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Renewable Energy Context, Scope, Application and Green Business in Bangladesh

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Abstract—*Energy from fossil fuel (coals, diesel, kerosene, wood etc.) generates carbon, carbon dioxide emissions, green house emissions that pollute air, and destroy environment resulted global warming that's harmful to living beings and nature. Hence energy scientists are looking for alternative energy resources uses that are environmentally friendly and good for human being. This paper talks about fossil fuel energy and renewable energy use and their consequence and impact respectively in the nature and society. The paper identifies different RE resources and different RE projects undertaken in the world particularly Bangladesh. The study discovers Grameen Shakti, a sister organization of Grameen Bank, is the largest RE implementing organization not only in Bangladesh, but also in the world. GS has developed a micro-utility RE financial model that has disseminated to the IDCOL partnered RE implementing agencies in Bangladesh. The RE technologies need further improvement for to not only more handy at the micro level, but also valuable at the economic scale.*

Key terms*: Bio gas, climate change, fossil fuel energy, Grameen Shakti, green house gas emission, global warming, renewable energy and solar panel.*

1. INTRODUCTION

Many NGOs, private agencies and public institutions are involved in renewable energy green businesses and earn income by selling renewable energy products to people in Bangladesh. The paper studies the context of renewable energy in Bangladesh, its scope and applications there. The research also discerns renewable energy business models that exit in Bangladesh. In the paper, the author incorporates his working experience with Grameen Shakti (GS) and the collected data from different RE implementing organizations in Bangladesh during his visit to Bangladesh in September 2014-April 2015.

2. ENVIRONMENTAL ISSUE

Green house gases (CO_2 Ch_4, and N_2O) emitted in burning of different types of fuel lead to air pollution, environmental pollution and global warming. GHG emissions factors are mostly due to CO_2 are shown below.

Table 1: GHG emission factor

Item	GHG emission factor
Kerosene	2.5 ton CO2/ton
Wood/straw	1.7 ton CO2/ton
Diesel genset	1.3 ton CO2 /MWh
Diesel	0.897 ton CO2/MWh
Bangladesh grid (natural gas 90%)	0.452 ton CO2/MWh
Natural gas	0.452 ton CO2/MWh
Hydro, Solar, Wind	0

Source: SWERA, 2007

The gradual increase of global temperature and its consequences affect Bangladesh, risen the sea level of Bay of Bengal. It is because of climate change and because of radiant energy leaving the planet is naturally retained in the atmosphere. The concentration of the atmospheric gases slowly increases and helps to rise temperature. This issue is being termed as global warming, which accelerates the earth's climate change.

Fuel mixed grid electricity production contains huge CO_2, CH_4, N_{2O} emission. Table-2 shows World Energy generation, supply, consumption and CO_2 increasing trend from 1973 to 2006.

Table 2: GHG Emission Factor

Fuel Type	Fuel Mix	CO2 emission	CH4 emission	N 2 O emission	Fuel conversion efficiency	GHG emission factor
	%	Kg/GJ	Kg/GJ	Kg/GJ	%	(tco2 /MWh)
Small hydro	4.9 %	0.0	0.0000	0.0000	100.0%	0.000
Natural gas	90 %	56.1	0.0030	0.0010	45.0%	0.452
Diesel (#2 oil)	5.1 %	74.1	0.0020	0.0020	30.0%	0.897
Electricity mix	100 %		-	-	-	-452

Source: RETScreen analysis in SWERA report 2007.

With availability of effective bright roof areas, satisfactory global irradiation and sunshine duration, the environmental concerns are very practical and pragmatic consideration for the installation of the photovoltaic systems. As a result, countries with capacity of technological innovation and strong economy have emphasized on harnessing energy from the renewable resources. The Kyoto Protocol prescribed that countries largely contributing to GHG emission could take part in emission trading, clean development mechanism and joint implementation to reduce their shares of GHG emission. Germany, Japan, Netherland etc. are some of the industrialized countries, which have been shown their obedience to the protocol since it was adopted.

3. SIGNIFICANCE OF THE STUDY

3.1. Bangladesh Energy Concerns

Before 2006, only 40% people of the country are connected to grid electricity and the rest depend mostly on biomass energy, kerosene and diesel powered electricity. Remote villagers and coastal energy users are suffering from energy use. Kerosene is the most common fuel used by the households for illumination purposes. Price of kerosene is often subject to fluctuations with price going up in the event of scarcity of supply. The quality of light from kerosene lamps is poor and not adequate enough for all purposes. Besides, it pollutes the household environment through emission of smokes and is also hazardous. Small-scale private generators are in operation in some markets to provide electricity to the shops for limited hours, usually after the evening. The commercial shops in the non-electrified market places use kerosene lamps, candles, etc. which are not found suitable for their activities. The electrified shops face problems of load shedding, irregular supply of electricity and poor service by the utility agencies.

Bangladesh is also not a big contributor to global greenhouse gas emission. But the imminent consequences of climate change in the country are likely to be higher due to sea-level rise and frequently occurring catastrophes. Meanwhile the country has experienced massive destruction due to severe cyclones in the south and frequent flood events, which are reported to be the result of global climate change. It is evident that due to the accelerated industrial growth of the developed countries, relatively low-lying countries (e.g., Bangladesh, Maldives) are getting more vulnerable to climate change. Therefore, use renewable energy technology, environmentally friendly clean energy, and use of renewable energy education is essential to reach out to mass people in Bangladesh

4. WHY NEED RENEWABLE ENERGY

Reduction of global greenhouse gas emission to seize global warming requires minimizing the use of fossil fuels. To achieve this, a large scale use of renewable energies must be made over the globe for production of electrical and thermal energy. World resources of oil, gas, and coal are limited and there is a global concern about this but for Bangladesh the situation appears to be extremely unhappy as per capita reserve of fossil fuels is only $1/50^{th}$ to $12/100^{th}$ of world per capita.

According to a recent study by the World Health Organization, around 46,000 people die every year in Bangladesh from exposure to indoor air pollution caused by inefficient traditional cook stoves, with 70% of the victims being children under age of five years. Around 90% of the households in Bangladesh uses biomass fuels and low efficiency stoves for cooking resulting incomplete combustion and corresponding Indoor Air Pollution (IAP) through emissions of greenhouse pollutants and particular materials. It causes severely adverse health impacts which are particularly acute for women and children who are the most exposed groups to indoor air pollution.

4. 1 CO_2 Emissions in Bangladesh

SWERA (2007) finds GHG (Green House Gas) emission from electricity grid (20,062 MKWh) is 9 million tons. By 2020 electricity demand should be doubled and CO_2 emission would be around 18 million tons.

Table 3: CO_2 Emission Energy Production in Bangladesh:

Description	Quantity of emission
Energy-related Carbon Dioxide Emissions	32.9 million tons
Per capita energy consumption	4.0 million Btu
Per capita carbon dioxide emissions	0.23 tons

Source: IEA, 2003

At least 89% of air emissions associated with electricity generation could be prevented if electricity from photovoltaic displaces electricity from the grid (Fthenakis et al. 2008; Scheer, 2002 Renewable energy emission of CO_2 is very low. Technologies on wind power generation have been reported as the lowest CO_2 emitter. Hydro and solar PV systems also have low emissions, with average reported values at less than 100g/kWh CO_2 (Evans et al. 2008).

4.2. Large Electricity Deficit in Bangladesh

The country had an initial installed capacity of 5,202 MW (current rerated capacity- 4,000 MW mainly due to ageing of infrastructures), while average electricity generation at present is around 3,700-3,800 MW against the present demand of over 5,000 MW (BPDB, 2009; World Bank and GTZ, 2009). Alongside, the country's electricity demand is increasing over 500MW each year (Stromsta, 2009).

Therefore, Bangladesh has been suffering from energy crisis. Huge load shading, lack of sufficient energy for agricultural irrigation is because of energy crisis. Heavy industries in Bangladesh cannot be developed because of energy crisis. Before 2000s, rural people use biomass fuel for cooking. 50% energy obtained from biomass energy in the rural areas. Indigenous gas (available within the field), oil (petroleum and coal (few from Bangladeshi coal mines and imported) are the

major source of primary commercial energy in Bangladesh. Hydroelectric energy sources are managing by the public sector which is very limited and inefficient. The country's power is being mostly generated with conventional fuel (82% indigenous natural gas, 9% imported oil, 5% coal) and renewable sources (4% hydropower and solar). According to Bangladesh Bureau of Statistics (BBS, 2006), around 32% people of the country had electricity connection, and around 4% have natural gas supply. Currently around 40% people are connected with electricity grid. But still 60% people throughout country are still remaining without electricity (Kabir & Endlicher, 2012). However, the annual GDP growth of electricity is gradually rising (BBS, 2006).

Bangladesh is one of the most disaster prone countries in the world, and is vulnerable to various devastating disasters like cyclone, tidal surge, sea level rise etc. The imminent consequences of global warming due to increase of GHG emissions will certainly affect the deltaic Bangladesh. The country has experienced with massive coastal cyclones and saline intrusion. It is predicted that in the near future, more severe impacts are likely to happen if immediate measures are not undertaken. This tremendous power shortfall and air pollution drives for alternative energy (solar home systems) exploitations in Bangladesh. Solar home systems (SHSs) has covered more than 2.2 million households providing at least some lighting (February, IDCOL, 2015).

5. ENERGY STATUS IN BANGLADESH

About 90% of the population in vast rural areas were practically without electricity. For the benefit of this vast rural people, REB (Rural Electrification Board) was established in 1977. It provides electricity to consumers in a selected area by forming a Rural Electric Co-operative called Pally Bidyut Samity (PBS). Activities of rural electrification co-operative are given below

Table 4: Production and consumption of Natural Gas in Bangladesh

Category	2000-01	2001-02	2002-03	2003-04	2004-05
Gas Production Gas (109cft	372.16	391.53	421.16	454.59	486.75
Consumption (109cft)					
Electricity	175.27	190.03	190.54	199.40	211.02
Captive	0	0	0	32.03	37.87
Fertilizer	88.43	78.78	95.89	92.80	93.97
Industrial	47.99	53.56	63.76	46.49	51.68
Tea-garden	0.65	0.72	0.74	0.82	0.80
Brick field	0.44	0.53	0.52	0.12	0
Commercial	4.06	4.25	4.56	4.83	4.85
Domestic	31.85	36.74	44.80	49.22	52.49
CNG	0	0	0.23	1.94	3.62
Total Consumption	348.69	364.61	401.04	427.65	456.30

Source: BBS (2006)

5.1. Imported Fossil Fuels

Bangladesh transport system depends almost totally on imported liquid fuels, but good news is after 2008, CNG fuel is using from national source. Kerosene is used widely for lighting in villages while diesel generators are getting unavoidable. The amount of crude oil and petroleum products imported is shown below in Table 7.

5.2. Electrical Energy

During financial year 2005-06, per capita consumption was 136kWh whereas per capita electricity generation was reported to be 167kWh (SEWERA, RERC, 2007). At present, the electricity situation little better.

The availability of the most useful form of energy, electricity, is again extremely small as shown below.

Table 5: Electricity Generation and Consumption in Bangladesh, 2005-2006.

Item	Quantity
Installation Capacity	5,275MW
Average demand	4,300-4,500MW
Average generation	3,200-3,300MW
Per capita generation	167 kWh
Per capita consumption	136 kWh

The shortfall in electricity generation continues till today mainly due to old inefficient generators requiring heavy maintenance.

6. SCOPE OF RENEWABLE ENERGY USE IN BANGLADESH

Bangladesh has an enormous potential in solar energy, and therefore the installations of small and large-scale PV systems can help to reduce its current share of GHG emission. One family using a typical solar home system can save yearly 290 litres of family using this small system can save yearly 290 litters of kerosene by using solar lighting technology and can prevent the emission of 0.76 ton CO_2 per year (SWERA , 2007).

Solar PV generated lighting program in Bangladesh primarily includes on rural houses, small businesses, and income generation activities in the remote rural areas which is being implementing by Grameen Shakti, and other NGOs in Bangladesh. Many SPV aimed at providing income generating opportunities through running motors, permitting longer working hours and facilitating longer selling hours by rural traders. The government sponsored organization infrastructure Development Company Limited (IDCOL) in Bangladesh has been involved to a large extent in the promotion of SPV systems and has already installed around 450,000 solar home systems all over the country through the partner NGOs (Haque, 2008; IDCOL, 2009).

In Bangladesh, 60% of the total population still depend on biomass based energy. Agricultural residues (rice straws, jute sticks, rice husks etc.), cow dung, twigs etc. have been being used as fuel for cooking by the rural households since time immemorial. But the inefficient use of traditional fuel sources produces immense indoor air pollution causing massive health hazards particularly to women and children. At the same time, there has been a decline in the supply of biomass mainly due to the high population pressure on agricultural production (Grameen Shakti, 2015).

The major attention of the RE technology is still concentrated into the rural areas although the urban areas generate enormous solid wastes which can be used for power generation and to produce compost. By 2010, the renewable energy sources (especially hydropower) contribute only 4% of the total power generation (4,000 MW) (Hussain & Badr, 2005).

The country has potential in wind power generation particularly in the coastal areas, although there is still lack of reliable wind speed data. Bangladesh being an agrarian country produces enormous biomass energy which can be used to generate biogas for clean fuel for cooking and electricity for lighting in the rural areas. In spite of enormous potential biogas technology has not been well accepted due to initial expenditure.

In Dhaka Megacity, the application of solar PV systems on the bright roof-tops can generate more than 1,000 MW of electricity (at 105 efficiency with 75 Wp modules) preferably through grid connected PV systems.

7. RENEWABLE ENERGY SERVICE PROMOTIONS AND SUPPORTS BY IDCOL IN BANGLADESH

Bangladesh government promote and support renewable energy, saving energy and GH emission reduction have been the goals. The legal framework for the support of the renewable energy sources of the country Infrastructure Development Company Limited (IDCOL), a project of the World Bank Bangladesh. IDCOL is providing financial support, technological support to the implementing RE projects in Bangladesh. For example GS, BRAC, Rahimaforz etc get solar panel installation support from IDCOl Bangladesh.

IDCOL starts its solar program in January 2003 with the support from International Development Association (IDA) and Global Environmental Facility (GEF) to fulfill basic electricity requirements in the rural areas of Bangladesh. IDCOL provides both grant and refinancing for 50,000 SHS over a period of five-and –half years (January 2003-June 2008). The target was achieved in August 2006, three years ahead of the project completion period and US$2.0 million below estimated project cost of US$20 million. Therefore, the target was revised to finance a total of 200,000 SHS by the year 2009 with additional support from the World Bank, GTZ and KFW (IDCOl, 2014).

Many job opportunities created through SHS program. Through GS, 5,000 people have employed in Bangladesh.

Table-6: IDCOL Program Benefits (2014)

Program achievement:	3 million SHS
Number of beneficiaries:	13.5 million people
Power generation:	150 MW
Fossil fuel saving:	216,000 ton/yr
CO_2 reduction:	503,000 ton/yr
Job creation:	60,000
IDCOL investment:	USD$ 500 million

Source: IDCOL, 2014.

Solar powered irrigation system is an innovative, economic and environmentally friendly solution for the agro-based economy of Bangladesh ICOL has financed 38 and approved financing of additional 76 solar PV based submersible water pump in different locations of the country. IDCOL has a target to finance 1,550 pumps by 2016. IDCL provides subsidy, soft loan and technical support to ensure effective implementation of the program. IDCOL also financed to NGOs for biomass gasification based power plants

IDCOl claims through IDCOL more than 70,000 direct jobs created in Bangladesh. Due to SHSs, students now benefit from extended hours of studies at night in better lighting condition, small businesses enjoy extended operating hours and women feel more secured at night. The existing SHSs installed under the program reduces approximately 528,000 ton of CO_2 annually (IDCOL, 2014).

8. GRAMEEN SHAKTI

Grameen Shakti is a non-profit organization established in 1996 to promote, develop and popularize renewable energy technologies in remote, rural areas of Bangladesh. Currently, GS is one of the largest and fastest growing rural based renewable energy companies in the world. GS is also promoting Small Solar Home System to reach low income rural households. It enlighten houses by solar power, cook comfortably by bio-gas.

Table 7: Grameen Shakti Programs at a Glance as of February, 2015

Description	This Month	This Year	Since Inception
No. of Solar Home System	16,594	33,184	1,583,319
No. of Biogas Plants installed	279	556	30,847
No. of Improved Cooking Stoves	9,767	19,299	910,204
No. of Branches	0	0	1,245
No. of Persons trained	124	238	44,252

Grameen Shakti is providing loans to SHS receivers both GB borrowers and to the non-GB members. Till February 2015, GS has alone installed 1,583,319 solar home systems covering 64 districts in Bangladesh. It is working at the grass roots

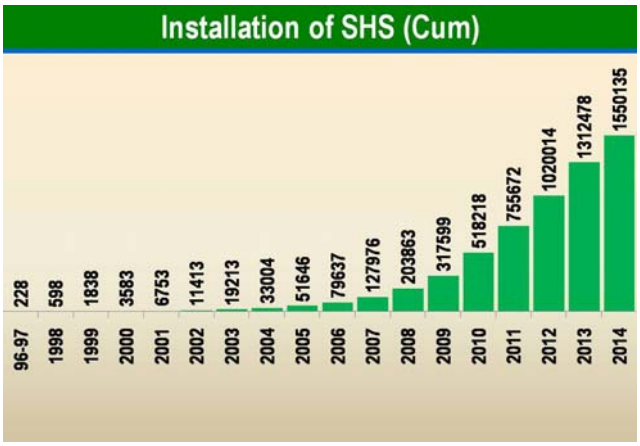
village level and selling SHS to villagers with credit who pay their SHS prices at an instalment basis over three years. For the solar PV installation, GS selects areas where there is no availability of conventional electricity or areas with low coverage by Rural Electrification Board (REB) or areas with almost no possibility of the extension of rural electrification within 5-10 years period.

Grameen Shakti is working not as a charity rather follows social business model. It has successfully blended technology with social market forces to develop a market based approach to reach the rural people. It does not provide direct subsidies to RE users. It has developed an innovative micro-credit service to RE users to reduce costs and to reach economy scale.

8.1. Installations of SPV Systems by Grameen Shakti

Within a period of one and an half decade, it has been able to develop a large number (2500) trained technicians, (mostly women) and altogether 7,000 employees for preparing, installing and taking care of the home systems. It has targeted to empower 75 million people all over the country through renewable energy technologies by 2015 (Grameen Shakti, 2009). It continues to provide solar home systems at a rate of 10,000 systems per month. The price of the SHS is still expensive for the rural poor; (Hackett, 2009). The application of solar PV systems by GS until now includes mostly stand-alone PV systems, SHSs to run CFL lights, black and white television, mobile chargers, refrigerators for vaccine preservation etc.

Grameen Shakti SHSs is used to light up homes, shops, fishing boats etc. People also used to charge cellular phones, run televisions, radios and cassette players. People also use for operating TVs cassettes, audios, VCPs etc., operational small fans and amplifiers, running computers and cellular phones, running computers and cellular phones and running DC motor driven equipments such as drill machines, soldering irons etc.



Source: Grameen Shakti, 2015.

Fig. 1

Grameen Shakti SHSs users become the owner of an electric power generating and supply system. No need to pay monthly electricity bill in every month. SHSs life span is more than 20 years. There is no load shedding with SHSs. This technology is clean, safe and is environmental friendly & health hazards free.

Table 7: Grameen Shakti package price of LED Lamp solar home system 2014-2015 (price is changeable)

SL.	System Capacity (Watt)	Loads can be used	Equipments supplied by Grameen Shakti	Package price TK.
1	10	2X2.5 watt LED light	A 10 watt panel, 2X2.5 watt LED light, a 15 AH battery, a charge controller, a frame and cables	8,100
2	15	2X3 watt LED light	A 15 watt panel, 2X3 watt LED light, a 15 AH battery, a charge controller, a frame and cables	9,400
3	20	3X3 watt LED light	A 10 watt panel, 3X3 watt LED light, a 20/23 AH battery, a charge controller, a frame and cables	12,000
4	20	3X3 watt LED light	A 20 watt panel, 3X3 watt LED light, a 15 AH battery, a charge controller, a frame and cables	13,000
5	30	2x3 watt LD light and a 15" LCD/LED TV	A 10 watt panel, 2X2.5 watt LED light, a 30 AH battery, a charge controller, a frame and cables	15,500
6	40/42	3X3 watt LED light and a 15" LCD/LED TV	A 10 watt panel, 2X2.5 watt LED light, a 40/45 AH battery, a charge controller, a frame and cables	22,000
7	50	4X3 watt LED light and a 15" LCD/LED TV	A 50 watt panel, 4X3 watt LED light, a 55/60 AH battery, a charge controller, a frame and cables	27,100
8	60	5x3 watt LED light and a 15" LCD/LED TV	A 60 watt panel, 5X3 watt LED light, a 60 AH battery, a charge controller, a frame and cables	30,600
9	63/65	5x3 watt LED light and a 15" LCD/LED TV	A 63/65 watt panel, 5X3 watt LED light, a 70/80 AH battery, a charge controller, a frame and cables	31,600

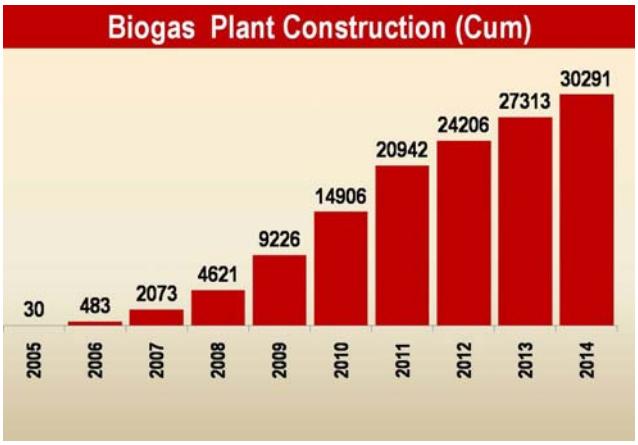
10	75	6x3 watt LED light and a 12 watt fan and 15" LCD/LED TV	A 75 watt panel, 6X3 watt LED light, a 80 AH battery, a charge controller, a frame and cables	34,100
11	80	7x3 watt LED light, a 12 watt fan and a 15" LCD/LED TV	A 80 watt panel, 7X3 watt LED light, a 880 AH battery, a charge controller, a frame and cables	36,600
12	83/85	7x3 watt LED light, a 12 watt fan and a 15" LCD/LED TV	A 83/85 watt panel, 7X3 watt LED light, a 100 AH battery, a charge controller, a frame and cables	37,600
13	100	9x3 watt LED light, a 12 watt fan and a 15" LCD/LED TV and a 15" LCD/LED TV	A 100 watt panel, 9X3 watt LED light, a 100 AH battery, a charge controller, a frame and cables	41,600
14	130/135	7x3 watt LED light, two 12 watt fans and a 15" LCD/LED TV and a 15" LCD/LED TV	A 130/135 watt panel, 7X3 watt LED light, a 130 AH battery, a charge controller, a frame and cables	46,100
Warranty for different parts off LED Solar Home system Solar Panel: 20 years LED Lamp; 3 years 15 AH Battery: 3 years Change Controller: 3 years				

Source: Grameen Shakti, 2015.

Grameen Shakti's SHSs packages the most popular demand are serial number 3, 4, and 5 items in Bangladesh.

GS has been successful in promoting and constructing both domestic and larger sizes biogas plants to rural villagers. GS Biogas Program has a unique financial mechanism based on credit, which makes biogas plants affordable to the villagers. People use cow dung in their bio gas plants. Biogas technology can be also used with the home wastes. Grameen Shakti provides free services after sales including monthly visits by GS engineers for two to three years. People use slurry of Biogas plant for organic fertilizer.

Biogas protects women and children from in-door air pollution and related diseases such as coughs, asthmas etc. It helps keep the environment clean and stops the spread of diseases by transforming pollutants into clean energy. It saves fire woods resulted stops deforestation.



Source: Grameen Shakti, 2015

Fig-2

8.3. Grameen Technology Centers

GS has set up 45 Grameen Technology Centers (GTC). These CTCs are producing SHS accessories by manufacturing these locally. GTCs are also contributing to women empowerment by developing Solar Technicians in the villages. Women members of 5000 SHSs user families are also trained on proper repair and maintenance of their systems. Besides these, 10,000 school students gain awareness about the renewable energy technologies and the environment. GS also trained 300 engineers in order to implement this project smoothly. Women technicians have already been trained, many of them are assembling SHS accessories at local GTCs, others are providing after sales service. These GTCs train renewable energy entrepreneurs and link them up with different technical and financial institutions.

14.6. GS Improved Cooking Stoves contributes 50% less fuel cost, women protected from in-door air pollution, no blackening, and no heat from stove. GS has become interested in ICS because it helps women and makes their lives easier. GS sees a potential market of at least 2 million ICSs in the first three years of the program.

Source: Grameen Shakti, 2015

Fig-3

8.7. Bio-fuels

India established the first biodiesel produce from Jatropha plant in Hyderabad of Andra Pradesh (GTZ, 2008). It is expected that at least 2.5 m. tons of biodiesel can be supplemented to the total demand of around 50 m. tons for Indian vehicles. Jatropha plant in the dry-arid part of the Indian State has promoted the local's income generation. Grameen Shakti has started to cultivate Jatropha on a plot basis in Dhaka in 2010, but it is yet not cultivate at mass scale.

8.8. Social Business and Nabin Udoykta Program of Grameen Shakti- a new Dimension

All the activities of the organization Grameen Shakti executes are fully related to social business perspective. It is a new category of cause-driven business. The company must cover all costs and make profit, at the same time achieve the social objective. In a social business, the investors/owners can gradually recoup the money invested, but cannot take any dividend (profit) beyond that point. Grameen Shakti follows all seven principles of social business.

Grameen Shakti has been attached to 'Nobin Udyokta Program' of Nobel Laureate Prof. Muhammad Yunus, a very promising project to bring new young entrepreneurs in the light. Prof. Muhammad Yunus has given permission to include the children (2nd generation) of Grameen Bank Borrowers from Birulia, Ahshulia and Dhamshona Union under Savar Upazilla of Dhaka district in the Social Business as well as Nobin Udyokta (New Entrepreneurs) Program. The activity of investment in the different promising project of Nobin Udyokta has already been started in the Grameen Bank Area of above mentioned unions under Nobin Udyokta program. Till now, 6 Nobin Udyokta projects have been presented in Executive Design Lab and approval for investing of Tk. 1.4 million has been made. Four Nobin Udyokta have received Nine Hundred Thousand Taka till now. These projects include tailoring, textile business, telecom service, grocery shop, dairy farm etc. Rest of 2 projects is now in the process to be invested as early as possible. Moreover, more than 10 promising project are in pipe line to be presented in Executive Design Lab in near future. There is a plan to invest 5 million Taka among 20 Nobin Udyokta (New Entrepreneur) by December, 2014 and 50 million Taka among 250 Nobin Udyokta by 2015 (Grameen Shakti, April, 2015).

Table 8: Grameen Shakti Programs at a Glance February, 2015

Total Office	1528
Branch Office	1245
Grameen Technology Centre	34
ICS Production Center	67
Number of districts covered	Covered all districts of Bangladesh
Number of villages covered	50,000 villages
Total beneficiaries	Around 17.67 million people
Total employees	11,230
Total installation of SHS	1,583,319
Total Number of Improved Cook Stove (ICS)	910,204
Total biogas plant constructed	30,847
Number of trained technicians (Mostly woman technicians)	22,822 technicians
Number of trained customers (Mostly woman)	839,725 users
Full Paid customer (ownership)	604,694 customers
Future plan- biogas plant construction by 2015	100,000
Future plan- Improved Cooking Stove construction by 2015	2 million

Source: Grameen Shakti, February, 2015

9. NATIONAL ENERGY POLICY

The Renewable Energy Program in Bangladesh has emphasized on the exploitation of solar, wind, biomass gasification, biogas and hydro energy. The policy has targeted to develop RES to meet 5% of the total power demand by 2015 and 10%by the year 2020 (MPEMR, 2008).

The first National Policy (NEP) of Bangladesh completed and gazetted in 1996 was adopted mainly with the aim of achieving sustainable economic growth and developing sufficient energy for different sectors (Islam et al. 2006). The guidelines of the renewable energy were mentioned in the NEP. Later, the government adopted Private Power Generation Policy in order to promote private sector participation in power generation. In April 2004, Bangladesh Energy Regulatory Commission (BERC) was established and started functioning. The major objectives of the renewable energy policy mentioned in the NEP 2004 are targeted to provide energy for sustainable economic growth to meet the energy needs of different zones of the country, ensure environmentally sound sustainable energy development programmes causing minimum damage to environment,

encourage public and private sector participation in the development and management of the energy sector, to bring entire country under electrification by the year 2020, to ensure reliable supply of energy to the people at reasonable and affordable price and too develop a regional energy market for rational exchange of commercial energy to ensure energy security (MPEMR, 2004).

10. RECOMMENDATIONS

RETs along with technologies for energy conservation and energy efficiency can help overcome energy shortages and lead the country to progress provided necessary steps are taken now without delays. Solar radiation is excellent for all locations of Bangladesh. Large scale utilization of solar and wind energy should help energy security in the face of impending energy crisis from dearth of conventional energy supply. Renewable energy public education could be included in the formal and non-formal adult education in Bangladesh. Ongoing SHS program should be strengthen to enable installation of 500,000 units by 2020. The program for biogas project and biomass cooking stove can solve rural firewood cooking problems so these two technologies can be promoted through public extension agencies, and green NGOs in Bangladesh. The government sponsored Infrastructure Development Company (IDCOL) has to initiate financing (micro-credit) for solar home systems in the urban slums (like off-grid remote areas). In order to promote sustainable wind power generation, an efficient management system and strong coordination among the respective authorities have to be ensured.

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