1.3.1 Solar energy

In Bangladesh, sun oriented vitality sources solving power crisis is mostly. In Bangladesh the foremost of created control that's come from diesel, coal and gasses

from control stations. Natural resources are exhausted the alarming rate, with the current utilization rate. This truth associated which is over 70% Bangladesh of remain exterior the national framework ought to be grave concern. Total demand of the country 7000 MW per day but we can produce only 4500-4600MW. In spite the capability of producing 6700 MW per day. Bangladesh is semi-tropical region so that the sunshine dry season 7.6 hours a day and rainstorm season is 4.7 hours. Most of the areas of Bangladesh amount of sun powered radiation gotten reduce amid storm season yearly normal daylight hour and sun based radiation for operation of small scale of solar home system. Bangladesh as high solar radiation availability is 1700 Kwh/m². Vary on season during monsoon season average solar radiation availability about 174.2 cal/cm²/min. Solar energy involves photovoltaic cells (PV) and CSP (concentrated solar power). Concentrated sunlight are the high efficiency heat transfer through a conventional thermal power plant. Using CSP technology cost of producing power recently around 23 BDT per watt. Four from of the CSP technologies each from having various levels of efficiency due to the focus on sunlight. Recently used in many power plants combining sun based control towers with characteristic gas control generators. Integrated solar combined cycle (ISCC) is the another from of solar concentrating solar technology. Photo-voltaic cells (PV) it's current average efficiency ranging from 8-20%. It's used off grid purposes [6].

1.3.2 Wind energy

Wind energy the from of solar vitality. Wind power is the process by which it's used to produce electricity. Convert kinetic energy into mechanical power by the wind turbines. In Bangladesh, southern districts have a very good potential of wind vitality. Bangladesh, potential of wind vitality is above 20,000 MW being the speed of wind is <7 m/sec. In 1996-97, cooperate in Bangladesh Middle for Progressed thinks about (BCAS) with Nearby Government and Building Division (LGED) and also an Organization Vitality Innovation and Benefit Unit (ETSU) from UK with subsidizing from Division Of Remote And Worldwide Improvement (DFID) have tried instructor and conditions at seven coastal destinations for a period of one year. Height of wind parameters measured 25m. Various wind resources work is under way the nation by BPDB (Bangladesh Control Advancement Board), BCSIR (Bangladesh Chamber of Logical and Mechanical Investigate). Bangladesh, era of power from wind is Muhuri Dam firstly, Feni which having receptivity 0.9 MW of 225 KW and 4 turbines and other

one Kutubdia Island 20 KW, 50 turbines of receptivity 1 MW. Patuakhali will be made wind power plant 100 MW invest Vesta Company of Denmark [7]. This will be the largest wind power plant in Bangladesh. Our government taken step set up three wind power plant in our country by 2021. Located in three power plants has been selected wind mapping will be Chandpur, Iani Beach of Cox's Bazar and Dakop Upazila of Khulna. Bangladesh has not been explored the potential of wind energy, chiefly lack of solid wind speed information. It look that speed of wind will not be tall but wind vitality uses of variety for wind pumps, cross breed power creating frameworks with the energy source of wind vitality, the chargers of little battery at several place and inputs power to nearby lattices in a few coastal regions. In Bangladesh wind energy may well be utilized in angle or firming of poultry, fish-mill businesses, residential applications and vegetable water system utilizing decentralized power. Renewable vitality source, wind vitality is the clean vitality source accessible to preserve defense fuel and can grant away decentralized of electricity. We ought to greatest utilize of it and needs source of essential information and labor base and putting up exhibit plants at positions and carrying out inquire about and considers for indigenization of innovation [8].

1.3.3 Hydro energy

One of the oldest power source on the plant is hydropower. The renewable source of hydropower it generates no air pollution is considered be the most important and eco-friendly. The most of the countries to give priority to improve hydropower being economic and technically beneficial. In Bangladesh, has very limited plain plants few hilly region in the northeast and southeast parts of the country the scope of hydropower generation. Bangladesh, the largest hydropower station being Karnaphuli hydropower station which has the capability 230 MW to generate. In 1962, At Firstly two turbines alternator of 80 MW produce electricity. In 1982, January third turbine generator started 50 MW power generator. In 1988 to fulfill additional potential two more alternators 50 MW capacity were installed. It's worked by Bangladesh Control Improvement Board (BPDB). BPDB identify other two hydropower generating station at prospective sites in Shangu river which produce electricity 140 MW and Matamuhuri river which produce electricity 75 MW. Chittagong Hill Tracts (CHT) in waterfall and rivers Karnaphuli, shangu and Matamuhuri with a lot of canals have good potentials for micro hydropower units. In Bangladesh, has been installed the first micro hydropower plant by Aung Thuwi Khoi Marma, residency of Mongjaipara town of Bandarban. This

power plant based on indigenous technology and first generated electricity 10 KW which supplied to a local Buddhist temple [9]. Two of the ongoing projects of BPDB these are 50-70 KW Mohamaya irrigation-cum-Hydro control at Miresorai and others projects Chittagong and rehabilitation at Baraka Upazila 50KW Micro-hydropower plant of Rangamati locale.

1.3.4 Biogas energy

Probably biomass is our most seasoned source of vitality after the sun. The biomass is organic matter that can be used the energy source such as wood, crops, seaweed, animal wastes. Biogas originated from biogenic material materials and comprises of 40-70% methane, 30-40% CO₂ and 1-5% other gasses. Biomass vitality does not radiate destructive gasses compared to other conventional vitality sources the primary positive side. Basically emits carbon dioxide and ethanol. Biomass energy is back the carbon dioxide for its claim utilize while fossil powers discharge the environment which is capable for nursery impacts and climate alter. Biogas source is enough for Bangladesh and it's universal from of renewable energy. The materials of biogas is based power era systems are generator, biogas and collection tank and moreover digester and also few channeling and controls that's the required of operation for electricity generation of the biogas. IDCOL had aim setting up to 37,669 the plant of biogas in 2012 additionally to be set up 25% of planned within the northern zone which however to be brought beneath the national framework. To develop biogas Grameen Shakti is working. This organization completed 13,500 biogas plants totally the country. Few organizations are working to advance biogas plants with their possess stores. Since 2011 total plants of biogas have been to set up by IDCOL and the several of organizations [9].

1.3.5 Tidal Power

Tidal control is one from of hydropower that changes over vitality tides into power. Bangladesh the coast has tidal rise and fall from 2 to 5 meters. According to literature, Bangladesh can generate tidal power by applying moo head tidal developments and medium head tidal developments from these coastal tidal sources. Zones like Khulna, Barisal, Bagerhat, Satkhira and Cox's Bazar regions [9].

1.3.6 Ocean wave energy

This energy is produced electricity from waves in oceans. Ocean wave energy is another reasonable class of renewable vitality source which makes a difference to reduce the hurtful greenhouse gases emissions is cooperated with the generation of power. In Bangladesh, ocean wave energy has potential of being an important source of electricity [9].

1.4 Electricity demand

Bangladesh the largest energy consumer are businesses and the private segment taken after the commercial and agrarian divisions. Bangladesh will needs calculated 34,000 MW of control by 2030 to support financial development of over 7%. At present for the nation is fair assembly the request which is ever developing mode. Government increase the era capacity through introducing unused control station by open and privet segments. In 1974-75, was 667 Mw electricity installed as in August 2016, it was 12780 MW counting 600 MW control consequence from India. Greatest control request of the nation always has been expanding and the rate has expanded over the past couple of a long time. Total population of one third still don't have get to to power. Can't maintain the quality control cause the deficiency of era and inadequately capacity and moo quality of transmission and dissemination systems. The development of greatest request from 1994-95 to 2014-15 it's colossal. Electricity demand increased rapidly after 2010 [10].

1.5 Future electricity demand

In Bangladesh, to increase power generation government has plans wide hoped request to assist development within the export-oriented and meets the demand developing center lesson. Whole speculation the power division over the following 15 a long time is assessed at \$70 billion. Population of Bangladesh only two-thirds is currently connected to electricity grid. The Government plans to Bangladesh decrease reliance on characteristic gas and towards coal with plans to produce 50% power by utilizing coal-based control plants by 2030. Another arrangements involves bringing in melted normal gas (LNG), growing utilize renewable assets, counting sun based and wind importing from neighboring countries. Bangladesh imports LNG gas to help met burgeoning fuel demands. A few LNG gas based control plants is planning in Bangladesh. Bangladesh effectively has overseen to execute large-balance sun based

domestic framework projects that can support the development of renewable vitality in our country, focusing on 20,000 MW by 2021 [11].

1.6 Methodology

In chapter 1 introduce the renewable energy in worldwide and introduce the renewable energy in Bangladesh. And also discuss electricity demand and future electricity demand.

In chapter 2 reviews of literature of renewable energy and its prospects.

In chapter 3 potentials of renewable energy in Bangladesh including present scenario of electricity, definition of energy potentials, potentials of solar energy sources, technical potentials, prospects of solar PV, potentials of wind energy and its turbines and stabilities and future prospects for wind energy, renewable energy target and wind energy, potentials of biomass, biomass innovations and prospects for control era, hydro source of potential.

In chapter 4 current status of renewable vitality in Bangladesh. In this paper viewed the governmental and non-governmental organization research work and their step. And also viewed research and development for renewable energy and what are the challenges and opportunities of renewable energy.

In chapter 5 sustainability and renewable energy, this paper viewed environmental impact and their importance. And also essential factors for sustainable development and renewable energy policy. Also viewed assessable and security of energy and their opportunities.

In chapter 6 discuss on final comment by conclusion and future work scope.

Chapter 2

Literature Reviews

Renewable energy technology have founded as quick-flourishing substitute vitality sources to bargain maintainable control creation for long haul. Elective a few advances re loaded to stand against across ordinary power propagation sources and convention vitality needs of buildings, cities and parcels [12]. We are able to our dependency of fossil fuels if we improvement and expansion of new technologies to grant the world's energy needs from renewable resources which are emergent.

Greenhouse gases that are the avail global warming from ardent fossil fuels that raise environment worries as ozone layer exhaustion and worldwide climate alter.

We can creation power from renewable vitality resources as geothermal energy, hydro energy, wind energy, ocean energy and solar energy. To reduce air pollution performed as electricity creation from renewable energy resources relief less nursery gasses.

Execution of renewable vitality frameworks remain electrical grids and to merger the energy requirement for long-standing time and maintain environment.

Renewable vitality systems can also subscribe on the part of energy price fixity and affordability [13].

The world's sustainable energy goals are short of perishable, more people have to entrance to electricity then always since.

Washington, May 22, 2019 in current years malignancy the World's is entrance brief of perceivability the worldwide vitality targets the Joined together Countries Economical Improvement Objectives for 2030. Assure affordability, feasible and present energy by 2030 stay probable but need preserved shots in chief come at a few of the world impoverished populaces and promote vitality supportability.

In current years, number of caste alieve barring electricity get down to roundly 840 million in 2016 and 1.2 billion in 2010. If not more entertained and step-up objects, 650 million caste nevertheless left outside of electricity in going to electricity by 2030.

Observing and pervaded the improvement the fields and sections will claim strong political assurance, long-term energy planning, enraged private pay up and sufficient policy and faster wide of new technologies.

The consequence of authenticity and affordability for sustainability energy ingress to amplify through interface the impoverished and the hardest come at householders, off-grid arrangements, counting sun powered lighting, sun powered domestic framework and developing smaller than expected networks.

Renewables regards global energy dealings in 2016 for 17.5% Vs 16.6% in 2010.

Francesco La Camera said, “Renewable energy and energy efficiency are key to sustainable improvement, enabling energy entrance, inspiring economic growth, establishing service and progressing health. We can diffuse the energy attenuation to all countries and assure that the benefits reach the most vincible communities” [14].

Renewable estimate for 2005 of worldwide final energy treatment the most eminent enhancement case in the power section and including worldwide capacity increasing more than 8% in 2013 (IEA 2014).

Worldwide energy treatment to increase 56% by 2040, including fossil fuels bring under controlling energy grid (US EIA, 2013).

For improving world and emerging economics to contribute to expand of renewables through the policy, constructing and funding. Renewable energy polices, mart and craft be on the increase they enhancement face to face new challenges which are multifaceted and very much complicated. The integration and abbreviation of several energy sources from a market, police and technical perspective bring more challenging. New technologies rely on the capability to construct, monitor and sustain energy infrastructure.

Most renewable energy policies focus on the power section, still big challenge for the renewable energy handcraft.

The source of quality situation and goals that can stimulate the private sector to take part in the evolution of renewable energy projects (UNDP, 2013).

The installation of novel policies and convey of renewable vitality markets and innovation may opportunity the acceptance of an in total vitality governance system.

Continuation of renewable vitality technologies may importantly avail to setting extensive technique towards more sustainable financial enhancement. Germany and Denmark display power in wind vitality innovations, the Joined together States. Germany and Japan maximum part allowance for solar PV technology and EU presents maximum allowance portion for biomass and biogas, wind and solar thermal technologies.

The outgoing objection with the acceptance and stretch of renewable energy technologies is double. The raise in the outgoing economics, whilst renewable energy novelty has traditionally been patent the exhibited world.

Use of mini-grids grown adopted of renewable vitality powered electrification in rustic and suburban zones. Intelligence and communication technology for the power administration and end-users services, progress that accommodate the integration the renewable energy sources in mini-grid systems, estimated quick continuation the use renewables.

Worldwide commission in renewable power retention and fuels grown more than quintuple above period 2004-2013. Entire worldwide commission in research and prosperity of the renewable energy technologies has nearly twofold above the past decenniad (REN21, 2013).

Whilst new worldwide commission in renewable energy stay comparatively high, remarkable reduce in the last various years. Worldwide commission in renewable power, outside hydropower project, was US \$214.4 billion in 2013 (REN 21, 2014).

Growing countries, the obstacle at a partly exchange to renewable energy are not just asymmetrical be calm and technology costs but the challenges of conforming long-term assurance and affordable finance (UNDP, 2013) [15].

Challenges touching renewable energy sources:

- Costs;
- Transmission;
- Barriers to supply;
- Policies;
- Oversupply [16].

Framework was taken by the energy security literature and expanded:

- Availability;
- Accessibility;
- Affordability;
- Acceptability;

Gracceva and Zeniewski (2014) recognize few attributes of energy secure systems:

- Stability;
- Flexibility;
- Adequacy;
- Robustness;

The type of bio energy is the renewable energy improve biogas to produce electricity. In recent years, integration system of bio-energy including other renewable vitality innovations, particularly solar vitality. Sun powered vitality to be proselyte and gathered within the chemical of fuel that can be utilized afterward.

Sun powered vitality is the foremost well known and quick increasing renewable advances. Power creation two modes sun powered photovoltaics (PV) and concentratingsun oriented control. Research on PV solar cells for power creation instantaneously risen in popular. The major navel of solar PV exploration in the last several decenniad to raise efficiency of solar cells [13].

Bangladesh has densely populated country and only 40% populace has entry to power per capita of 136 KWh per the year.

Bangladesh has workable renewable vitality and characteristic accessibility of substitute vitality originate convenience of enhancement in control section. Lack of energy sufficiency is opposing the socioeconomic and industrial progress of Bangladesh [17].

Chapter 3

Potential of renewable energy in Bangladesh

3.1 Introduction

Supply of vitality is rough is the central responsibility for the by and large improvement and enhancement of the way of life of human being in any nation in this present day period. The worldwide vitality necessity is expanding rough because of raise in populace and mechanical improvement. Consumption of vitality of the world come to 12,739.4 million tons oil identical (Mtoe) in 2013 that was 6629.8 Mtoe in 1980 nearly twofold. Sources of energy among oil calculates for the most noteworthy percentage 32.9% the part of taken after by coal 30.1%.The worldwide demand of energy would raise by the five times of the current request by 2100, its expectant. Currently, the world's vitality is delivered about three-fourth from the fossil of fuel origins. Fossil fuel burns essentially contributes to emission CO_2 which dependable to climate alter and effects of green house. During electricity production the average amount of CO_2 from coal is around 888 t CO_2/GWh taken after by oil and characteristic gas that's around 733 and 499 t CO_2/GWh as separately. The major challenge and concerns, the worldwide warming and nursery impact which are considered to achieve maintainability within the world. Bangladesh, commercial vitality like as normal gas, coal and oil that's are primary contributing source in essential vitality utilization. Consumption of essential vitality was increased in almost double since 2002 to 2013 which was 14.8 Mtoe in 2002 which increase 26.7 Mtoe in 2013. Our country the amount of these energy has very limited. The end of 2013 she had as it were 1063 million tons of reclaimable coal reserves and 9.7 trillion cubic feet (TCF) of common gas. In Bangladesh, demand of electricity has raised significantly and the generation totally depends on fossil fuel. Besides, generation of power contributes 40% the whole CO_2 emission within the nation. Generation of power within the nation has raised 7418 MW against a request 9268 MW

at 2014. Bangladesh government has taken initiatives to improve and enhance the sources of renewable to optimize vitality emergency and natural impacts. Bangladesh, the renewable energy demand. In between the sources of renewable is available biogas is considered that can be utilized not as it were cooking but moreover in creating power. In our nation guarantees the most extreme using of sun powered vitality the geographical location. Besides, the solar photovoltaic (PV) is suitable popular technology the rural off-grid, coastal area and hill tracks in mainly Bangladesh. A few government and non-government has taken various activities to creating power by the small wind and micro-hydro turbine although that's are not much widespread [18].

3.2 Present scenario of electricity

In Bangladesh, one of the current major concerns electricity crisis. Generation of electricity is from of energy and it's the critical input for the industrial, technological and economic development. The country 41.1 million individuals underneath destitution. The destitution mitigation adequate power supply must be need for country's GDP development as continuously.

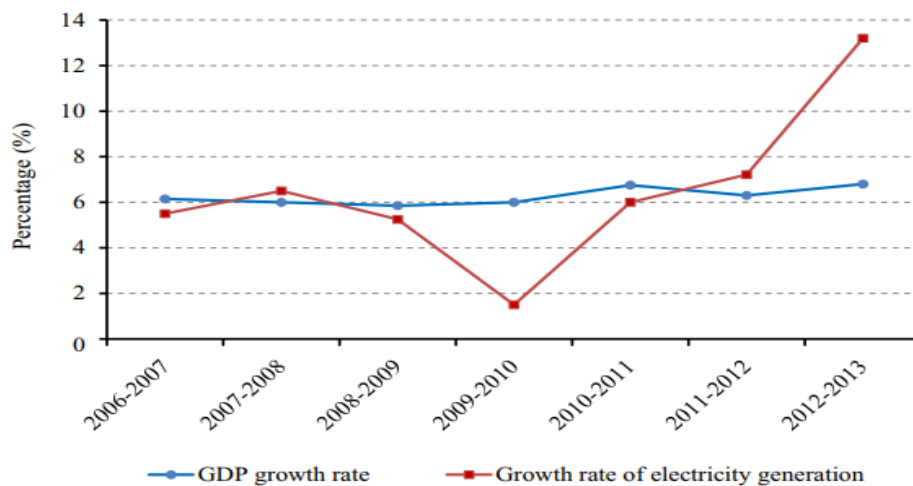


Figure: 3.1 Relationship between power era and GDP development.

From this fig. 3.1 shown generation of electricity the rate of growth was 5.5% the financial year 2006-2007 which was expanded to 13.2% within the financial year 2012-2013. The development rate of GDP has expanded to 6.8% the monetary year 2012-2013 from 6.155 the monetary year 2006-2007. Generation of electricity Bangladesh is profoundly subordinate on fossil fuel particularly on common gas. Total retention capacity was around 10,709 MW counting 5880 MW from the open segment and the

private segment from 4829 MW, where the accounts for 62.39% natural gas crude fabric for the generation of control. The industrial development, economic growth and rapid urbanization of the nation have raised the request for power. Recently, the entry of power has raised to 68% associated with renewable vitality add up to populace from 47% with per capita era of 348 Kwh, compared the other improving country. Government vision 2021 to the electricity of all ranges of the nation. Though Generation of power is expanded a noticeable sum the year 2012-2013, fig.2 till stack shedding exists of 1000 MW. Fig.2 whole generation of electricity capacity within the country was 5166 MW within the monetary year 2008-2009 that expanded to 8525 MW within the monetary year 2012-2013 normal raise rate of 13%. Besides the greatest era of power has expanded 6350 MW within the monetary year 2012-2013 normal yearly expanded rate of 10.51% from 4162 MW within the financial year 2008-2009. Annual electricity installed capacity is higher than the annual demand except the year 2008-2011. The year of 2011, consumption of electricity in Bangladesh was about 39533 GWH. Consumption of electricity is increased about 192.70 TWH in 2035 [12].

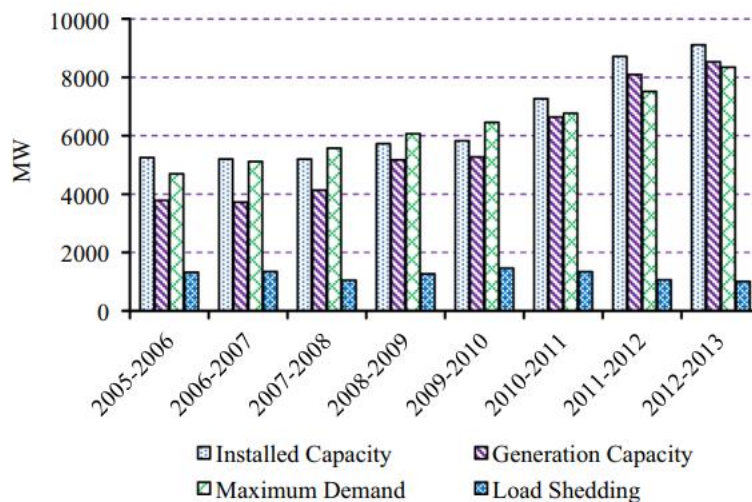


Figure: 3.2. Electricity crisis scenario of Bangladesh.

3.3 Definition of energy potential

Potential vitality is the vitality by held question since its position relative to other objects, stresses inside itself, its electric charge or other components.

Potentials of renewable energy are classified into various categories they are namely available potentials, theoretical potentials, economic potentials and technical potentials. Refers to the theoretical potentials to the add up to vitality accessible for expulsion in a

characterized zones without thought of specialized limitations. Therefore, the theoretical potential is much, due to forms of energy like as sun powered and wind vitality. Refers to the available potentials, this part of the theoretical potentials without causing influence on the environment that can be harvested easily. Refers to the technical potentials the amount of energy by utilizing existing advances and depends the time point evaluation that can be exploited. Refers to the economical potentials the sum of potential vitality is being economical practical by recently given advances. The economic potential, by the define limits of specialized imperatives and financial angles. Consequently, the economic potentials rely on the costs energy sources competing.

3.4 Potentials of solar energy sources

In Bangladesh is located at between 20.30° and 26.38° north scope and 88.04° and 92.44° east longitude with of a zone of 147,500 km² that is a perfect area of utilization for sun powered vitality. Bangladesh is performed by employing a GIS-based Geospatial Toolkit (GST) and NASA source Meteorology and Sun powered vitality (SSE) sun powered radiation information. The assessment of solar and wind energy sources (SWERA) is used GST in one of the tools SWERA application created by the Joined together Countries Natural Program (UNEP) venture financed by the worldwide natural Office (GEF). In Bangladesh, due to sun oriented radiation information is limited. Renewable Vitality Investigate Center (RERC), Dhaka College for the six distinctive station in Bangladesh (table-1) compared and measured data from by this six stations a NASA SSE set for the part out of July 1983 to June 1993 was utilized. Set as the same location information change from 66% to a most extreme 4.52% from the NASA SSE information. Estimation the hypothetical potentials of sun powered source based on the accessibility of information on sun oriented light and zone of land. Social and technical limitations by introduced the theoretical potentials is the converted into technical potential. Social obligations basically concern the recognizable proof of appropriate areas of sun oriented vitality advances for installation. Specialized obligations responsible the characterization of abuse advances and the organizational projects the implementation of renewable energy technology conditions that have to be satisfied.

Table 3.1

Normal day by day sun powered radiation at 14 location in Bangladesh.

Station name	Elevation(m)	Latitude(degrees)	Longitude(degrees)	Radiation (RERC) (kwh/m ² /day)	Radiation (NASA) (kwh/m ² /day)
Dhaka	50	23.7	90.4	4.73	4.56
Rajshahi	56	24.4	88.6	5.00	4.87
Sylhet	225	24.9	91.9	4.54	4.57
Khulna	11	22.8	89.6	-	4.55
Rangpur	230	25.7	89.3	-	4.86
Cox's bazar	76	21.4	92	-	4.77
Dinajpur	194	25.6	88.6	-	4.99
Kaptai	345	22.5	92.2	-	4.71
Chittagon g	118	22.3	91.8	-	4.55
Bogra	59	24.8	89.4	4.85	4.74
Barishal	31	22.7	90.4	4.71	4.51
Jessore	23	23.2	89.2	4.85	4.67
Mymensingh	114	24.8	90.4	-	4.64
Sherpur	308	25	90	-	4.67

Data from RERC, Dhaka University, Bangladesh.

3.4.1 Theoretical Potential

In Bangladesh solar map it appears that the sun based radiation within the run of 4-5 kwh/m²/day on approximately 94% of Bangladesh by Geospatial Toolkit provides (fig.3.3). The information on normal per day sunny hours (fig.4) and radiation of sun based monthly were taken from NASA SSE for 14 broadly disseminated areas in Bangladesh by utilizing the crossover framework optimization show for Electric Renewables (HOMER) program. The annual mean solar radiation is 0.2 kwh/m²/day and average sunny hours per day are 6.5. Shows that Bangladesh receives theoretically

approximately 69,751 TWH of solar energy every year that is more than 3000 times higher than the current 2006 electricity generation in the country. Anyway, abuse, imperatives like as arrive utilize, geological range and climate are discourage. Various sun oriented vitality innovations are constrained by distinctive variables. Get detail information it's essential to look at the potential of sun powered vitality from of view point of particular application.

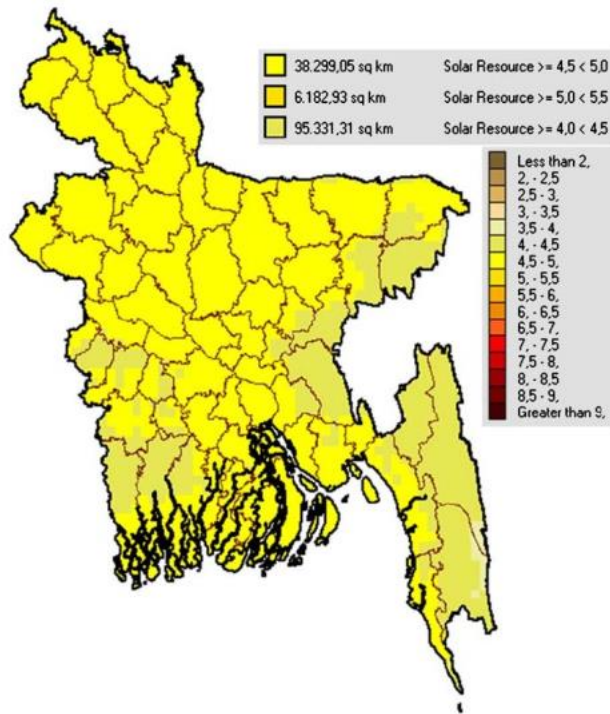


Figure: 3.3 Sun based radiation (kwh/m²/day) and region of Bangladesh with most elevated potential for sun oriented vitality utilization.

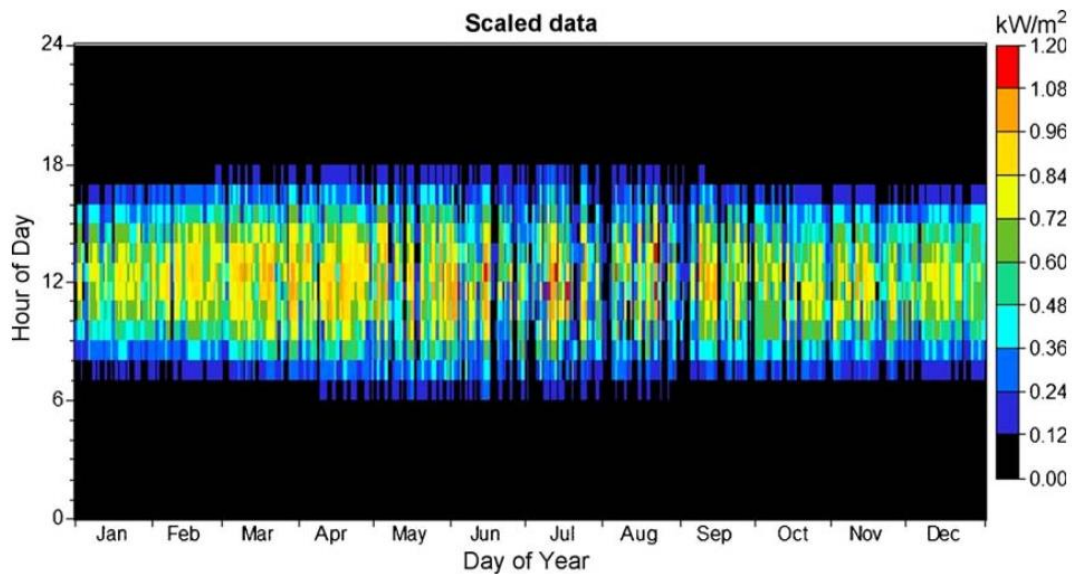


Fig.3.4. Month to month normal daylight hours in Bangladesh.

3.4.2 Selection of technology

Several sun based vitality advances are accessible in world showcase. Three Innovations are suitable for Bangladesh are Solar Home System (SHS), Concentrating solar power (CSP), Grid-connected sun powered PV and Cross breed frameworks (sun powered, wind and diesel generator) [19].

3.4.3 Technical potential

Power generation by the solar source advances are so critical for giving a main share of the clean and renewable vitality required within the future, since they are the cost-effective among the renewable control era advances. Sun powered technology for control era has proved the one of the most alluring choice for electricity era in grid-connected and disseminated modes. This era can be done by photovoltaic (PV) and concentrating sun oriented control (CSP) frameworks. The photovoltaic advances like as the single other is multi-crystalline organic, organic dry-sensitized, thin film cells and multi-junction sun oriented cells that have observed a raising tendency for their utilities as reinforcement vitality era frameworks for rooftop and small-scale petitions. Concentrating solar power advances generation like as sun powered dish, direct Fresnel reflectors and parabolic trough and control tower are picking up energy for large-scale control era of solar by utilizing is noticed mainly several advances, materials and control procedures for compelling sun based vitality change, control, vitality capacity and usage approaches [20]. The concentrating sun oriented power (CSP), large-scale CSP mostly concentrate sunlight by reflected. The CSP technology is clean vitality with no fuel fetched but required colossal arrive in their primary disadvantage. California involve 6.5 km² of arrive region to create 354 MW by the Solar energy Generating Systems. An annual average DNI (Direct Normal Irradiance) of the required area is 2000 Kwh/m² to generate 100 MW electricity of electricity is about 2 km². Bangladesh, accepts average annual (DNI) it's the from of CSP that's means sun's direct normal irradiance nearly 1900 kwh/m² which is adequate to function a CSP plant in the northern side of the country is suitable for the site of CSP. The capital taken a toll of CSP plants will gotten to be \$3800kwh electricity by the year of 2015. This CSP to moderate control emergency of Bangladesh [21]. Government of Bangladesh has already include CSP in renewable energy policy in 2009. Generally, the sun based

radiation within the extend of 100-300 w/m² the normal annual power density. In this way, with a sun oriented effectiveness of 10% an range 3-10 km² is required to set up an normal power yield of 100 MW, that is approximately 10% of an expansive coal or atomic control plant. Not like the other vitality change advances, sun oriented vitality innovations cause not one or the other clamor nor contamination, thus they are regularly introduced to decrease development costs. The application solar energy to identification a suitable locations is essentially the hunt for appropriate housetops and unused arrive. In Bangladesh, a ponder recommended that 6.8% that is 10,000 km² add up to arrive is vital for control era from sun based PV to meet power request of 3000 KWh per capita/year. Other consider found that add up to family rooftops region is around 4670 km² that's approximately 3.2% of add up to arrive range of the nation. Dhaka city (urban region) have 7.86% of add up to arrive is reasonable for sun based PV power era. Consider the framework accessibility, Bangladesh have as it were 1.7 % of the arrive is accepted appropriate for solar PV power generation. The capability of framework associated sun based PV is determined utilizing the yearly cruel esteem of sun powered radiation 200 w/m² and effectiveness of sun based radiation is 10%. In Bangladesh, the specialized dynamic of grid-connected of sun based is calculated as approximately 50,174 MW. Bangladesh, while the potential advertise for grid-connected PV framework is in thickly populated urban and zapped zones, the potential showcase for planetary home classification (SHSs) is family units without get to the national network organize particularly those in inaccessible and precipitous zones. Following an overview report, a showcase of solar home system of roughly 0.5 million families coming to 4 million within the future is imagine in Bangladesh [19]. Considered normal standard 50-wp sun powered board for each family, the specialized add up to capacity will be proportionate to 200 MW. Largest photovoltaic sun powered domestic framework (SHSs) accessible in Bangladesh is of 120kw electricity charge of 713\$. The taken a toll of a sun based dish of 25kw electricity is 150,000\$ and is anticipated to gotten to be 50,000\$ before long. Charge per watt for SHS is 5.94\$ and sun based dish is 2\$ respectively. The same capability is pertinent for half breed framework, only this framework is reasonable for rustic non-electrified inaccessible ranges. Evaluated the inancial reasonability of SHSs in Bangladesh and Techno-economic reasonability of half breed frameworks was described.

3.4.4 Prospect of solar PV

There are a few components that can be make sun based PV more competitive in future.

3.4.4.a Cost of solar PV

The prosperity of the taken a toll situation of sun oriented PV is exceptionally vital as parameter, so it decides its showcase entrance in progressing nation in Bangladesh. The most of the items appear a diminish in unit taken a toll with diminished fabricating encounter. Decreased the taken a toll of PV from various hundred US \$/WP in 1970 to around US \$ 5-6/WP the mid in 1990s. Idealized show, the costs advance as a consistent learning bend. The prospect for sun based PV are uncovered when extrapolating the verifiable learning fetched bend that it show a learning the rate 20.2%. The current financing activities on PV arrangement will lead to an increment in involvement and this will likely lead to a noteworthy drop costs. The recent market speed is increased that can be assessed that the cost will drop around 20% each four a long time [19].

3.4.4.b Efficiency

The current efficiency is far below the theoretical efficiency. This gave a simply adequate room for the change of sun powered productivity. The observation was the ostensible proficiency of to begin with era commercial modules gave a extend of 10-15%.The crystalline silicon its proficiency cell expanded from 13% in 1976 to about 2% in 1992. By the same period, commonplace module productivity rose from 7-8 % to 10-13%.The recent assured improvement the of industry help to invigorate the presentation of moved forward fabricating methods and innovation. Secondly era of sun powered PV that's more competitive, is anticipated to seem over the coming decade [19]. In later a long time the effectiveness of sun oriented power increased gradually. Sun based economy, the accessibility and reasonableness of sun powered control will develop at an amazing pace [22].

3.4.4.c Limitation of fossil resources and increasing prices

Happening at a quick rate the depletion of fossil fuel is developing hole between the request and generation of fossil powers. Due to the same time, these powers involvement an inverse drift to that of solar PV that is the cost for delivered power is expanding due to the increment within the cost of fossil powers and natural costs that's for CO₂ emanation [19].

3.4.4.d Benefits of sun powered vitality

The sun powered vitality is potential of sun then other energy prospects for Bangladesh. The solar energy is more competent of satisfying the world's power requests, as the sun oriented power is theoretically abundant enough. Sun oriented vitality isn't as it were economical but only it's renewable. International warming is hurtful affect on the climate, environment and human wellbeing. Specially, coal-fired control plants are significant paternity of Green House gas (GHG) that's are responsible for 25% anthropogenic emissions. CO₂ outflow range per of kilowatt hour created from coal, normal gas, and sun based are evaluated as.64-1.63, .27-.91, .03-.09kg are respectively. The sun oriented control has becomes one of the foremost attainable arrangements to the recent worldwide warming emergency. Considering the sun powered vitality is non-polluting, solid and clean source of vitality. Although the installation of solar power systems require upfront environment. Not like the charge of fossil powers that's are inclined to considerable cost swings, the temperate request for sun based control is generally steady over long periods. The free of clamor contamination and solid with exceptionally small within the way of required support. However, the sun based modules to improve the energy generation capacity [22].

3.5 Potentials of wind energy

The renewable sources, wind energy becomes well known all over the world due to its alluring commitment on nearly zero fuel fetched and lower natural impact than ordinary sources with guaranteeing until the end of time vitality supply. The wind vitality acceptance capacity of the wind creator is higher as weighted to photovoltaic creator. The energy sources of conventional is contribute to climate alter and international microwaving are confined other than depleted [23].

3.5.1 Grid-connection of wind turbines and stability

The level of process and technological developments of a nation depend on electricity consumption. Globally and originally Bangladesh is one of the most reduced power consumption nation, Control deficiency is the foremost critical infrastructural restriction in enhancement and advance. Bangladesh, has not however guaranteed 100% power openness but has arranged to reach by 2021. Now as it were 46% individuals are connected on grid-connected and 88 million individuals have no get to power [23]. Energy demand for the power has been expanded due to developing

populace and temperate improvement. In Bangladesh, power grid is extending quickly. Grid connection of larger windfarms tens of MWs is mind and will have to be argued encourage for particular areas. Numerous inaccessible zones there will be inadequately network connected capacity accessible. The framework solidness could be a point of concern. Conveying the wind turbines is the as it were source of wage for a windfarms, a continuous lattice association is crucial. The display status national framework will not be connected large windfarms scale. The costs for framework association of windfarms will be generally tall since of the huge distance to closest reasonable national framework association point and expansive ventures in difficult product like as transformer stations, switches, controllers. Future windfarms could be combined with advancement of the national network and costs may well be socialized and not loaded at statement windfarm the of. The improvement of the national network is pointed at more solidness, extending network get to and interfacing modern control plants [24].

3.5.2 Wind celerity

Bangladesh comprising of numerous humble islands and 724 km long coast line within the Inlet of Bengal encounters south-westerly relentless wind, calm north-easterly exchange wind, arrive breeze in winter months and sea-breeze impact within the months summer. Wind speed of annual mean at 30 m tallness is than more 5m/s. North-eastern virtues Bangladesh of, wind speed is up 4.5 m/s while around the virtues of the nations is 3.5 m/s. Various organization of Bangladesh have districted several place in distinct years in show the table 3.2.

Table 3.2

Wind mappings of distinctive areas in unmistakable a long time.

Place	Sensor height (m)	Annual avg. wind speed (m/s)	Organizations
Kuakata	25	4.54	
Kutubdia	25	4.18	Wind mapping at
Char Fassion	10/25	3.28/4.07	7 place by
Patenga	25	3.84	LGED/BCAS/DF
Cox's Bazar	25	3.34	ID
Noakhali	25	2.96	(1996-97)
Kutubdia	25	4.18	
St Martin	25	4.96/4.56/4.8	Wind mapping at
Ptenga		6.70	St. Martin by

Feni		6.20	Wind mapping at 5 places by PDB (2003-05)
Kuakata	50	6.89	
Kutubdia		6.73	
Mognamaghat		7.1	
Kuakata	30	4.23	Wind mapping at 10 places by LGED/BUET/UN DP (2005-07)
Pakshy	30	2.78	
Khagrachari	20	3.28	
Naogaon	20	1.92	
Panchagarh	20	3.00	
Kishoregonj	30	2.37	
Kutubdia	20	3.58	
Cuet	20	2.33	
Munshigonj	40	6.26	
Sitakunda	30	4.15	

The wind energy for Bangladesh are appropriate to tackle the wind vitality specifically Patenga, Kuakata, Kutubdia, Megnamaghat and Munshigonj based on the information (table 3.2) carried at 50 meters stature in inland. On the off chance that these put are conducted more than 50 meters tallness, hoped it'll unquestionably surpass the wind celerity esteem more than 7 m/s at tallness 80-100 meters, it's tallness extend are accessible in advanced wind turbines. It is additionally expected that on the off chance that the conducted information would be in seaward the wind celerity also increased [23]. Due to constrained wind asset potential which is as it were the coastal locales, stand-alone wind turbines are not thought in this think about [19].

3.5.3 Future glance for wind vitality

In 2002, worldwide installed capacity were over 32 GW and in 2008 up 122 GW the wind of. Wind potency contributed to entirety renewable control is 39% of world potency where it surpassed 1470 GW 2012. Year of 2012, world add up to introduced capacity of wind control was expanded to 283 GW by including circa 45 GW, which

has 19% of add up to sum. End of year 2012, add up to wind control capacity was accessible to supply the least 2.6-3% of world power utilization. In spite of the fact that wind vitality as of now speaks to almost 0.1% add up to power it has the speediest moderately development rate of any power creating innovation. The increasing with misuse of wind vitality the fetched of wind turbines get down significantly by 25% within 1982 and 1997. The biggest wind turbine introduced Bangladesh in is 225kw at as it were 50 meter heights, in spite of the fact that the world biggest appraised capacity is 7.58 MW with generally tallness 198m and the tallest wind turbine is 210m build up in Poland. The Danish vitality office predicts that taken a toll diminishment of 50% can be accomplished by 2020. However, thriving enough energy with cost for ordinary innovations and thriving natural cost, wind control in getting to be increasingly appealing [19].

3.5.4 Renewable vitality target and wind vitality

Renewable sources, getting to be increasingly mindful of the need of renewable vitality to decrease the sum of nursery gases, Bangladesh set renewable has vitality objectives. The targets of renewable vitality can be realized utilizing biomass, sun based and wind vitality. Hydropower have not does much potential since no expansive tallness contrasts are show within the nation since the accessible arrive ought to be basically utilized for nourishment generation, expansive scale production of biomass isn't conceivable. Renewable vitality source the sun powered vitality has incredible potential and has had a fruitful rollout so distant. These sun oriented frameworks are restricted to small-scale era a family level in zones where no network association is accessible. The multi-megawatt sun oriented vitality plants the big disadvantage is that an extensive zone must be accessible to set up the PV boards. In Bangladesh, this put is difficult to final since all the gainable space it's utilized for horticulture and nourishment generation. Wind vitality needs essentially outside space and can effortlessly be united with agrarian and is hence an curiously choice. Government of Bangladesh has set renewable vitality evolvement targets for various advances for from year each 2015 to 2021, "Renewable Energy Development Targets". These targets require an extra 3,100 MW of renewable vitality astringency settled by 2021. The modern capacity ought to be given by sun based 1676 MW or 54% and the wind 1,370 MW or 44%. These intention be can seen as challenges. Other than large-scale era of wind vitality, the deliver of wind vitality in a framework combining medium scale sun based vitality, a

battery and mini-grid at the level of a town, that may well be exceptionally curiously as well. Although commercially perspective this is not so much, more providing electricity to people therefore this is reduce electricity crisis and people have to access electricity [24].

3.6 Potentials of biomass

Bangladesh has abundant potential of renewable energy. Major renewable sources of renewable energy are solar energy, wind energy, hydropower and biomass. However, investigate exercises, utilization and advancement of other renewable assets for power era are till the at essential tallness. Biomass is similar the of most promising vitality renewable source for because of Bangladesh. Nowadays, biogas based power plants are being installed. Besides, the possibility of wind energy based control plant depend on the accessibility of coastal regions and seaward islands. The potentiality of hydro power is exceptionally constrained but the Chittagong uneven districts. Other stout of renewable paternity having solid plausibility but yet not investigated incorporate wave, tidal spirit, bio fills and gasohol and control geothermal. The common biomass assets accessible in Bangladesh are agrarian trim buildups, wood buildups, creature squander and metropolitan strong squander etc. Resource take advance of can on be a large scale for power era. Firstly, total biomass production is estimated and then the vitality stout is weigh by applying the person recuperation rate, buildup to surrender proportion, dampness substance and calorific esteem.

3.6.1 Predial crop surplus

In Bangladesh, the main agricultural crops are wheat, rice, maize, large coconut, the groundnut, bean, few vegetables, the jute and a few sugarcane etc. Rural crops create buildups that can be utilized to produce vitality. Crops buildups are collected same either the time at or after collecting the essential crops of. Constructive arrive utilize for agricultural is 55% of the whole arrive range of Bangladesh. The epoch of restudies depending, two sorts of trim restudies. One is buildup field and another is handling buildup. Generally, Field buildups are utilized as fertilizer and culled the from field abaft harvesting. And prepare buildups are collected from the plants, where crops are assist prepared. The total biomass energy cover about 46% by rice, rice husk, straw, from bagasse and sugarcane jute adhere. Edit buildups are not as it were used renewable vitality source but too also for cooking and manufacturing crude fabric. Bangladesh,

there supply is commercial no of gas within the provincial regions. So, the town individuals are agrarian trim restudies (thatch, husk,) main paternity of cooking fuel taken after by dry dairy animals waste, clears out and twigs, woods and kitchen by item. The era proportions for edit buildups have been utilized for book keeping total era of the comparing buildups. The recent study, a few neighboring south Asian developing nations, the rate of the buildups era and recuperation proportions for rural crops are taken after. Assumed the buildups recuperation rate has been as 35% for the field trim buildups and 100% recuperation in case of handle trim buildups. In Bangladesh, rice is the most agrarian edit that covers 76% of the overall agrarian range and supplies 70% of the entire caloric necessity for country (Table 3.3).

Table 3.3

Gauges of agrarian edit generation in Bangladesh in 2009-10 to 2010-11

Crop	2009-10 Areas (acres)	2009-10 (kton)	2010-11 Areas (acres)	2010-11 (kton)
Rice				
Aus	2,431,692	1709.127	2750,015	2132.821
Arman	1,39,92,863	12,207.162	13,95,09,33	12,791.500
Boro	1,16,31,160	18,058.962	11,787.978	18,616.500
Total rice	2,80,55,515	31,975.251	2,84,88,926	33,541.101
Sugarcane	290,354	4490.812	287,080	4671.348
Vegetables (Summer)	626,917	1445.162	645,552	1468.159
Vegetables (winter)	471,451	1555.271	470,414	1593.681
Total vegetables	1,098,368	3000.433	1,115,966	3061.840
Wheat	929,766	901.490	923,470	970.085
Jute	1,028,832	5089.728	1751,325	8385.840
Pulses	593,384	220.786	627,129	232.127
Coconut	6071	402.391	7283	325.949
Groundnut	82,997	53.467	78,470	53.664
Maize	375,628	887.391	409,070	1018.282

Cotton	23,651	15.343	24,147	14.453
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From the agricultural crops production presents status of FY 2009-2010 to 2010-2011. Following the BBS, the piece of rice making in FY 2010-11 was 33,541.101 kilo tons of which Aus be responsible for 2132.821 kton, Aman 12,791.500 kton and Boro 18616.780 kton. Add up to rice generation be responsible for 1709.127, 12,207.162 and 18058.962 kton are individually in FY 2009-10. By this part, increased the land of range for rice headway from 2805715 sections of land to 28488926 acres. Rice husk, rice straw from and bran are rice the most buildups delivered rice. Rice straw is the dry stalks of cereal plants which are collected as field residues. On the diverse hand, rice husk, which is outer the ground of grain and rice rice and is reckon straw as prepare buildups. Generally, Bangladesh, rice bran and rice are utilized as nourishment straw cattle, poultry and fish etc. These days, rice is becomes husk utilized for power making is a little scale. In Bangladesh, the outturn of rice risk is thriving. The sector of rice processing is the most buyer of rice husk vitality. The rice husk vitality, about 70% is devoured by rice parboiling framework. In Bangladesh, the add up to sum of the redeemable rice buildups in FY 2010-11 that was 58,504.07 kton of which 51.54% and 48.46% were moor and handle buildups individually (Table 3.4).

Table 3.4

Era and redeemable rates of agrarian buildups in Bangladesh in FY 2010-11.

Crops	Residues	Residues	Generation ratio (kton/capital/day)	Residues generation (kton/year)	Residues recovery (kton/year)
Rice	Field	Process			
	Straw		1.695	56,852.17	19,898.26
	-	Husks	0.321	10,766.70	10,766.70
	-	Bran	0.83	27,839.11	27,839.11
Sugarcane	Tops		0.3	1401.40	490.50
	-	Bagasse	0.29	1354.70	1354.70
Wheat	Straw	-	1.75	1701.15	595.40
Jute	Stalks	-	3	25,157.52	8805.132
Maize	Stalks		2	2036.56	712.80

	-	Cobs	0.273	278	278
	-	Husks	0.2	203.65	203.65
Groundnut	Straw	-	2.3	123.43	43.20
	-	Husks	0.477	25.60	25.60
Cotton		Stalks	2.755	39.89	39.89
Vegetables	Residues	-	0.4	1224.73	428.65
Pulse	Residues	-	1.9	441.04	441.04
Coconut	-	Shells	0.12	39.11	39.11
	-	Husks	0.41	133.64	133.64
	Subtotal	-		88,938	31,427.62
	-	Subtotal	-	40,689.4	40,680.004
	Total	-	-	129,618.4	72,107.66

In Bangladesh, sugarcane is similar of most stout biomass assets. The portions of sugarcane development in FY 2010-11 and FY 2009-10 were 4671.348 and 4490.811 kton individually. The arrive region for sugarcane advancement has increased from 290354 sections of land to 287080 sections of land. Granulated, water, sugar, bagasse, molasses, and dry clears out are take advantage of as foremost assets of biomass vitality. The redeemable sugarcane buildups the total amount in FY 2010-11 was 27010 kton of that's 26.58% and 73.42% were moor buildups and prepare buildups separately. In Bangladesh, vegetables and courteous all through year. Vegetables range as summer and are winter depends on season. The amount of vegetable tillage in FY 2010-11 was 3061.840 kton, of that summer incur for 47.50% and winter 52.50%. Add up to vegetables making for FY 2009-10 was 3000.433 kton that summer and winter incur for 48.16% and 51.84% individually. Increased the tillage zone from 1098,568 sections of land to 115,966 sections of land. In FY 2010-11, total amount of vegetable residues was generated 1224.73 kton, of which 428.65 kton was recovered. Generally, wheat straws are used as biogas energy source. Increased the add up to headway of wheat from 910.490 kton (FY 2009-10) to 972.085 kton (FY 2010-11). But decreased the cultivating region from 929,760 sections of land to 923,470 sections of land. The redeemable buildups tumid the total amount owing to 552.16 kton and 595.470 kton. Jute is yclept the brilliant fiber in Bangladesh. As a rule, jute are stalks biomass vitality paternity. Increased the add up to ranch of jute from 5089,728 kton (FY 2009-10) to

8395,850 kton (FY 2010-11) which than was 64.96% over the anterior year. The cultivating zone has overgrown owing to 028,832 sections of land to 1751,315 sections of land. The add up to sum of renewable buildups reflex owing to 534,451.44 kton to 8815,632 kton, which 37.12% former than the outturn in FY 2009-10. In Bangladesh, ibid was several sorts of beats are courteous which are locally versed as Gram, Arhar, masur, Motor, Mung, Muskalai, Kheshari and Karikalai. Plenary tillage in FY 2010-11 and were 232.127 and 220.786 kton Fy 2009-10 individually. Expanded the arrive region for tillage owing to 593,384 to 627,129 sections of land. The redeemable resides tumid the total amount kton to of 146.82 154.30 kton. Other vitality making owing to praedial crops incorporate coconut shells, maize husk, coconut stalks, cotton straw stalks, groundnut husks and. The add up to ranch has abject owing to 402.39 (FY 2010-11) kton to 325.949 (FY 2009-10). But the arrive region for headway has reflex by 10.56% and .2% are individually, whereas the recuperation by 2.88% and 10.50% individually.

3.6.2 Creature excrement

The blend of moisture, natural fabric and fiery remains is known as animal manure. The fertilizer can be deteriorated both in oxygen consuming and anaerobic conditions. Carbon and ballast embodied arsenal are formal under aerobic condition dioxide. On diverse hand, methane, carbon dioxide condition gas and ballast organic arsenal are shaped at anaerobic. General sources buffaloes of animal goats, manure are cattle, and in the country sheep. Biomass vitality generation and control era utilizing creature excrement may ended up an successful vitality and control request arrangement in inaccessible and provincial ranges of Bangladesh. In this way terrible odors of excrement and disturbance gas outflows from the application of crude fertilizer are too diminished. Biogas delivered from excrement can merger the purl fuel request. Also, to generate electricity gas generation from butcher house squander should plausibility in little scale. The amount of excrement manufacture from the creatures depends on age progeny and bolstering propensities. Too, the sum of compost surrender shifts with the seasons. For case, the waste yields are produced more within the blustery season than that of summer, since grasses develop more amid sprinkling.

3.6.3 Civil strong squander (MSW)

Civil strong squander is the heterogeneous composition of waste that's natural and inorganic, quickly and gradually biodegradable, new, unsafe and non-hazardous produced from different sources in urban regions due to human exercises. In general, per capita squander era depends on the financial status, nourishment, propensity, age, sexual orientation of family individuals and seasons. The increment of strong squander in each Asian city is basically ascribed to populace increment, industrialization and the advancement of living benchmarks. The government have sodden that Green Efficiency (GP) measures such as lessening, reusing, reuse and recuperation are fundamental components in solid-waste administration as a from of combat the fast development rate of squander within the cities. National mindfulness campaigns on GP pardon are frequently to advance reusing exercises. Bangladesh like most of the creating nations is confronting a genuine natural issue due to colossal sum of MSW era and its fumble. The fundamental source of metropolitan strong squander (MSW) in Bangladesh are family units, commercial zones, businesses and healing centers. Plastic, aril, eraser, textile, wood and additional commercial materials this are the components of MSW. A list of strong squanders created in businesses and their items are dis played in (Table 3.5)

Table 3.5

Natural strong waste creating businesses and their items.

Manufacturing Industries	Major products
Food	Fast food, vegetables, oil, sugar, tea and dairy, etc
Tobacco	Cigarettes and biddies, etc
Textile	Cotton yarn, synthetic yarn, cloth, jute mat and carpet, etc.
Paper and publishing	Paper, newsprint, books and newspaper etc.
Wood products	Hard board, particle board and cork products etc.
Leather products	Footwear, bags, luggage etc.
Furniture (wooden)	Variety of wooden furnitures.
Rubber	Cycle tire, tube, tube, rubber footwear.
Plastic	PVC pipe, office and households equipments, etc.

Wheat warm recuperation incinerator innovation is utilized to change over the MSW into vitality, which employments natural MSW as fuel. Taking after the statistics-2005,

the era of MSW in six city enterprise of Bangladesh to be specific Dhaka, Chittagong, Khulna, Rajshahi, Barisal and Sylhet are shown in (Table 3.6).

Table 3.6

Era of MSW in six city organizations of Bangladesh in 2005.

MSW generation	Dhaka	Chittagong	Khulna	Rajshahi	Barisal	Sylhet
Population(million)	11	3.65	1.5	0.45	0.40	0.50
MSW generation (kton/day)	5.340	1.315	0.520	0.170	0.130	0.215
MSW generation rate (kg/capita/day)	0.485	0.360	0.346	0.378	0.325	0.430

Municipal Solid Waste (MSW) was produced at the most reduced rate of 0.325 to the most noteworthy rate of 0.485 kg/capital/day and strain untaught was 0.387 kg/capital/day. In the six city corporations generated a add up to of 7.690 kton squander every day. The Dhaka contributed the most noteworthy amount of 5.340 kton, which is approximately 69% of the whole squander stream. Added approximately Dhaka Chittagong and 87% of the municipal solid waste daily. Counting tall development rate of populace, urbanization and industrialization in general socio-economic condition of the nation are capable for the exceptionally rate of municipal solid waste (Table-3.7).

Table 3.7

Source of rate of MSW era in six city organizations of Bangladesh.

Sources	Dhaka (MSW generation %)	Chittagong (MSW generation %)	Khulna (MSW generation %)	Rajshahi (MSW generation %)	Barisal (MSW generation %)	Sylhet (MSW generation %)
Residential	75.86	83.83	85.87	77.18	79.55	78.04
Commercial	22.07	13.92	11.60	18.59	15.52	18.48
Institutional	1.17	1.14	1.02	1.22	1.46	1.29
Municipal services	0.53	0.51	0.55	1.24	1.15	0.80
Others	0.37	0.60	0.96	1.77	2.32	1.40

Presents, total nativity MSW the involvement of several sources where about 75-85% of created squander came from the private division, 11-12% from the commercial segment, 1-1.5% from the regulation segment, 0.5-1.25% from metropolitan administrations and rest from other divisions.

Shows (Table-3.8) the scribble of city MSW six marketplace in Bangladesh. It was evaluated that about 68-81% of produced squander is delivered from the natural things, 7-11% from paper, 3-4% from plastic and 9-16% from material, wood, calfskin, elastic, metal, glass and others. The natural matter is ordinarily higher than any other squander source due to the utilize of new vegetables and nourishments and need of nourishment preparing businesses.

Table 3.8

MSW scribble of chosen areas in Bangladesh.

Waste Category	Dhaka (MSW composition on wet wt %)	Chittagon g (MSW composition on wet wt %)	Khulna (MSW composition on wet wt %)	Rajshahi (MSW composition on wet wt %)	Barisal (MSW composition on wet wt %)	Sylhet (MSW composition on wet wt %)
Food and vegetables	68.3	73.6	78.9	71.1	81.1	73.8
Paper	10.7	9.9	9.5	7.2	7.2	8.4
Plastic	4.3	2.8	3.1	4.0	3.5	3.4
Textile & wood	2.2	2.1	1.3	1.9	1.9	2.1
Leather & rubber	1.4	1	0.5	1.1	0.1	0.6
Metal	2	2.2	1.1	1.1	1.2	1.1
Glass	0.7	1	0.5	1.1	0.5	0.7
Others	10.4	7.4	5.1	10.8	4.5	9.9

Following the measurements of Jointed together Nation (UN), the full populace of Bangladesh within the year 2010 was 148.69 million. Urban and were population 40.14 rural 108.55 and million individually. Generation of municipal solid waste the average fear in the is urban and provincial regions of Bangladesh .4kg/capital/day and also .15 kg/capital/day (Table 3.9).

Table 3.9

Era and redeemable rates of MSW in Bangladesh in 2010.

Residue	Generation ratio (kg/capital/day)	Residue generation (kton/year)	Waste recovery rate (Kton/year)
MSW			
Urban	0.4	5860.44	4102.31
Rural	0.15	5943.11	4160.17
Total		11,803.55	8262.48

3.6.4 Forest residues

Woodland buildups can play a viable part to deliver biomass vitality. These days, loss of biodiversity, the unsustainable worth of deforestation, soil disintegration and traditional use of timberland buildups as fuel are driving to debasement of the living environment of the nation day by day. The embryo of renewable vitality forest residues give different natural benefits. In Bangladesh, as regards 805 of the overall vitality utilization roll up from biomass assets. Add up to region bookkeeping 2.52 mha of arrive within the nation has timberland cover about 17.08%. Out of 2.52 mha, woodland division bargains with 1.52 mha, 0.73 mha are overseen by service of arrive which is outlined as unclassified state woodland and .27 mha is towntimberland involving property arrive (Table -3.10).

Table 3.10

Add up to timberland arrive f Bangladesh.

Category of forest	Area (mha)	Percentage
Under forest department		
Tidal mangrove forest and plantation	0.73	4.95

Tropical moist evergreen and semi-evergreen forest	0.67	4.54
Moist or dry deciduous forests	0.12	0.81
Subtotal	1.52	10.3
Unclassified state forest	0.73	4.95
Village forest	0.27	1.83
Total	2.52	17.08

Based major on three the area and nature ibid are classes beneath woodland division of Bangladesh. There are:

- Tropical damp evergreen and semi-evergreen timberland are arranged within the Chittagong, Cox's Bazar, Sylhet and Chittagong slope tracts region.
- Tropical damp or dry deciduous woodlands which are as a rule cognizant as sal (*shorea robusta*) timberlands within the fields and freshwater districts of the northwest side and
- Mangrove timberland within the southwest of the Khulna, Chittagong, Cox's Bazar and Noakhali coastal ranges. The Sundarbans is the world's biggest mangrove woodland found in Khulna, Bangladesh.

Within the country regions for need of adequate cooking fuel, fuel wood is for the most part collected from the gather town timberland. It is assessed that the rate of lessening of woodland arrive in Bangladesh is approximately 3.3% per year since of fill-conceived deforestation for collecting fire-wood and making furniture. This rate of woodland lessening is entirely unsustainable. Tree wood buildups and both are extricated from timberland. Leaves, twigs, and peel rats are the most tree buildups. Productive utilize of timberland buildups can be a potential source of vitality in Bangladesh (Table 3.11) display that the assessed wood and bamboo outcome in Bangladesh up to 2020. The recent comes about that wood generation rate within the timberland is lower than the property woodlands. It appears that the provincial individuals are more cognizant approximately their fuel wood need. Following the measurements, in Bangladesh the whole fuel wood nativity was 6.932 million tons in 2003. The recovery dosage of woodland buildups is approximately 80% whilst the rest

20% of tree is basically utilized as timber for scribble furniture and belongings. Maxim logs, lacquer, plywood, molecule board and logs fuel pulpwood wood are the ecumenical are the common root of wood buildups. Saw logs and veneer logs are the mighty embryo of peel, saw, clipping dust slabs and sharpness planer serving, veneer split and wood squander buildups. Plywood and opposite mechanical bill wood logs are created within the frame of set aside plywood, polish clippings and squander, board, panel grace and sander tidy.

Table 3.11

Weigh wood and bamboo propagation in Bangladesh till 2020.

Year	Wood (million m ³)	Village (million m ³)	Total wood (million m ³)	Bamboo (million culms)
1990	0.87	4.01	4.88	70.51
2000	0.18	6.07	6.25	78.61
2010	1.10	7.86	8.96	63.45
2020	3.62	10.62	14.24	65.68

Table 3.12

Era of forest buildups in 2004.

Types of buildups	Inception (million tons)
Fuel wood	6.932
Tree buildups	1.806
Sawdust	0.123
Total	8.871

(Table 3.12) outgiving the yearly era rate of forests buildups in 2004, so as to 1.816 million tons of saw dust were produced for energy purposes, 100% recuperation rate is for the most part considered. By utilizing this recuperation rate the overall sum of recoverable buildups from timberlands and ranger service industry in Bangladesh was 8.871 million tons in 2004 [25].

3.6.5 Biomass innovations and glance for control era

A number of innovations show themselves for large-scale biomass affluence. Appeared on biomass to affluence generate power by utilizing boiler-steam turbine well built up. Global the recent introduced affluence of power era from biomass is circa 40 GW. For improvement efficiency generation biomass-based technologies is well set up within the pulp and paper industry as well in a number of agro-industries and there's significant scope. India has propelled a sugar-mill-based neoteric cogeneration program which capacity of 348 MW has been as of now sanctioned. Biomass-based electricity generation China has executed some projects. Conclusion of the 2012, add up to introduced capacity of bio-energy control era was 2 GW, in there which era owing to bagasse was 1.7 GW, whereas the oddment was emerged on crop buildups, biogas, and landfill metropolitan gas strong squander. In Bangladesh, has inaugurated 14 sugar-mill- risen cogeneration plants deal bagasse. The whole control era affluence is 38.1 MW. Usually bagasse anneal to outturn steam in sugar- handling deeds and gender power to suffice the to themselves sugar mills. The existing plants create steam in boilers at 15 kg/cm². The entry level

into can be pumped national framework. In Bangladesh normal ruined -cane affluence per sugar process is approximately 1400 tons/day and might create up to 12.75 MW and in add up to almost 178.5 MW. There are new hopeful eyesight for biomass innovations the rice processing industry in Bangladesh. The rice-husk developed off-grid control plant sanctioned in was 2007. The rice developed husk on a biomass-gasifier blazing (IC) is engine strait, and an evaluate affluence of has 250 KW. It be assessed that a tone can of rice passion might deliver 282 kg glacial rice husks together with a calorific esteem of 16.3 MJ/kg. A turbine ritual gas for gasification this buildup would spawn in relation to 10.6 KW. A seeing fabricate that 540 mills show oneself in Bangladesh rice. As it were rice with a potency higher plants than 30 tons/day the specialized stout of electrical control is nearly 171 MW. Propels and strategies for control era from municipal solid waste have ones created persistently from corny to progressed ones within the taking after arrange: mass anneal fervid, landfill bed and fluidized, gasifier converter and incinerator plasma squander. The landfill gas to control innovation is the foremost cost-compelling way to covenant with a gargantuan sum of squander with moo calorific esteem. Landfill innovation, as proposed by the ADB banishment, appears to be the foremost favored innovation for Dhaka city. Alone Dhaka city has a receptivity sublime than 5000 tons/day and the stout

control era is in regard to 20 MW. In 1972 the to begin with biogas plant in Bangladesh was the operable. Inasmuch as, various formation have aching this initiatives to battue, invent and latitude biogas innovation within the nation. Types of two biogas digester are in the rough vulgar in Bangladesh that the fixed- chateau is and drifting arch sort. Various government-pay up biogas ventures have been carry through with diverse degrees of victory. Concerning 2500 fixed-edifice biogas plants have been inaugurated and a few expansive ranches invent power take advantage of, this innovation. For sake of heating, a passable-size paint is sensible whereas unco ranches may too invent power. Poultry ranches that more than 500 fowls might ancestry well night 360 GWH per have year which is identic to 197 MW repute to run the plants 5 h/day [19].

3.7 Hydro source of stout

Hydro power generation the scope is exceptionally constrained in Bangladesh. Mostly the nation is level but for a few sloping locale within the northeastern and southern a parts. Thereto, Bangladesh is riverine a realm and major waterways have a tall stream rate for around 5-6 months. Amid rainstorm season which is impressively reduce amid winter. The main source of power era, hydro control, bio-fuels, coal and noted gas. Bangladesh, small and large hydro power have limited potentials. Large-scale hydro power (>40MW) eduction has been inaugurated which leads to resettlements thus evil agrarian lands. The realm incorporates a tall reliance on inartificial gas and hydropower for power era but said already moo per capita vitality utilization. Due to the colossal commitment, the world's power of 19% control owing to both sweeping and little control plants, hydro control is the foremost broadly fulfil renewable vitality. Hydro power, eduction receptivity of hydro plants more than 30 MW. Small-hydropower plants are named as zeminary an eduction receptivity of 100 KW to 30 KW. Micro-hydro power plants having eduction receptivity latitude owing to 5KW to 100 KW. Water heads of 2 meters can be appropriate to produce control productively with legitimate usage of progressed innovation. The vitality issues in inaccessible and sloping ranges exist due to uneconomical arranging of the network organize. Micro-hydro caliber impart moo-cost arrangement for it inaccessible locales. It impart a lofty arrangement for vitality issues in inaccessible and sloping regions where the expansion of lattice framework is comparatively uneconomical [26].

3.7.1 Small-scale hydropower potentials

Small-scale hydropower this infers potency less than 10 MW. This run within hydropower plants advance partitioned into little hydropower (>3 MW<10MW), slightly hydro (>300KW<300KW) and Pico hydro (<5KW) caliber plants are different regard to speculation fetched [19].

Table 3.13

Small hydropower potentials.

Receptivity run	Numbers of sites	Location	Total capacity (KW)
Small hydro (3-10MW)	14	Northeastern region	111000
Mini hydro (300kw to 3 MW)	11	Mainly at Teesta barrage, Rangpur and northeastern region	12900
Micro hydro	32	Chittagong Hill tracts, Dinajpur and Rangpur	798
Pico hydro	1	Lake Fiaz, Chittagong	4
Total			124702

Hydropower, that is ecofriendly clean control era strategy based on the ecumenical water roadster. The conception of producing heroism from water has been circa for a lengthy time and ibid are multiple chuckle hydro- impelled offices well night the world. Generally hydro- control is serial by estimate on originate receptivity and the sort of plot like as run of stream, stocks, pumped capacity. There are a part of a canals, effluent, of fundamental stream like Karnaphuli, as shangu, well Matamuhuri, as very small rivulet, domain great possibilities for consecration unit slightly/micro hydro power in Chittagong Hill Stretch,(CHT) zone. Agrees the logical plump on the awesome stout asserted by insignificant-scale and tidal steam hydro clout plants this shrubberies are employ unusual water drifts then again have not any booms or else regulations capacities. Such as hefty-measure [clout power era in minimal shrubberies

is renewable and expensive. The first micro-hydro power unit devices been set up in a hamlet of Bandarban done reserved ingenuities which capacity of 10KW. Provided power to 140 folks in the settlement and to a Buddhist shrine by this project. Within the past for ushering little hydro control plants, various reconnaissance surveys and studies have been conducted but so distant as it were one hydro control plants has been inaugurated. SRE beneath LGED has effectively exhibited to begin with micro-hydro control unit at Bamerchara, Chittagong. This power plants inaugurated aptitude was 10 KW however owing to insufficient water dome roughly 4 KW command was spawned. The Power enlargement Panel (PBDB) and Bangladesh Water Development Board (BWDB). Conceded on view a united revision on micro-hydro clout stout within the nation. Details in the given below table 3.14.

Table 3.14

Identified potential small hydro sites.

District	River/stream	Prospective of electrical energy in KW
Chittagong	Foy's lake	4
Chittagong	Choto kumira	15
Chittagong	Hinguli Chara	12
Chittagong	Sealock	81
Chittagong	Nikhari Chara	26
Chittagong	Budia chara	10
Chittagong Hill Tracts	Lungi Chara	10
Sylhet	Madhab Chara 1500 ft. from fall	78
Sylhet	Ranga Pani fall	616
Sylhet	Bhugai-Kongsa at 2 miles U/S. of Nalitabari P.S	69 kw for 10 months & 48 kw for 2 months
Jamalpur	Marisi at Duka-bad near Jhinaigati Thena Head Quarter	35 kw for 10 months & 20 kw for 2 months
Dinajpur	Dahuk at Burabari	24
Rangpur	Buri Khora Chikli	32
Rangpur	Fulkumar at Raiganj bazar.	48

The current a waterway water and moor head of water drop may be utilized for tackling hydro-power as great numbers of waterways of Bangladesh are following with reliable water speed all through the year. The current of these waterway water might be utilized as a gifted renewable vitality source. The run of waterway plans have small or no capacity, in spite of the fact that definitely-of-river plans minus capacity with some of the time devour a dam. The activities rule of ride-of-tributary plants, per and minus poundage, hang on cripplingly on hydro entries. In Bangladesh about 1.4 stacks cubic tempos of water drifts per the nation in a normal liquid the year. The country captain streams devise a tall speed of marine stream of approximately 5 to 6 months amid rainstorm spell. Recently the tree crucial waterways that stream over the level fields of India and Bangladesh (Ganges, Brahmaputra and Meghna) freedom a typical of ($2.5 \times 10^4 \text{m}^3 \text{s}^{-1}$) to the Cove of Bengal. These brooks terror dread or heartrending water stay cradle of motile vitality. By using this active vitality we are able create hydroelectricity. Hereafter, outing-of-brooks of the nation might employ as successful renewable vitality font. This sum of control can be exceptionally valuable for these adjacent tenants as they are still out of ethnical, network run [27].

3.7.1 a Micro-hydro power source

Micro-hydro power plants, firstly select potentials sites which are suitable. Generally micro-power plants are situated sloping zones with cannel characteristic water falls on the block or drops toe. Micro-hydro power, wind and sun oriented control plants are clean and contamination free. Basically they are very environment friendly source. Micro-hydro control keeps up the of biological adjust and steam pour the waterways. Apiece oomph fonts sways on the milieu have been examined altogether and the boost of these innovations has been wistful. Micro supremacy is hydro a would-be cradle of verve this and full result deployment of vitality will in natural neighbor era of and control commencing cannel waterways. Micro-hydro power have been effectively actualized to run ascertained innovations for off-grid spread out clout to these inaccessible uneven regions and little towns. A few hilly towns has fetched around chief financial advancement of control. Micro-hydro control have supplanted diesel makers and executed in a cross breed systems in line with sun powered control. These been control plants have employed for coordinate mechanical vitality for little businesses and horticulture. Slight-scale ventures incorporate battery charging, soldering, plant,

edit handling, grain processing, domestic cultivate, farm and town. A new trivial-scale execution may be to control homes in inaccessible zones without a dam. The foremost noteworthy employ of micro-hydro clout is the off-gridiron subsidiarity of its encompassing ranges. Micro-power chances tender and steady control stream. The encompassing zones of person inventing producing stations can be effortlessly fueled and it is exceptionally temperate. This will diminish shopper request on the endemic network arrange. In addition, hydro clout stations can continuously be micro nourished to the national framework. Generally considered micro-hydro control ventures are to be more natural neighborly than both expansive and fossil fuel hydro fueled plants with all these preferences micro-hydro power can be actualized as guideline renewable cradles for maintainable improvement particularly in crafting nations like Bangladesh [22]. Micro-hydro power locales ought to be covered by crib into thought accessibility of tall crick speed (Table 3.15).

Table 3.15

Recognized little hydro destinations distinguished by BPDB and BWDB.

District	Name river/stream	Potential of electrical energy in KW
Chittagong	1.Foy's lake	4
Chittagong	2.Choto kumira	13
Chittagong	3.Hinguli chara	12
Chittagong Hill Tracts	4.Sealock	81
Chittagong	5. Lungi chara	10
Chittagong	6. Budia chara	10
Sylhet	7. Nikhari chara	26
Sylhet	9. Ranga pani gung	616
Jamalpur	8. bhugai-kongsa at 2 miles U/S of nalitabari P.S	69 KW for 10 months 48 KW for 2 months
Jamalpur	9. Marisi at Dukabad near jhinaigati thana head quarter	35 KW for 10 months 20 KW for 2 months
Dinajpur	11. Dahuk at burabari	24
	12. Chawai at U/S of chawai L.L.p	32 24
	13. Talam at U/S at L.L.P	32
	14. Pathraj at Fulbari	48
	15. Tangon at D/S of nargun L.L.P	11
	16. Punarbhaba at singraban	

Rangpur	17. Bhuri khora chikli at nizbari 18. Fulkumar at raigang bazar.	32 48
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3.7.1 b Socio monetary sways

Bangladesh is primarily an agrarian nation. Nearly the entire populace is subordinate upon farming either specifically and in a roundabout way. Bangladesh never delighted in 100% charge. As an end water system has avert a awesome bargain due to the control emergency. In Bangladesh overall has 232 rivers counting the most their streams and branches. In the event that legitimate choice criteria are kept up it'll not be exceptionally surplus troublesome to discover the potential locales where micro be hydro power plant can group. Produce power from these destinations can play an awfully imperative part in encouraging the total agriculturists to have legitimate water system office. Peak of the distinguished place so distant are in uneven regions where primarily the tribal individuals their living space. Recently peak out of are them of charge office. Investigation of advance potentials locales and legitimate disposition of the surviving cites will craft break to bring them beneath jolt. Other than making strides their standard of life it'll empower them to begin small-scale businesses in those farther regions. Subsequently, there will be openings for occupations and self-employed. It would to moreover energize them begin home-built industry over the accessibility of three-period control. Fabrication of current in inaccessible ranges being an attractive tourist spot undoubtedly of clout. Tourism a has moreover been virtuous font of expenses for Bangladesh. Shrimp development n is individual of leading the cause of outside income of the nation. Nevertheless owed to deficiency pf current it was been exceptionally troublesome to apply the cutting edge methods of development. Potential waterway destinations using run-off-micro-hydro power office will empower the nearby rancher relate semi-serious and seriously strategy of development [28].

3.7.2 Large scale hydro power potential

Large-scale hydro power this implies a potency upper than 10 MW. At present, merely individual hydro-absorbing influence plant in Bangladesh at Karnaphuli hydropower plant which has generated installed capacity 230 MW. The has control station 5 units. The to begin through unit was built in 1962 and the past unit in 1988. This power plant

worked by Bangladesh Control Improvement Board (BPDB). The BPDB is considering contraction of this control plant to include a different 100MW aptitude. The extra vitality will be produced amid the stormy season. Apart karnafuly hydro power station, Kaptai and the two new imminent locales for expansive hydropower plants at Sangu and Matamuhuri have existed recognized via BDPB. It gauges that the budding aptitude is 140 MW at Sangu and extra is individual 75 MW Matamuhuri. Comparisom to the world hydro current production rate, production rate, invention frequency, Bangladesh the fabrication magnitude of hydro-electricity in 2014 Comparisom to the world hydroelectricity production rate, Bangladesh the fabrication magnitude of hydro-electricity in 2014 was 230 MW and worldwide sharing is exceptionally insignificant. Table 3.16 speaks to hydro-current venture.

Table 3.16

Anticipated future hydro-current ventures in Bangladesh.

Name of the river	Budding of electrical vitality in MW
Kaptai	100
Shangu river	100
Matamuhuri river	100
Mohamaya	23-65
Lohajari	4.5

3.8 Conclusion

Fossil fuel reserves are limited and energy, as well as environmental crisis is a big issue, Bangladesh has to be unequivocally subordinate upon conventional renewable causes. There's an impressive opening for Bangladesh to see its future control request, guarantee economical perfection and fiscal development over renewable assets. Governmental and non-governmental organizations has taken initiatives to emanated headfirst and link hands through government to unravel long-term emergency circumstance [9].

CHAPTER 4

Current status of renewable energy in Bangladesh

4.1 Introduction

Bangladesh is largely pack nation in South Asia. The nation foodstuffs power basically since normal gas taken after by fluid powers. The country's, although fit electricity era aptitude has been bigger to 12261 MW there's scarcity of power within the hot summer season which may be an obstruction to mechanical improvement as well as socio-economic improvement. Discharges nursery gasses (GHS) into the air through combustion of fossil fuels into the air which causes worldwide warming. Bangladesh can gravely inclined by nursery be power and worldwide warming. These disputes are moderated by consolidating renewable vitality sources like sun powered, wind, hydro, biomass etc to the country's power era [29].

4.2 Research and development for renewable energy

Renewable energy technologies the recent research and development activities in Bangladesh may not however grasp to the end-public. Public and private both organizations are waged to advance suitable dissemination. There are several research and development partners within the advertise. In arrange to outline these partners the taking after focuses to be unavailable care of. Research and development partners diagramming is a critical issue which is however to be full caution of. This might be through by analyzing the inquire nearby bulk, monetization and intrigued of the research and development sponsors. Subject on monetization, investigate aptitude, effective human asset and intrigued, partners need ought to be given due thought.

The is most crucial variables in plotting isomorphism. This implies that families concerning the components of one framework totally outline the components of one more framework. The research and development partners ought to be fetched beneath a communal approach so they can be taken care of effectively with minus officialdom.

Together with private partners, free partners and both remote-public patrons: building colleges ought to too take an interest in research and development mechanism to emanated up per reasonable arrangements or distinctive renewable vitality ventures. Having collective all these disputes it is additionally basic to cogitate the taking after variables in plotting:

Accessibility of satisfactory information in dealing with renewable vitality ventures.

Associate liaison mid research and development patrons.

Executing the administrative arrangements.

Applying the qualified third festivities in research and development ventures.

Research and development ought to be particular for a firm time based on partners execution, intrigued and asset.

The college investigate groups ought to give key investigate arrangements to the cloistered and open partners.

4.3 Inquire about bearings

Renewable vitality plotting for the entire nation agreeing to sorts of sources- sun based, wind, hydro, geothermal etc. The trend change is experiencing essentially, or maybe such sporadically and as the ancient information may not be valuable. An entire year for new data would stay further reasonable.

Original springs of renewable verves exploring wind such as and scenes hydro. However, in the Bangladesh context concede hydro-whereabouts may be a troublesome recommendation.

Mode need and operation to induce the neighborhood individuals and societies included in investigate and improvement exercises request further human-revenues-advance.

Cosiness provide support services, innovation exchange and proceed crafting fresh advances.

Further springs of fossil fills are exploring in numerous parts of the nation, particularly within the northeastern portion of the nation.

Renewable vitality possibilities are assess in Bangladesh and parallel dissemination of renewable vitality advances individually within the rustic and urban ranges.

Individually open and remote segments are encourages also counting civic-secretive organization, speculation within the renewable vitality segment.

Creating collaboration non amid renewable and providers and renewable partners and bring them beneath individual umbrella to encourage absorption of innovation see-just how and making unused trade openings.

Renewable energy re-emphasize utilization all over the nation indeed at passage level.

Improvement the innate advancement to back renewable vitality innovations activities that in the long run make innovation cos- successful for moo salary bunch populace. Research and development is the mode headlong.

Clean Advancement Component (CDM), equally in note and soul as agreed within the Kyoto convention that Bangladesh government acknowledged and approved in 2001 [29].

4.4 Investigate and improvement exercises

The several introduces, colleges and investigate organizations both open and private sectors are booming out investigate and advancement (R & D) exercises in different areas of renewable vitality innovations. Research and development exercises of are Bangladesh described by much imperatives, need of master information and money related assets are including. Distinctive officialdoms and their pitch of intrigued related to investigate and advancement and renewable vitality innovations are presents in table 4.1.

Table 4.1

Status of R& D of distinctive administrations.

Technology	Related organization	Remarks
Solar photovoltaic balance of systems	Grameen Shakti, CMES, IFRD,	Nearby fabricating of all adjust of framework components (like care controller, cable,

		inverter, converter etc) conceivable.
Solar water heaters	RERC, Dhaka university, IFRD, CMES	Fabricating with nearby plan and manufacture office conceivable.
Improved stoves	IFRD	A few plans have been created at IFRD in three essential categories: Minus chimney, thru chimney, and thru squander warm application.
Solar cooker-parabolic	IFRD, ANANDO	IFRD has effectively field-tried its plan which can rapidly bubble water on strong bright days. Such sun powered cookers are presently on deal at a cost of Tk. 450.00 (US\$ 9.00) at IFRD. ANANDO is also fabricating and promoting it's items with imported materials and plan.
Solar cooker-box type	IFRD, CMES	IFRD's plan is over of far away accessible crude materials. The fabricating costs of such a cooker is almost tk. 800 (US\$ 16.00) barring the fetched of utensils. The cookers are presently

		actuality hawked at IERD.
Solar dryer	IFRD, BRRI, BAU	Distinctive sorts have been planned and tried with locally accessible materials.
Sun powered wood flavoring plant	BFRI	A straightforward, cheap and viable sun powered oven has been created for flavoring timber utilizing sun based radiation. The furnace can be built helpfully with locally accessible materials. Timbers of distinctive species and measurements can be prepared all through the year within the sun based furnace.

4.5 Noticeable initiatives

Various endeavors for by and large advancement of the renewable vitality division have been busy up by a few of the government organization and NGOs which are depicted within the taking after underneath sections.

Utilization of different renewable energy technologies which has stayed hoarded from detached springs (Table 4.2).

Table 4.2

RETs in Bangladesh.

Technology	Installed capacity (approximate estimate upto 2004)
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Sun oriented photovoltaic	2.5 MW p/37,000 SHS
Wind turbine	20 KW
Wind pump	6 nos.
Biogas plants	19,596 nos.
Micro-hydro	10 KW

4.6 Ventures by government officialdoms

4.6.1 Biogas trial plant projects of IFRD

This venture has been actualized by the Organized of fuel investigate and advancement (IFRD) since 1995. Beneath the extend up to 2004, 17,200 biogas plants were developed. Agreeing to an evaluation story it has been gotten that 99% of the plants introduced beneath the extend are in maneuver and 91% of the owner might be meet their family fuel request since the flowers. The extend made a difference hold natural enricher within the dust, enhancement agrarian peers, guaranteed contamination-free location, elective fonts of vitality within the country and made a difference creating human assets [29].

After a long inquire about, IFRD has created the two sorts of biogas herbal is appropriate for Bangladesh and they are:

- a) Detached-upper biogas plant
- b) Immovable-ceiling biogas plant

The immobile-cupola biogas plant has stood create to reasonable and prevalent in this nation.

And the detached-uppermost biogas plant have been introduced in numerous parts of the state thru the alliance of NGO's this project approved by government and this project under a fuel-saving and being implemented around the country by IFRG. A project biogas pilot plants (2nd phase) and it's duration time 2000-2004 and approximately under this projects 12,000 biogas plants have stood introduced beneath the extend within the nation [30].

4.6.2 Biogas project of LGED, BRAC and GS

LGED, ERAC and GS too executing biogas venture for wide-gage dispersal of the innovation. LGED has as of now introduced almost 1,166 biogas plant of distinctive sorts from expanded substrates counting cow GS muck, hyacinth, hominid excreta. BRAC mounted 1200 and native units.

4.6.3 Chittagong hill tracts sun based zap ventures of BPDB

Engineers of BPDB have steered a possibility consider for sun oriented PV in Chittagong Slope Tracts Locale and right now actualizing Sun based photovoltaic Extend at three Upazilas in the Chittagong Hill Tracts locale where distinctive sorts of sun oriented photovoltaic claims counting sun powered domestic frameworks, liquid pushes, serum freezers, highway spots, consolidate control post etc resolve be introduced exceptionally before long. The generally care of direction and charge collection of distinctive frameworks will be thru by the recipient administration board by the nearby individuals.

4.6.4 Wind assets impost package (WRAP) of PBDB

After preparatory ponder led by BPDB, Muhuri dam range at Feni has grew shining diagnoses of power era since wind. Long term and reliable wind information will empower BPDB to decide the precise wind speed of higherstatures and wind vitality surrender from the location from reasonable wind turbine. In this BPDB unambiguous to undertaken the Wind Asset Appraisal Program (WRAP) at the Muhuri weir stand at 50 m tallness for individual year.

4.6.5 Micro-hydro power plant at Barkal by BPDP

Barkal is one farther of and unelectrified the upazila (sub-district) within the Chittagong Slope Tracts locale. The range is secured with slopes extending 300-500 m in tallness. Unpaid to the environmental assembly, the region is farther in terms of building the foundation. Hence, the expansion of network power will be exceptionally troublesome and costly. Engineers of BPDB the have steered surveillance overview in upazila and distinguished accessibility of water springs for Micro Plant Hydro Influence. Grounded on the rebuked stack request of the adjoining space of the projected 20 KW Micro plant authority Hydro is outlined with the assistance of RETScreen, urbanized by CANMET liveliness Expansion Investigate Laboratory of

Canada (CEDRL). This venture will be supported by Mountain the Agency of Chittagong Expanses Issues.

4.6.6 Dissemination of renewable liveliness knowledges venture by REB

Beneath the primary stage of the extend, a 'Renewable Oomph' cell of Rustic Jolt Board (REB) has executed the prime semi-moneymaking 62 KW Sun oriented Photovoltaic Extend in 1997. In next part of the venture (1999-2004), 6000 punter devour been energized by sun oriented domestic frameworks.

4.6.7 Achievability study and enquiries and advance of renewable energies by IFRD

As of late a venture on the achievability consider on R&D of Renewable Vitality like as sun powered, wind, micro has mini hydro been attempted by the Founded of Fuel Inquire about Advancement (IFRD) of Bangladesh Chamber of Logical and Mechanical Inquire about (IERD). The point of the extend is so harvest material and records to consider the plausibility of nature sun oriented, wind and micro-hydro control bids in Bangladesh whichever for water impelling or for era of power especially in farther and off-beach islands. The little businesses may discover sun powered, wind micro and hydro control planned in inaccessible provincial ranges or within the islands and shore state. Obtained specialized information from this venture will be supportive to create unused advances within the field of sun powered, wind, micro-hydro so the of worth of that life the individuals of beach, off-oceanfront islands, craggy and further farther provincial can zones be through strides essentially.

IFRD has set up a research facility for steering investigate and easy on sun based, wind micro and hydro gear.

4.6.7.a Sun powered vitality cog

Sun based information isolation, temperature and mugginess partake been composed for

-Dhaka

-Tecknaf

-sailo propat, Bandarban

4.6.7.b Wind vitality section

IFRD is amassing wind information for the attractive after destinations:

-Saint Martin (Seaward Island) for the final 2 a long time

-Tecknaf for 1 year

-Meghnaghat, Dhaka meant for roughly 6 months

The most extreme speed gotten at holy person martins is 20 m/s normal wind speed in 4.6 m/s. The most extreme speed gotten at Teknaf is 16 m/s and per annum ordinary wind speed in 3.8 m/s.

IFRD has 1000 as of now imported 3 NEPC 2500, and wind 600w turbines. The 1100w turbine is introduced at the ocean shoreline of Technaf and 600 W turbine is announced at Meghnaghat. It has watched that most extreme 600 been 200w and control has been placid from Technaf and Meghnaghat, separately.

4.6.7.c Micro-hydro module

There are little weirs at Sailo Madhab propat, bandorban and, Sylhet. BCSIR is piloting pre-likelihood consider for introducing micro or mini hydro extend at these destinations. Stream meters and vital hardware has as of now been hosted to degree the sea stream and head.

4.7 Projects by private sector and NGOs

4.7.1 RET programs of Grameen Shakti

Grameen Shakti (GS) or 'Country Vitality', was reputable in 1996 to mature and spread renewable vitality assets. Grameen Shakti has been acknowledged universally for it is extraordinary slant of 'micro-credit' for forming sun based domestic frameworks in rustic zones. Grameen Shakti anticipates not as it were to supply renewable vitality administrations, but too to form business and proceeds-group openings in rustic Bangladesh. Grameen Shakti right now has 26 workplaces in locale of Bangladesh and by and by actualizing three programs:

- Sun powered vitality driver,

-Wind vitality sequencer,

-Biogas platform.

Over the following 2 a long time, Grameen Shakti serious to introduce 20 little freestyle-arraigning postings, 20 computer preparing hearts and 20 multi-package cores, all fueled by sun oriented vitality.

Grameen Shakti grown credit give from distinctive respective and mutual improvement abettors counting GEF, IFC, USAID, SIDA etc.

4.7.2 Spread suite of CMES

The Middle for Mass Instruction in Science (CMES) was made in 1978 with a point to require science and innovation to the public individuals of the nation. Afterward on CMES begun sun based vitality related exercises within the far off ranges of the nation through its field workplaces. It has agreed inquire about and perfection (R&D) exercises on sun based stoves, sun oriented seawater radiators, sun oriented dryers, sun powered domestic frameworks etc. It has as of late built up its 'Stellar Lab' to yield up versatile investigate on adornments of sun powered PV frameworks, such as duct sunny, responsibility switches, inverters, wage creating apparatuses like needlework machines, boring engines etc.

At display, CMES is one of country's central organizations within the RET (Renewable Vitality Innovation) in 'Asia program'.

4.7.3 Renewable vitality sequencer of BRAC

Bangladesh Rustic Headway Committee (BRAC) is the biggest NGO in Bangladesh and propelled its sun powered vitality sequencer in 1997. BRAC begun it is Renewable vitality Suite to energize inaccessible areas within the nation. By the conclusion of 2000, the suite has led more than 500 sun powered PV frameworks, biogas 1000 flowers, 10 wind and 260 boiling chest cookers. It has led two grid-shared PV frameworks and six PV-wind crossover frameworks.

The platform tangled fixing PV frameworks it its department workplaces (Preparation cores, schools, shape clinics) and micro-readiness ventures (woodwork, fitting, cover tinting etc) and in government-preserved shops (recreation firms, violent wind shelters, weather rule). A couple of frameworks have been group for flusher family units. A

impediment of this it suite that is largely working inside BRAC's venture precincts and to a few degree with government offices.

4.8 Unilateral and mutual change mate helped ventures

4.8.1 Maintainable rustic vitality (SRE) venture of LGED

The 'Maintainable country vitality (SRE)' venture has been apprehended by LGED inside the by and large system of the Maintainable Environment Administration Program (SEMP) being executed by the Service of Environs and Woodland (MOEF) with money related help from the Joined together Countries Advancement Program (UNDP). The twin goals of SRE component beneath SEMP are innovation show and innovation exchange within the turf of renewable vitality in Bangladesh. Allowing for the characteristic assets ignoble and socio-fiscal complaint, SRE extend has painstaking four prospective renewable vitality homes in Bangladesh to pact per: Planetary, Biomass, Wind Micro and hydro command. SRE has moreover created the Renewable Vitality Data Arrange (REIN), with a broad space for fashioning a data stage for Renewable Vitality Innovations (RETs). This organize will be outlined and custom fitted to encourage the vitality organizers, ventures designers, assistants and all pertinent officialdoms in forming RET ventures and advancement of renewable vitality exploitation in Bangladesh.

4.8.2 Renewable vitality advances in Asia (RETs in Asia) driver

Renewable vitality innovations in Asia (RETs in Asia) is a inquire about and dispersal program supported by the Swedish Universal Improvement Participation organization (SIDA) and facilitated by the Asian Organized of Innovation, Bangkok. The primary stage of the territorial platform (RETs in Asia I) was conceded out terminated a 2-year era amid 1996-1998, whereas the moment 3-year stage (RETs in Asia II) begun in January 1999.

Essentially, RETs in Asia may be a territorial Investigate and Spread platform Fundamentally, RETs in Asia could be a territorial Inquire about and Spread program which is to advance the dissemination of chosen develop or nearly-mature Renewable six Vitality Advances through twelve National Investigate Educate (NRIs of countries: Bangladesh, Asian Cambodia, Lao PDR, Philippines and Nepal Vietnam.

The primary briquetting stage of the suite briquette secured three RETs-(1) photovoltaic (2) Sun based drying and (3) Biomass and stoves.

The most destinations of the moment stage of the sequencer are as takes after:

- To department connected specialized investigate to adjust RETs to neighborhood conditions in chosen Asian nations with powerless science and innovation framework.
- To improve and execute instruments for spreading RETs within the chosen nations.
- To prepare business visionaries and specialized individual with the point of spreading RETs.
- To spread the comes about of the program among policy-makers, with a see to making an affect on the approach prepare.

4.8.3 ‘Openings for ladies in renewable vitality innovation utilization in Bangladesh’ extend by PSL

This spearheading extend was started in September 1999 with subsidizing from ESMAP as an exertion towards illustrating the capacity of country ladies from creating nations in locks in as clean vitality benefit suppliers for their community. Rustic ladies are as of now the biggest clients of renewable itality, by ethicalness of utilizing biomass fuel enemy cooking, however their part in present day vitality utilization is as a rule hard. This venture was planned with vision that permits the part of rustic ladies to be improved by amplifying their cooperation in innovation based exercises.

The venture Golachipa area is Char Montaz, as Thana Island with 2000 houseowner, within the southern coastal locale of of Bangladesh. Currently 35 rustic ladies of Char Montaz are locked in within the operation of a micro-enterprise for development and deal of DC lights, which can be utilized in combination with batteries in Sun oriented Domestic frameworks (SHS). With proceeded preparing from this ventures, the ladies scholarly light development through class governor, trade advancement and showcasing. Nowadays more 1000 lights are being utilized by re successions for lighting the searchable country houses, shops, mosques and angling vessels.

In general affect to be accomplished from this extend has far-feat possibilities not constrained to the coordinate members as it were, since the good thing about made

strides environment amplifies with each modern family that embraces advanced striking.

The extend has come in its moment stage in 2002 someplace the neutral is to:

- Extend the room of salary era for ladies. In expansion to on-working DC light gathering, improve the fabricating capacity to amass state-of-art charge directors for sun based domestic frameworks for the up and coming national ventures.
- Extend the advertise for off-grating DC light and battery benefit to a bigger are so that more provincial individuals can encounter the good thing about advanced lighting.
- Illustrate monetary reasonability of sun based charge benefit for scattered families that are as well removed for network and micro-grid options.

4.8.4 Sun based and wind vitality asset appraisal (SWERA) venture

In record of the creating nations, renewable asset data is missing or lacking. Typically one of the key boundaries adversary wide-binge arrangement of RETs in these nations. Accepting this impediment, UNEP is ringing purchasable a 3-year (June 2001-july 2004) long Sun powered and Wind vitality Assets Appraisal (SWERA) venture per GEF finance. SWERA will begin with the taking after countries-China, Bangladesh, Sri Lanka, Nepal, Ghana, Cuba, Honduras, El Kenya Salvador, Nicaragua, Algeria, Brazil and Guatemala. SWERA will begin with the by and large objective of this venture is to advance the integration of wind and sun oriented options in national and territorial vitality arranging and segment rebuilding as well related arrangement making owing countries-China, Bangladesh, Sri Lanka, Nepal, Ghana, Kenya, Cuba, Honduras, El Salvador, Nicaragua, Algeria, Brazil and Guatemala. The venture will empower educated choice making and improve the capacity of taking part governments to pull in expanded financial specialist intrigued in renewable vitality.

4.8.5 Rustic charge and renewable vitality advancement venture

The mixed IDA/GEF Bangladesh Country Zap and Renewable Vitality Improvement venture underpins the Government's advancement technique to extend rustic power get to and subsequently advance social improvement and financial development. This goals is looked for to be accomplished within the taking after four ways:

- a) Assisting the REB to extend and concentrated provincial lattices, progress the operation and budgetary execution of the country co-operatives known as PBSs, and decrease control blackouts within the rustic lattice frameworks. Encouraging improvement of decentralized, mini-lattices, created on normal gas, diesel, wind hydro fonts where and doable.
- b) Promoting utilize of sun powered domestic frameworks in provincial regions improper for network extension.

Aggregate profitable utilize of power and improving destitution would

The venture characterizes the organization models, the partners and actualizing organizations, financing and actualizing points of interest created to put the renewables component inside the setting of a bigger country zap technique for Bangladesh. The mix IDA/GEF extend will back this technique and a portion of the IDA credit will be utilized to advance large-scale application of renewables with speculation and specialized help assets.

4.8.5.a Foundation of a SHS based pre-charge suite for PBSs

The extend will empower REB and five PBSs to create a ‘fee-for-service’ SHS advertise and introduce 14,000 SHS in provincial family units on this premise. IDA and Government will give recognition assets, with GEF gifts to back the SHS program. Other than venture financing, TA assets are to be given to reinforce regulation capacity, create a supported ‘fee-for-service’ PV showcase, elasticity execution back and preparing, set up courses of action to test and certify gear, screen venture advance, build up and work a socio-economic cell in REB plan, execute and assess programs to utilize power increment rustic earnings and societal well-actuality, and build up comprehensive execution observing and assessment strategies.

4.8.5.b Foundation of a SHS credit line and TA to back private division, NGOs and MFIS

The venture will particularly back capacity edifice of cloistered division, PBSs, NGOs and MFIs to move in hooked on and actualize sun powered advancement series. Bulk shop would incorporate creating mindfulness approximately sun powered based openings, dispersing data mostly and successfully ingenious aptitudes among institution and individuals to actualize and oversee the program and preparing for sun based specialists, community mobilizers and microfinance specialists. ■ The venture

conceives GEF back TA, coordinated by IDA and government, for showcase improvement and sun oriented advancement. To bewildered sponsoring allow is suggested to be format and worked by the Framework Improvement Company Constrained (IDCOL) on commercial terms to fund 50,000 SHS. IDCOL backbone on the offer to MFIs or NGOs as instance may be and sun centered businesses to encourage the buy of sun powered domestic frameworks by buyers.

4.8.5.c Enlargement framework slog for further renewables

The venture will give back for appraisal of wind assets within the coastal regions of Bangladesh and run-of-the-river mini-hydro within the sloping districts. In case appraisals show positive potential, IDA would bolster improvement and execution of pilots to affirm commercial achievability. Bolster will that case be expanded to define a arrangement system for moneymaking improvement of these assets, counting enlargements of Little Control Buy Understanding (SPPA) and motivating forces

Advancement of renewable vitality in chosen rustic regions of Bangladesh. The most neutral of the venture is to respite, advance and spread renewable vitality in preferred farther precincts of Bangladesh. The extend period is can 3 a long time and evaluated fetched is DM 4 million which of be GTZ Germany. GTZ has recherché Bangladesh Rustic Jolt Board as the actualizing office of the extend.

To realize the extend destination, the taking after been five outspread yields have recommended by GTZ:

- a) Backing of setting up an organization system for co-ceremony of renewable vitality exercises at national level and encouraging advancement of reasonable techniques.
- b) Reworking a advancement of suitable advances for beneficial operate of renewables in slight-balance undertakings.
- c) Cloistered division flourished promoting, generation, support and reusing framework for renewables.
- d) Sustainable get to to renewable vitality administrations for chosen self-help bunches and social benefit suppliers at community level that's schools, rustic wellbeing clinics, tornado covers.
- e) Corroborant of specialized and administration astringency of captain actualizing.

4.9 Conclusions

Bangladesh is as of now emphatically subordinate upon conventional renewable vitality innovations and discernible activities have been instituted to disseminate extant day RETs by distinctive offices. The renewable vitality programs of Grameen Shakti has ended up exceedingly acclaimed among national and worldwide approach producers, respective and multidimensional advancement accomplices and by the RET devotees. The ‘Opening for Ladies in Renewable Vitality Innovation Employment in Bangladesh’ extend has too been distinguished as an imaginative approach for spread of RETs with the cooperation of rustic ladies. It is anticipated that the GEF financed ‘Rural Electrification’ and ‘Renewable Vitality Advancement Venture’ will too quicken the development of RETs consumption within the nation [31].

Chapter 5

Sustainability of renewable energy

5.1 Introduction

Feasible vitality or clean vitality is the hone of utilizing vitality in a way that meets desires of the show without the capacity of future eras to meet their claim needs. Assembly the world's needs for vitality in a feasible way is broadly considered to be one of the greatest challenges confronting humankind within the 21st century. Around the world, about a billion individuals need of get to to power and around 3 billion individuals depend on messy fills such as wood and creature waste for cooking. Generation and utilization of vitality cause around 72% of human-caused nursery gas outflows and are a major donor to discuss contamination which causes an evaluated 7 million passing per a long time. Projected alleyways for restricting worldwide boiling to 1.5°c depict fast execution of moo emanation strategies of creating power a move towards more utilize of power in segments such as sun oriented, wind, hydroelectric vitality are broadly painstaking to be feasible. Specific renewable vitality ventures such as the clearing of woodlands for generation of biofuels can prime to comparable or indeed more awful natural harm when equated to utilizing fossil fuel vitality. There's significant contention done in case atomic vitality can be painstaking maintainable [32].

5.2 Natural affect and maintainability of renewable vitality

Broad utilize of fossil powers nut to unverifiable improvements since of tremendous CO₂ emanation. Most vitally, fossil fuel, for occasion, coal has been set for control era and other mechanical exercises in later times, which has deleterious natural dominance Green House Gas impact is basically exuding from intemperate lam, passage and control plant make use of fossil powers. As tall as 70% of GHG emanation twigs from the utilize of fossil fuel in carriage. Be that as it may, it is cultured that Bangladesh government expecting to introduce a number of coal centered control plants to create up for the show vitality emergency. This may cause genuine natural harm in this thickly populated nation. As detailed as of late, it is as of now causing harm to the agrarian

crops within the northwestern portion of Bangladesh. From 2010 to 2011, the world coal utilization has expanded up to 60%, which may be a cause of concern for natural preservation. Bangladesh is as of now in potential dangerous zone such as ocean level rise and climate alter since of this GHG marvel. Be that as it may, Bangladesh is still one of the nations capable for moo GHG gas outflow but it is defenseless to worldwide microwaving marvel that would influence 17 million individuals and 22,000 m² of arrive at the southern portion of the nation. Besides, this negative GHG outflow marvel would influence the complete biodiversity, farming, ranger service and other major components of characteristic occupants. Renewable luster such as sun powered, wind and biomass may be resolve this pending disastrous situation, moderate natural corruption and simulation compounds to light the howling vitality request. As anticipated by the important assets, Bangladesh has colossal potential in tackling renewable vitality sources, biomass has its most elevated possibilities, since larger part of the populace dwell in rustic ranges. This may moreover offer assistance in moderating the possibilities GHG emanation. Sun powered Domestic Frameworks (SHS) is additionally getting to be well known that will supplant the utilize of customary lamp fuel fuel. Ordinary lamp fuel furl is presently still broadly utilized both in provincial and urban zones. By and large, commitment from renewable vitality sources might lead to a economical vitality arrangement in close future a portion from contributing to guaranteeing a pollution-free environment [30].

5.3 Significance of renewable vitality assets and innovations for maintainable improvement

The misuse of renewable vitality assets and advances could be a key component of feasible advancement. There are three noteworthy reasons for it as takes after.

- a) They drink far less natural affect matched to other springs of vitality since there's no any vitality fonts with zero natural affect. There are a assortment of choice accessible in hone that a move to renewables may give a distant cleaner vitality framework than would be doable by helping controls on ordinary vitality.
- b) Renewable vitality assets can't be exhausted not at all like fossil fuel and uranium assets. In the event that utilized admirably in fitting and productive applications, they can give a solid and feasible supply vitality nearly uncertainly.

In differentiate, fossil fuel and uranium assets are limited and can be lessened by extraction and utilization.

- c) They indulgence framework reorganization and locally pertinent arrangements further or less autonomous of the national systems hence upgrading the adaptability of the framework and financial control supply to little supply to little disconnect clearings. That's why numerous diverse renewable vitality innovations are possibly accessible for operate in municipal regions.

5.4 Fundamental variables for feasible improvement:

The record notion of maintainability which regularly motivates nearby and national specialists to consolidate natural contemplations in setting vitality programs, through being given many distinctive implications in numerous settings, encapsulates a long-span viewpoint. Other than the long run vitality framework will be to a great extent molded and effective patterns that drink their heritages in fundamental human wishes. In unification with this the expanding would populace requires the characterization and l e x e c u t i o n of feasible improvement. There are different basic parameters in a people. Such bounds can be portrayed as takes after:

Public awareness: This can be the starting step and exceptionally pivotal in making the supportability vitality program effective. This ought to be accepted out concluded the media by open or proficient officialdoms.

Evidence: Fundamental data input on vitality operation, natural impacts, renewable vitality assets, etc ought to be give to open through open and government channels.

Natural instruction and preparing: This will be actualized as a completing portion of the data. Any line That's why this could be painstaking as the implication prerequisite for a feasible for a feasible vitality program. For this cause an eclectic room of focused organizations and preparing offices ought to be made accessible to the open.

Advancing renewable vitality assets: In arrange to attain naturally being feasible vitality programs, renewable vitality sources ought to be advanced in each organize. This will make a solid premise for the brief and stretched tenure monitors.

Imaginative vitality procedures: These ought to be given for a viable feasible vitality program and so require the proficient dispersal of data grounded on modern strategies and comprising of relations, preparing and treatment.

Financing: Typically a really imperative device that can be utilized for coming to the most objective and will quicken the usage of renewable vitality frameworks and innovations for feasible vitality advancement of the nation.

Checking and assessment devices: In arrange to see how effectively the program eats been actualized, it is of extraordinary significance to screen separately footstep and assess the information and discoveries gotten. In this respect, fitting observing and assessment apparatuses ought to be utilized [33].

5.5 Renewable vitality approach

Bangladesh's renewable vitality approach is generally modern. The primary renewable vitality approach was drafted in 2002 tending to the issues relating to the current request and supply in control era. In 2008 the approach was reexamined by MPEMR of government of Bangladesh. The approach was put in a newspaper notice as an official notice. The arrangement actually secured the taking after goals:

- Saddling the likely of renewable vitality assets and accept renewable vitality innovations in rustic, urban zones.
- Empower, energize and encourage both open and private division ventures in renewable vitality ventures.
- Create feasible vitality supplies to substitute innate non-renewable vitality ventures.
- Gauge up commitment of renewable vitality to power era.
- Ruler up commitments of renewable vitality to both power and warm vitality.
- Advance proficient and background inviting utilize of renewable vitality.
- Encourage and energize the utilize of renewable vitality at each level of vitality utilization.
- Advance improvement of inborn innovation within the field of renewable vitality.
- Advance clean vitality for CDM.

- Accomplish the targets for creating renewable vitality assets to meet five percent of the entire control request by 2015 and ten percent by 2020 [30].

5.6 Vitality approachability and energy refuge

Vitality administrations are crucial to improvement and financial development and reality at the level of the person cutting edge vitality administrations can change people's lives for the way better. In spite of the fact that a huge rate on normal 20% of add up to open segment speculation has been designated for the improvement of Bangladesh's vitality division, the accomplishments made within the vitality division have not been able to manage with sharp developing request for vitality either in vitality benefit. Hoard of power request and controlled control hoard by stack shedding. Power openness is additionally undermined in provincial, inaccessible and coastal zones by extraordinary climate occasions. In 2002 about 26% of the full populace had get to power and power has utilization was as it were 96 KWh per capita for all divisions. Power get to was restricted to as it were approximately 30% of add up to family units and as it were 4% families had get to the normal gas arrange across the country. Be that as it may, the request is power has expanded at a disturbing rate in later a long time in Bangladesh. This quick increment in power utilization is due to tall development patterns in financial improvement and populace development (2% in 2003) and in part due to transformation in communication innovation. Vitality security may be a portion and divide of feasible advancement for both industrialized and creating countries. In Bangladesh, haven of vitality stream is debilitated due to number of reasons counting need of household vitality assets, tall reliance on imported carriage fills and destitute vitality foundation. Bangladesh has considerable characteristic gas saves (424-909 Gm³) which give more than two-thirds of the country commercial fossil fuel supply, with a generation of 11 Gm³ in 2002. Agreeing to most recent accessible data, Bangladesh has over 2 billion of low-sulphur substance coal assets. Be that as it may, the financial potential for this coal is however to be affirmed. Indeed in spite of the fact that Bangladesh has these characteristic gas saves and as of late found coal assets, effective utilize of assets is restricted due to need of misuse and dispersion offices. Moreover, in spite of the fact that its demonstrated oil saves are evaluated to be 56.9 million barrels. Bangladesh chances completed 20% its oil requests finished ingresses

out of 3.6 GW of power produced yearly, 94% comes from warm and update from bulky-balance hydro control.

5.7 Contests and breaks of renewable oomph

Our government encompasses an awesome of coming to all with power by 2020. Sun oriented and other renewable are in a position to play an awfully vital role in complement government endeavors to require power to all by 2020.

5.7.1 Tasks

- There are further than 30 officialdoms locked in within the provincial renewable vitality division. Anticipate for a couple, of lion's share have an awfully little client base. Harsh control commerce philosophy is get to create in this field since of the predominance of NGO nation. There has been exceptionally small motivating force for advancement or modern item improvement since record of the association.
- Show hone of endless provincial arrange of branches and engineers in colossal exchange taken a toll and moderate infiltration course. Need of great letter particularly amid the blustery season imperatives developments and increment passage fetched. Regular variety within the wage of the country individuals makes collection of installment troublesome. This can be not taken a toll compelling of attainable within the long path.
- Preparing and holding effective human asset at the field level is additionally troublesome. Motivating force is moo matched to the difficult work. It is troublesome for officialdoms to extend motivations in arrange to keep their costs moo.
- There's need of gifted engineers who can type taken a toll viable and proficient SHS plans particularly for profitable claims.
- Added foremost task is tall freestyle costs and failure to cause eminence constituents or extras taken a toll successfully.
- Tremendous assess and vat are charged on purport of all crude materials but sun based boards. This increments the taken a toll of neighborhood fabricating of sun based extras which in turn increments the costs of sun powered domestic frameworks.

- There has stayed exceptionally small motivating forces from the government to popularize RET but for long term delicate advance through IDCOL. Supreme specialists are terminated subordinate on IDCOL with no expansion of financing. Standard budgetary educate however to require a major intrigued within the RET segment.

5 7.2 Prospects

Exponential request has been made among provincial individuals for sun oriented control and renewables. Usually basically due to expanded cost of lamp fuel, diesel and need of framework associated control, diminished cost of sun powered vitality and particularly due to developing desire and financial enhancement of the country individuals. Reliance on arrive or horticulture is decreasing, cattle is being supplanted by control tillers, bulldozer etc. About 60% of the country individuals claim a Tv.

- Specialized advance has diminished fetched, expanded effectiveness and broadened the application of sun based vitality. For illustration, utilize of Driven and CFL has diminished the taken a toll of sun based control, whereas expanding its effectiveness. Pico frameworks (1 to 5 watts) can control 2 or further lights where alleging versatile phones. This has took sun based innovation inside the reach of lower salary bunches. LED built frameworks have come nearby in sensational diminish in budgets. Variables to diminish taken a toll incorporate proficient loads, imaginative batteries and lower module taken a toll.
- Ready to utilize biogas innovation not as it were producing cooking gas, but moreover for producing unadulterated methane gas which can utilized for running vehicles, control pumps and other electronic gear. This will encourage provincial advancement. In spite of the fact that a few expansive measured biogas plants in Bangladesh are creating power, it is as it were for assembly the proprietors possess vitality wishes.
- Once more biogas innovation takes portion within the worldwide battle against the nursery impact by diminishing the discharge CO₂ from burning fossil powers in two ways. To begin with, biogas may be a coordinate substitute for gas or coal for cooking, warming, power era and lighting. Moment, the diminishment within the utilization of counterfeit fertilizer dodges carbon

dioxide outflows that would something else come from the fertilizer creating businesses. By making a difference to counter deforestation and corruption caused by overusing biological systems as sources of kindling and by melioration of soil conditions, biogas innovation diminish CO₂ discharges from these forms and forests to carbon turns as a sink.

- Made strides cooking stoves can be one of the foremost compelling gadgets to halt in-door discuss contamination and diminish deforestation. In this association, GS gas as of now developed around 373,969 ICSs concluded neighborhood specialists. A colossal positive reaction from ladies have been accepting since of 50% less fuel taken a toll and smoke free cooking. Different POs seem spread 10 Million cooking stoves by 2015 in case appropriate activities are booked.

Bangladesh as of now features a flourishing Ret segment with different companies fabricating batteries, lightings and other sun powered embellishments. Numerous of these companies are moreover trading their items. As of late government has chosen to incorporate sun oriented as pushed division in its industry approach [34].

5.8 Conclusion

Renewable vitality is no more an aspirations costly wander advancement taken a toll of renewable vitality, it proceeds to slack in connection to ordinary vitality For economical advancement each normal asset ought to be reasonably operated. In arrange to guarantee rustic people's get.to power, both open and private segment of Bangladesh ought to ponder on waged with feasible vitality springs. A joined together endeavors in this association can clear the way for future victory of the renewable vitality division in Bangladesh and can set up Bangladesh as an economical improvement show within the world in close future [34].

Chapter 6

Conclusion

6.1 Conclusion

Bangladesh has given birth to one of most effective models to duplicate RET. The most calculate behind the Bangladesh victory story is that it engages country publics to claim and employments RET and in the long run gotten to be accomplices to bring and grow RET in their peoples.

In these papers, Bangladesh as of now has involvement with RET ventures. The probable of these extend activities is tall. Vitality police and endowments are briefly displayed the weight long haul plans of the government of Bangladesh. Due to the deficiency of endless assets and natural issues caused by the emanations, conventional considered to be unsustainable within the long term. Boons an up-to-date and point by point current status and future prognosis of foremost renewable vitality assets. Integration of renewable vitality assets into keen network framework, care in intellect all challenges, will offer assistance in assembly ever expanding electric vitality requests viably.

6.2 Future scope of the work

Bangladesh's power sector in the last five years has been impressive due to solar and wind will be the key focus areas for future capacity addition. Digital power and associates Ltd is a 120 MW HFO based power plant under the scope.

Renewable energy and energy efficiency for future energy security. The renewable energy is rolling back in Bangladesh. The country is severely lagging behind. There is scope for work in Transport in transport and industrial sector.

References

- [1] https://en.wikipedia.org/wiki/renewable_energy
- [2] Shariful Islam Sharif, Md. Anisur Rahman anik, Md. Al-amin, Md. abu Bakr Siddique, “The Prospect of Renewable energy resources in Bangladesh: A study to achieve the national power demand”, Energy and power 2018, 8(1): 1-6 DOI: 10.5923/j.ep.2018081.01.
- [3] Omar Ellabban, Haitham abu-rub, Freed Blaanjerg, “Renewable energy resources: Current status, Future prospects and their enabling technology”, Available in: www.elsevier.com/locate/rser.
- [4] <https://www.youtube.com/watch?v=7ZN5CthZhvg>.
- [5] Saiful Islam, Md.”Ziaur Rahman Khan, a review Of energy sector of Bangladesh”, 1st International Conference on energy and Power, ICEP2016, 14-16 December 2016, RMIT University, Melbourne, Australia, Energy Procedia 110 (2017) 611-618.
- [6] Shakir-Ul-Haque khan, Towfiq-Ur-Rahman, Shahadat Hossain, “A brief study of the prospect of solar energy in generation of electricity in Bangladesh”, Cyber journals: Multidisciplinary journals in science and technology, Journal of selected areas in renewable and sustainable energy (JRES), June edition, 2012. Available in: <https://www.researchgate.net/publication/316170323>.
- [7] A.Z.A. Saifullah, Md. Abdur Karim, MD. Raisul Karim, “Wind energy potential in Bangladesh”, American journal of engineering research (AJER), E-ISSN: 2320-0847 p-ISSN: 2320-0936, volume-5, Issue-7, pp-85-94. Available in: <https://www.researchgate.net/publication/307906589>.
- [8] <http://www.sdnbd.org/wind.htm>
- [9] Rahmat Ullah Tanvir, Muhammad Rubayat Bin AShadat, Manoj Ghosh, Mohammad Khan, “Prospects and UtilizationOf renewable energy in Bangladesh”, International journal of scientific and engineering research, Volume 8, Issue 4, April-2017, ISSN 2229-5518.

- [10] www.sciencedirect.com.
- [11] <https://www.export.govt/article?id=Bangladesh-Power-and-energy>.
- [12] <https://www.cms.int/en/news/option-renewable-energy-lets-do-it-right-0>.
- [13] Thomas T.D. Tran, Amanda D. Smith,” Evaluation of renewable energy technologies and their potentials for technical integration and cost-effective Use within the U.S. energy sector.
- [14] <https://www.worldbank.org/en/news/press-release/2019/05/22/tracking-sdg7-the-energy-progress-report-2019>.
- [15] <https://www.e-ir.info/2016/05/27/renewable-energy-global-challenges/>.
- [16] <https://www.azon.com?article.aspx?articleID=18220>.
- [17] Md. Morslem Uddin, Atik Faysal, Md. Rashedul Raihan, k.M. Jahangir Alam, “Present energy scenario, necessity and future prospects of Renewable energy in Bangladesh”, E-ISSN: 2320-0847 P-ISSN: 2320-0936, Volume-7, Issue-8, pp-45-51.
- [18] P.K.Halder, N.Paul, M.U.H. Joardder, M.Sarker, “Energy scarcity and potential of renewable energy in Bangladesh”, ICSD 2017: 5th international conference on sustainable development, 6-7 September 2017rome, Italy.
<https://www.researchgate.net/publication/279977246>.
- [19] Md.Alam Hossain Mondoal, Manfred Denich.center for development research (ZEF), university of Bonn, Walter-Fles-Str. 3, 53113 Bonn, Germany, “Assessment of renewable energy resources potential for electricity generation in Bangladesh”.
- [20] K.S.Reddy, T.K. Mallick and D.Chemisana, “Solar power generation”, Hindawi publishing corporation international journal of photo energy volume 2013, Article Id 950564, 2 Pages <https://dx.doi.org/10.1155/2013/950564>.
- [21] Nafisa Noor, sadid Muneer, “Concentrating solar power (CSP) and its prospects in Bangladesh”, DOI: 10.1109/ICDRET.2009.5454207, Source: IEEE Xplore.
- [22] Ehsanul Jabir, Pawan Kumer, Sanddep Kumer, adedeji adebu, Kola Adelodun, “Solar energy: potential and future prospects”, Renewable and sustainable energy reviews September 2017, DOI: 10.1016/j.rser.2017.09.094.

- [23] Md. Alamgir Hossain, Md. Raju Ahmed, “Present energy scenario and potentiality of wind energy in Bangladesh”, International journal of electrical, computer, electronics and communication engineering, Vol: 7 No: 11, 2013.
- [24] Mararten jaspers fajjer, Eric Arends , Hans Rijntalder, “Wind energy potential Bangladesh”, Baseline Study, 716044, Netherlands Enterprise Agency.
- [25] A.S.N. Huda, S.Mekhilef, A.ahsan, “Biomass energy in Bangladesh: Current status and prospects”, Renewable and sustainable energy reviews 30 (2014) 504-417. Available in: www.elsevier.com/locate/rser.
- [26] Jahidul Islam Razan, Riasat Siam Islam, Rezaul hasan, samiul Hasan and Fokhrul Islam, “A comprehensive study of micro-hydropower plant and its potential in Bangladesh”, ISRN renewable energy, Volume 2012, article ID: 635396.
- [27] Md. Shahinur Islam , Sabuj Das Gupta, Md Shah Masum, NAZmul Islam Raju, Sayed Ashraful karim, “ potential of small –scale hydro power plant using the kinetic energy of flowing water of Gumoti and Surma river of Bangladesh: An energy Odyssey”, International journal of renewable energy research, Md Shahinur Islam et al, Vol. 3, No. 1, 2013.
- [28] Jahidul Islam Razan, RIAsatr siam, Rezaul Hasan, Samiul Hasan and Fokhrul Islam, “A Comprehensive study of micro-hydropower plant and its potential in Bangladesh” Interntional Scholarly research network, ISRN renewable energy, Volume 2012, Article ID 635396.
- [29] Md. Abdullah Hil Baky, Md. Mustafizur Rahman , A.K.M. Sadrul Islam, “Development of renewable energy sector in Bangladesh: Current status and future potentials”, DOI: 10.1016/jrser.2017.02.047.
- [30] Shamsuddin Ahmed, Md. Tasbirul Islam, Mohd aminul Karim, Nissar Mohmmad Karim, “Exploitation of renewable energy for sustainable development and overcoming power crisis in Bangladesh” Available in: www.elsevier.com/located/renene.
- [31] M.M Golam Hossain, “Improved Cookstove and biogas programmes in Bangladesh” Energy for sustainable development, Volume VI No. 2.
- [32] A.K.M Sadrul Islam, Muzharul Islam, Trzmilur Rahman, “Effective renewable energy activities in Bangladesh”, Available in: www.elsevier.com/locate/renene.

[33] https://en.wikipedia.org/wiki/Sustainable_energy.

[34] Ibrahim Dincer, “Renewable energy and sustainable development: a crucial Review”. Available in: www.elsevier.com/located/rser.

[35] M.S. Islam, A.M.H.R. khan, S. Nasreen, F. Rabbi and M.R. Islam, “Renewable energy the key to achieving sustainable development of rural Bangladesh”, Journal of chemical engineering, IEB, Vol, Che. 26, No. 1.

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