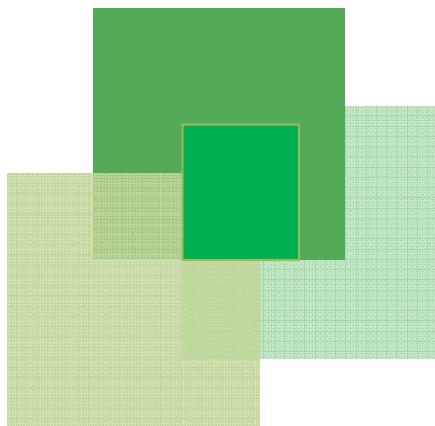




International
Labour
Office
Geneva



Skills for green jobs in Bangladesh

Unedited background country study

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Bangladesh Institute of Development Studies

ILO Skills and
Employability
Department

2010

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First published 2010

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ILO Cataloguing in Publication Data

Mondal, Abdul Hye; Iqbal, Zabid; Mehedi, Shaifullah

Skills for green jobs in Bangladesh : unedited background country study / Abdul Hye Mondal, Zabid Iqbal, Shaifullah Mehedi ; International Labour Office, Skills and Employability Department. - Geneva: ILO, 2010

1 v.

ISBN: 9789221239857 (web pdf)

International Labour Office; Skills and Employability Dept

skill / skill requirements / vocational training / training needs / green jobs / employment creation / climate change / environmental protection / Bangladesh

13.02.2

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Foreword

The world finds itself in a slow recovery after the deepest recession since the Great Depression. The world is also coping with a host of environmental problems and the urgent need to reduce carbon emissions. A greener future also promises an enormous potential in a much needed employment growth. However, without suitable skills, this potential cannot be realized. Today, skills gaps are already recognized as a major bottleneck in a number of sectors, such as renewable energy, energy and resource efficiency, green building and retrofitting, environmental services, and green manufacturing. Training response measures are successful where they are coherent across policy domains, systemic and systematic, and targeted at disadvantaged groups. These training measures can only be effective if based on timely identification of skills needs. Effectiveness of training measures is decisive not only for the economic recovery but also for a longer-term sustainability agenda.

This report was produced in the framework of the project, ‘Skills for green jobs’. The project was implemented in cooperation between the International Labour Organization (ILO) and the European Centre for the Development of Vocational Training (Cedefop). The project identifies skills needed for greener economies with respect to structural shifts, and new, emerging and changing occupational profiles. The ‘Skills for green jobs’ study is embedded in the Green Jobs Initiative, a joint initiative of the United Nations Environment Programme (UNEP), the ILO, the International Employers Organization (IOE) and the International Trade Union Confederation (ITUC), to assess, analyze and promote the creation of decent jobs as a consequence of the needed environmental policies. The global study was jointly funded by the Skills and Employability Department of the ILO and the Green Jobs Initiative. In Bangladesh, the country study was implemented through the EU-funded Technical and Vocational Education and Training (TVET) reform project, and contributed to the knowledge generation on current and future skills demand in the country.

The following countries have been included in the study: the ILO covered Australia, Bangladesh, Brazil, China, Costa Rica, Egypt, India, Indonesia, the Republic of Korea, Mali, the Philippines, South Africa, Thailand, Uganda and the United States. In addition, Cedefop covered six European Union (EU) member States: Denmark, Estonia, France, Germany, Spain and the United Kingdom. The ILO global synthesis report,¹ which analyzes the situation in all 21 countries involved in the study, and the European synthesis report,² which covers the six EU countries, as well as all individual country reports, are available at: http://www.ilo.org/skills/what/projects/lang--en/WCMS_115959/index.htm (the ILO website) and <http://www.cedefop.europa.eu> (Cedefop website; look under *Skills Needs* theme). The unedited background country studies have been published in the electronic form in order to make them available quickly. The summaries are published as part of the synthesis reports.

¹ Strietska-Illina, O.; Hofmann, C.; Duran Haro, M.; Jeon, S. (forthcoming 2010). *Skills for green jobs: A global view. Synthesis report based on 21 countries* (Geneva, ILO Skills and Employability Department).

² Cedefop. (forthcoming 2010). *Skills for green jobs: European synthesis report* (Luxembourg, Publications Office of the European Union).

The global project in the ILO was coordinated by the Skills and Employability Department and, in particular, benefited from comments and technical guidance by the team under the leadership of Olga Strietska-Illina, Christine Hofmann, Mercedes Duran and Shinyoung Jeon. The ILO coordinating team would like to express great thanks to the authors of the report, Abdul Hye Mondal, Md. Zabid Iqbal, and ATM Shaifullah Mehedi of the Bangladesh Institute of Development Studies, for their background country research which contributed to the global study. Special thanks also go to the ILO regional and country field offices for the project support and the ILO colleagues in the TVET reform project who assisted research at national level.

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Abstract

Main greening shifts in the economy and the labour market of Bangladesh have taken place strongly in renewable energy, but rather weakly in materials management, telecommunication and transport. The shifts in the sectors other than renewable energy remain weak primarily due to inadequate policy and institutional support. Skills for green jobs are instrumental in bringing about the desired change for sustainable development. Bangladesh has embarked on several policies and programmes for adaptation to climate change and mitigation of its adverse impact, but it has no policy for the formation and development of skills for greening the economy.

A coherent policy for the formation and development of skills for green jobs in all the potential sectors should be put in place and implemented. The paper argues that for greening the economy, the policy should target the implementation of the skills needs for green jobs in various sectors as identified by the present study and incorporate them into the occupational profiles, curriculum design and education and training provision for greening existing occupations and for developing emerging and new green occupations and embody strategic interventions for overcoming the skill gaps. The existing TVET system needs to be made environment-driven. Further research and regular data collection should be undertaken with a view to updating the knowledge and progress in greening the economy.

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Executive summary

This research report attempts to identify strategic skills development responses of Bangladesh in the light of environmental degradation, climate change and the global call for greening economies. It finds that climate change has already emerged as a serious challenge to development in general and poverty reduction in particular. The fragile ecological situation is under continuous threats from environmental degradation. But the policy priorities for greening the economy remains limited. General environmental strategy and, for that matter, skills development strategy in response to greening the economy are inadequate.

Main greening shifts in the economy and the labour market of Bangladesh have taken place strongly in energy, but rather weakly in materials management, telecommunication and transport. But these greening shifts remain weak primarily due to inadequate policy and institutional support. With the right policies, institutional framework, commitment, and immediate reinvestment on board, it is possible to bring about the change it needs for greening the economy.

The structural transformation that is taking place in Bangladesh is derived not merely from economic growth but also from spontaneous green structural change. However, current and future employment shifts and trends are likely to take place due to anticipated green structural change notably in renewable energy and telecommunication. Green employment shift to renewable energy with huge potential for growth is gaining momentum. Certain change is anticipated by green structural change especially in energy, manufacturing, waste management, construction, transport, telecommunication and trade.

Eight case studies illustrate anticipated change and provision of skills in different occupations. Skills for green jobs are instrumental in bringing about the desired change for sustainable development. But the policy response and institutional support to overcome existing skill gaps in different occupations remain very weak.

At the policy making level, there is inadequate appreciation of the need for a policy targeting the identification and development of skills for green jobs. Although Bangladesh has embarked on several policies and programmes for adaptation to climate change and mitigation of its adverse impact, it has no policy for the formation and development of skills for greening the economy. In this regard, isolated and sporadic efforts are taking place with very little impact on greening the economy.

In the absence of any strategic policy agenda and support, the delivery mechanisms of the existing institutions for developing skills for green jobs remain inadequate. Shortage of skills and poor institutional framework largely explains weak delivery mechanisms of these institutions.

A coherent policy for the formation and development of skills for green jobs should be formulated and put in place within the overall framework for HRD. For greening the economy, the policy should target the implementation of the programmes for meeting existing skills needs for green jobs in various sectors as identified by the present study and incorporate them into the occupational profiles, curriculum design and education and training provision for greening existing occupations and for developing emerging and new green occupations. The policy should embody strategic interventions and adequate guidelines for overcoming critical skill gaps for green jobs.

Existing education and training policies have inadequate provisions for environmental education at all levels. At the primary level, it should be made mandatory. Synergy among the existing policies and institutions (both public and private) for greening the economy is virtually non-existent. Existing TVET system has virtually no environment-driven curriculum and courses targeted towards establishing and improving the skill base for green jobs. Curriculum for greening the economy should be incorporated in the existing education and training programmes down from the primary level.

National Skills Development Council (NSDC), in collaboration with the Bureau of Manpower, Employment and Training (BMET); Department of Technical Education (DTE); Bangladesh Technical Education Board (BTEB); Ministry of Labour and Employment (MLE); Department of Environment (DOE); Department of Forest (DOF); Ministry of Environment and Forests (MEF); Ministry of Education; IDCOL (Infrastructure Development Company Limited); non-governmental organizations (NGOs), employers and workers associations, should play the central role in the formation and development of skills for green jobs in Bangladesh. Proposed SEDA as a focal point for development and promotion of sustainable energy should be put in place to steer the country towards a cleaner environment through developing skills for green jobs.

Bangladesh should develop information and technological knowledge base and conduct research on GHG emission to combat the impacts of climate change and search for suitable strategies to cope with the changing environment. In order to improve upon the ongoing policies and programmes relating to greening HRD, further research and regular data collection should be undertaken with a view to updating the knowledge and progress in greening the economy.

Abbreviations and acronyms

ADB	Asian Development Bank
ALGAS	Asia Least Cost Gas Abatement Strategy
AQMP	Air Quality Management Project
BADC	Bangladesh Agriculture Development Corporation
BBMA	Bangladesh Brick Manufacturers Association
BBS	Bangladesh Bureau of Statistics
BCAS	Bangladesh Centre for Advanced Studies
BCSIR	Bangladesh Council of Scientific and Industrial Research
BELA	Bangladesh Environment Lawyers Association
BERC	Bangladesh Energy Regulatory Commission
BMDA	Barind Multipurpose Development Authority
BMET	Bureau of Manpower, Employment and Training
BOD	Biochemical Oxygen Demand
BPDB	Bangladesh Power Development Board
BRAC	Bangladesh Rural Advancement Committee
BRTA	Bangladesh Road Transport Authority
BSES	Bangladesh Solar Energy Society
BTCL	Bangladesh Telecommunication Company Limited
BTEB	Bangladesh Technical Education Board
BUET	Bangladesh University of Engineering and Technology
CBOs	Community Based Organizations
CDM	Clean Development Mechanism
CDSP	Coastal Islands Development and Settlement Programme
CER	Carbon Emission Reduction
CES	Centre for Energy Studies
CFL	Compact Fluorescent
CLT	College of Leather Technology
CMES	Centre for Mass Education in Science
CNG	Compressed Natural Gas
CO2	Carbon dioxide
CSP	Concentrating Thermal Power
CSWC	Community Seed Wealth Centre
CVT	Continuing Vocational Education
DCC	Dhaka City Corporation

DG	Director General
DO	Dissolved Oxygen
DOE	Department of Environment
DOF	Department of Forest
DTE	Department of Technical Education
EAP	Ecological Agriculture Program
ECA	Environmental Conservation Act
ECR	Environmental Conservation Rules
ECNEC	Executive Committee of the National Economic Council
ERPA	Emissions Reduction Purchase Agreements
ETP	Effluent Treatment Plant
FGDs	Focus Group Discussions
FORAM	Forum for Regenerative Agriculture Movement
GDP	Gross Domestic Product
GEF	Global Environment Facility
Gg	Gigagrams
GHG	Greenhouse gas
GIS	Geographic Information System
GNI	Gross National Income
GOs	Governmental Organizations
GOB	Government of Bangladesh
GP	Gramin Phone
GS	Grameen Shakti
GTCs	Grameen Technology Centers
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit (German Agency for Technical Cooperation)
HBRI	Housing and Building Research Institute
HC	Hydro Carbon
HHK	Hybrid Hoffman Kilns
HRD	Human Resource Development
HSC	Higher Secondary Certificate
HVAC	Heating, Ventilating, and Air Conditioning
HYVs	High Yield Varieties
IDCOL	Infrastructure Development Company Limited
IIDFC	Industrial and Infrastructure Development Finance Company Limited
INC	Initial National Communication
IPS	Instant Power Services
IUCN	International Union for Conservation of Nature and Natural Resources

LFS	Labour Force Survey
LGED	Local Government Engineering Department
LMIS	Labour market information service
LPG	Liquefied petroleum gas
mcm	Micrograms per cubic meter
MDG	Millennium Development Goal
MEF	Ministry of Environment and Forests
MEMR	Ministry of Energy and Mineral Resources
MLE	Ministry of Labour and Employment
MSW	Municipal solid waste
MTOE	Million ton oil equivalent
NAPA	National Adaptation Programme of Action
NCSA	National Capacity Self-Assessment for Global Management
NEMAP	National Environmental Management Action Plan
NGOs	Non-governmental organizations
NGV	Natural Gas Vehicle
NIDCH	National Institute of Diseases of Chest and Hospital
NSAPR	National Strategy for Accelerated Poverty Reduction
NSDC	National Skills Development Council
O&M	Operation and Maintenance
OE	Oil equivalent
PJ	Pico-Joule
PM	Particulate Matter
PMO	Prime Minister's Office
PPM	Part per Million
PPP	Public-Private Partnership
PV	Photovoltaic
REB	Rural Electrification Board
RERC	Renewable Energy Research Centre
REREDP	Rural Electrification and Renewable Energy Development Project
RET	Renewable Energy Technology
RPGCL	Rupantarita Prakritik Gas Company Limited
RREL	Rahimafrooz Renewable Energy Limited
RSF	Rural Services Foundation
SAE	Society of Automotive Engineers
SEDA	Sustainable Energy Development Agency
SEMP	Sustainable Environment Management Programme

SHS	Solar home system
SIAs	Sub-implementing agencies
SIS	Solar Irrigation System
SMEs	Small and medium enterprises
SRE	Sustainable Rural Energy Project of LGED
TOT	Training of Trainers
TPP	Technical Project Proposal
TVET	Technical and Vocational Education and Training
TWh	Terawatt-hour
UBINIG	Unnayan Bikalper Nitinirdharoni Gobeshona
UNCRD	United Nations Centre for Regional Development
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention for Climate Change
USAID	United States Agency for International Development
VSBK	Vertical Shaft Brick Kiln

1. Introduction

The central objective of the present study is to identify strategic skills development responses of Bangladesh in the light of environmental degradation, climate change and the global call for greening economies.

In order to achieve its objective the study is essentially based on the secondary data and information available in the published and unpublished statistics, research reports, analytical and policy documents. Wherever information is not available, interviews and inputs from the key informants in the respective sectors as well as from experts were sought to fill the information gap. Information gaps that remain are clearly stated and examined to draw conclusions and recommendations for further research and data collection.

The study combines qualitative and quantitative research depending on the data availability. It, however, did not attempt collection of primary data. Quantitative analysis is based on and limited to the available national statistics on current and expected employment trends in greening economic activities disaggregated where possible by occupation, educational attainment, gender and age groups. A quantified estimate of green sectors/ green occupations and the outlook on trends in demand for green jobs and skills are analyzed in conjunction with the information on the supply of available skills and system's capacity to meet the demand in the larger context of the greening policy of Bangladesh. Given the scarcity of reliable statistics and information on green jobs, the present research clearly addresses such limitations and focuses on qualitative methods in order to gain insights into various aspects of greening the economy.

Qualitative methodologies, such as the Delphi methodology,³ structured interviewing and focus group discussions (FGDs) helped to generate information on the current and expected demand for skills, areas of workforce shortages and skill gaps, strategies and implementation channels applied to meet the demand. Personal interviews and FGDs included relevant and representative trade unions and employers' associations, policy makers at different levels, HRD (human resource development) and TVET (technical and vocational education and training) decision making bodies, sectoral organizations, public-private initiatives, representatives of companies in the forefront of sustainable development and those actively involved in the implementation of the greening policy agenda of Bangladesh. The selection of interviewees and other resource persons primarily targeted economic sectors with the largest greening potential for the economy.

The analytical framework of the present study consists in identifying the existing skills for green jobs already in place and in identifying the skills in non-green jobs that will become obsolete. It was useful to make the distinction between the following two types of skill sets. Those skills which are generic and therefore tend to apply across a range of different occupational groups; and those which are vocational in that they are specific skills needed to do the work within an occupation. Generic skills encompass leadership, communication, team working, problem solving and associated skills. Vocational skills tend to encompass work in a given occupation or job specific skills. In addition to these, many employers look for particular

³ The Delphi technique is a structured and systematic forecasting method based on an interactive information collection through expert panels. The method relies on expert judgments gathered with the use of a questionnaire and discussed in several rounds. The main criterion for accuracy of information is carefully selected panel of experts assuming that a structured collective judgment is more accurate than an unstructured or individual one. The method is especially useful where other types of information are not available. It could be adopted and simplified depending on needs and conditions.

individual characteristics in recruits, such as motivation, judgment, leadership skills and so on. Leadership skills are important generic skills, especially important in the context of green jobs because they are instrumental in green jobs initiatives. Many of the latter are thought to be innate skills. The key issue is to examine the extent to which this translates into fulfilling future skill requirements for green jobs. To address this, two components of the future flow of skills were considered. The first is greening the existing stock of skills and the second is the degree to which the enterprises as well as the training system of the country can provide new skills to meet the net demand requirement for green jobs in the future.

The present study describes a broad picture of the overall economy and takes into account all employment shifts and emerging skills needs for green across sectors in the context of greening the overall economy. A sample of 32 experts from all the broad economic sectors (representing the key ILO constituents, particularly the Ministry of Labour and Employment (MLE), Ministry of Education and the Ministry of Expatriates' Welfare and Overseas Employment, as well as representatives of employers' organizations and trade unions with at least one from each of the eight case studies) with greening potential was purposively selected for interview with structured checklist to represent a mix of experts from different sectors.. The checklist followed new and emerging green occupations classified by economic sectors in Dierdorff et al. (2009). These economic sectors include but are not limited to: energy, manufacturing, transport, materials management, construction, agriculture (farming) and forestry.

Three rounds of the assessment survey were conducted over two months to gather and analyze skill data for green jobs in all the three rounds. Personal interviews and FGDs with the representatives of the employers, workers and the MLE were conducted with on-the-site research for the case studies at the enterprise level.

The analysis of strategic skill needs and skill development responses includes eight in-depth case studies primarily based on on-the-site research as discussed in Chapter 3. The case studies are believed to help meet the overall research objectives and tasks. The added value of the case studies resulted in original findings which helped to draw conclusions and recommendations. Each case study presents a sound piece of research based on literature review as well as empirical analysis, which makes the type of skill needs clear, illustrative and representative, analyzing good practice examples of skills development strategies and actions in response to the identified skills needs and gaps. In order to capture the real change occurring in the labour market, the following case studies were undertaken:

Criteria	Selected case studies
(i) (Re)training needs deriving from identification of skills and occupations that become obsolete as a result of structural changes on the labour market and major employment shifts within and across sectors due to climate change and demands for greening the economy.	1: Refuse/Waste Collectors and Dumpers 2: Agricultural Workers and Inspectors in Organic Farming
(ii) New green collar occupations which emerge in the context of adaptation to climate change and mitigation of negative impacts in the country.	3: Carbon Trading 4: Solar Energy Engineers/Technicians 5: Mechanical Engineers and CNG Conversion Technicians
(iii) New types of skills, competences and skill gaps which need to be incorporated into existing occupational profiles (greening existing occupations).	6: Architects, Civil Engineers, Designers and Masons in Greening Buildings 7: Supervisors and Machine Operators in Tannery 8: Brickfield Managers in Brick Manufacturing

In total, eight case studies covering all types – (i), (ii) and (iii) – were undertaken. The national recovery programme in response to the current economic crisis includes a greening component; it is therefore ensured that at least one case study (e.g. solar energy engineers/technicians because they contribute to reducing electricity crisis which most affects the export-oriented industries) covers this context. However, final selection of the case studies has been made in consultation with the ILO.

2. Policy context

2.1 Key challenges and priorities for the green economy

Bangladesh is one of the biggest victims of climate change despite insignificant greenhouse gas (GHG) emission. Climate change has already emerged as a serious challenge to development in general and poverty reduction in particular. The fragile ecological situation is under continuous threats from environmental degradation taking place in the forms of soil erosion, deforestation, increased water salinity and water body pollution. Some of the major challenges are global warming and the pollution of air, water and earth, and the promotion of greener technology with implications for the formation and development of skills for green jobs to effectively respond to these challenges.

The only available detailed technology based estimate (BCAS, 1998) revealed that, as of 1990 National Inventory of GHG Sources and Sinks in Bangladesh, of the total (net) national emission of 39,900 Gigagrams (Gg) of CO₂, 12,863 Gg of CO₂ was released from all energy (fuel combustion plus fugitive) sector of which 4,392 Gg was emitted from the energy and transformation industries sector, 2,420 Gg from the industry sector, 1,875 Gg from the transport sector and the remaining from small combustion and fugitive emission. In addition, 4.4 Gg of N₂O and 331 Gg of CH₄ were also released from these sectors.

In Bangladesh, massive deforestation is going on and is changing climate and geography. Deforestation has a substantial contribution to global warming. In addition, burning of forests in order to clear land releases tones of carbon dioxide which increases global warming. Deforestation reduces the content of water in the soil and groundwater as well as atmospheric moisture. It also reduces soil cohesion. Subsequently, erosion, flooding and landslide occur. Mainly in the tropical areas, deforestation account for up to one-third of total anthropogenic carbon dioxide emissions (BCAS, 1998), which is harmful to the environment.

Conservation of biological diversity is reportedly one of the forest management objectives (primary and secondary) for more than 25 per cent of the forest area (FAO, 2005). But forest area in Bangladesh currently accounts for only 6.7 per cent (2005) of its total land area (UNDP, 2009) primarily due to increasing deforestation. It is crucially important to arrest the deforestation trend in Bangladesh. The civil societies, NGOs, local communities should come forward and work closely with the government agencies. Awareness building education and training can play a pivotal role in this process.

Different studies show that all the natural old forests of Bangladesh have become critically fragmented to the point where they are considered unlikely to maintain rich level of biodiversity, nor support viable populations of natural and native species of flora and fauna. Encroachment, clear felling, illegal logging, lopping, shifting cultivation, zhum cultivation, urbanization, industrialization, agroforestation, land use change and agricultural expansions are the major causes of forest fragmentations in Bangladesh (DOF, 2007). Fragmentation of forest throughout Bangladesh is occurring at an alarming rate to the peril of biodiversity.

The occupations that require critical skills for the conservation of forests include: (i) Forestry Supervisors, (ii) Forest and Conservation Technicians, and (iii) Forest and Conservation Workers. The skills required for these occupations are available in Bangladesh, but they are limited in supply suggesting the need for further skill development programmes in this sector.

According to National Strategy for Accelerated Poverty Reduction II (NSAPR-II) for FY 2009-11, poverty-environment linkages are evident at two levels:

- (i) conservation of nature and natural resources for sustainable livelihood, and
- (ii) controlling/combating pollution for the maintenance of biodiversity and protection of human health.

It stresses that a careful balancing must be orchestrated where economic growth is maximized without compromising environmental protection and safety. Bangladesh needs a strategic policy and programme for climate-resilient sustainable development. These environmental issues drive the green policy response in Bangladesh and affect the economy, employment and the labour market (GOB, 2008a).⁴

The challenges to attaining environmental sustainability (Millenium Development Goal (MDG) 7), which links environmental protection to poverty reduction, are difficult to overcome. These challenges are water and air pollution, land degradation, extreme degradation of terrestrial and aquatic ecosystems, unsustainable agricultural practices and unplanned urban growth accompanied by weak environmental governance. Climate change has compounded problems of environmental degradation and has led to serious deterioration of ecosystems.

According to NSAPR-II, current challenges in caring for environment and combating pollution include: conservation of nature; defining common property rights; agricultural, fisheries, livestock and forest sustainability; protection of wildlife species and floral habitats (protected area); ecologically critical areas under the Environment Conservation Act, 1995; ecosystem and biodiversity loss; land degradation and river erosion; coastal zone management; droughts and floods; ground water depletion; trans-boundary river linking; and artificial/manmade disaster – hill-cutting. All this serves as a starting point for further analysis and points out major environmental issues that should drive the green policy response in Bangladesh and that affect the economy, employment and the labour market (GOB, 2008a).⁵

Bangladesh's per capita energy consumption is very low. The 2008 energy consumption value stands at about 250 kgOE (oil equivalent), compared to 550 kgOE for India, 515 kgOE for Pakistan, and 430 kgOE for Sri Lanka. Total primary energy consumption in 2008 was 33.50 MTOE (million ton oil equivalent) and the energy consumption mix was estimated as: indigenous biomass (62 per cent), indigenous natural gas (25 per cent), imported oil (12 per cent), imported coal and hydro together about 1 per cent (Al-Muyeed & Shadullah, 2009). Table 2.1 provides some information on how the country's green economy is developing. Both energy production and energy use grow at the same rate of 4.1 per cent annually. Carbon emission grows alarmingly at the rate of 6.6 per cent annually.⁶

⁴ <http://www.rrcap.unep.org/nsds/uploadedfiles/file/sa/bg/reference/NSDS-BG-Draft%20NSDS%20Bangladesh.pdf>

⁵ <http://www.doe-bd.org/Environment.pdf>

⁶ http://www.thedailystar.net/newDesign/print_news.php?nid=114876

Table 2.1. Development of green economy in Bangladesh

Indicators	1980	1990	2000	2001	2002	2003	2006 (Latest available year)
Energy production (kt of oil equivalent)	6,745	10,758	15,156	16,178	16,739	17,549	19,311
Energy use (kt of oil equivalent)	8,453	12,826	18,710	20,428	20,993	21,981	24,187
Energy use (kg of oil equivalent per capita)	95.13	113.46	134.18	143.69	144.84	148.78	157.80
Electric power consumption per capita (kWh)	17.13	45.431	95.77	105.36	112.41	118	146
Combustible renewable and waste (% of total energy)						36.4	33.7
Population (million)	88.9	113	139.4	142.2	144.9	147.7	155.99
GDP (billion 2000 US\$)	20.44	29.47	47.1	49.5	51.7	51.9	65.48
Electricity consumption / Population (kWh/capita)						118	146
Waste generation rate (kg/cap/day)							0.5
Particulate emission damage (% of Gross National Income (GNI))							0.5
CO2 emissions (kt)	7,630	15,355	28,025	32,534	33,743	35,255	39,952
CO2/population (t CO2/capita)							0.24
CO2/GDP (kg CO2/2000 US\$)	0.37	0.52	0.60	0.66	0.65	0.65	0.58
CO2 emissions per unit of GDP (kg/2005 PPP \$)	0.29	0.27	0.25	0.27	0.26	0.2	0.2
CO2 emissions per capita (metric tons)	0.09	0.14	0.20	0.23	0.23	0.2	0.3
CO2 emissions growth (%)						5	8
CO2 emissions growth (%, 1990–2005)							160.1
CO2damage (% of GNI)							0.4
Rate of deforestation, (average annual %, 1990–2005)							0.1
Internal freshwater resources per capita (cu. M)							662
Access to improved water source (% of total population)						74 (2000)	80
Energy depletion (% of GNI)							2.9
Mineral depletion (% of GNI)							0.0
Net forest depletion (% of GNI)							0.7
PM10, country level (micrograms per cubic meter)	231	162	162	158	150	150	135

Indicators	1980	1990	2000	2001	2002	2003	2006 (Latest available year)
GEF benefit index for biodiversity (0 for no biodiversity potentiality and 100 for maximum)						1.6 (2005)	1.4 (2008)
Organic water pollutant (BOD) emissions (kg per day)						250,976.08 (1995)	303,264.22 (1998)

Sources: ADBI and ADB, 2000, Zurbrugg 2002 (Quoted in Chowdhury, 2006).

GEO: <http://geodata.grid.unep.ch/results.php>

IEA: <http://www.iea.org/Textbase/country/index.asp>

UNFCCC: http://unfccc.int/ghg_data/ghg_data_unfccc/items/4146.php

World Development Indicator, 2008

Industrial pollution in Bangladesh is increasing on an alarming scale. Air pollution in Dhaka City, for example, has gone higher than Mexico City and Mumbai killing thousands of people prematurely each year. According to the Department of Environment (DOE), the density of airborne particulate matter (PM) reaches 463 micrograms per cubic meter (mcm) in the city during December-March period – the highest level in the world. Mexico City and Mumbai follow Dhaka with 383 and 360 mcm respectively. An estimated 15,000 premature deaths, as well as several million cases of pulmonary, respiratory and neurological illness are attributed to poor air quality in Dhaka, according to the Air Quality Management Project (AQMP), funded by the Government of Bangladesh (GOB) and the World Bank.⁷

Vehicular air pollution is a major cause of respiratory distress in urban Bangladesh. According to the National Institute of Diseases of Chest and Hospital (NIDCH), nearly seven million people in Bangladesh suffer from asthma; more than half of them are children. WHO (2006) air quality guidelines (2005) recommend a maximum acceptable PM level of 20 mcm; cities with 70 mcm are considered highly polluted. Airborne lead is the worst of the harmful PMs.⁸

The phasing out of petrol-driven two-stroke auto-rickshaws in 2003 and their replacement with four-stroke versions, which use a much cleaner burning fuel (compressed natural gas), significantly decreased the volume of air contaminants. But, according to DOE sources, a sharp increase in the number of vehicles and construction sites in 2004-2008 led to a deterioration of Dhaka's air quality.⁹

According to Bangladesh Power Development Board (BPDB), Bangladesh at present generates 3,800 MW power daily against its peak hour demand of 5,500 MW every day. The Ministry of Energy and Mineral Resources (MEMR) estimates that the country needs US\$6 billion of investment for generating 3,000 MW new power and setting up new transmission and distribution line. This required investment is in addition to the existing on-going power projects totaling 3,547 MW capacity.

⁷ Downloaded from <http://www.thedailystar.net/newDesign/news-details.php?nid=113506>

⁸ The Global update 2005 indicates that reducing levels of one particular type of pollutant (known as PM10) could decrease mortality in polluted cities by as much as 15 per cent every year. It also substantially lowers the recommended limits of ozone and sulphur dioxide. These targets are far tougher than the national standards currently applied in many parts of the world and would mean in some cities reducing current pollution levels by more than three-fold.

⁹ <http://www.irinnews.org/report.aspx?ReportId=83772>

The share of biomass in total primary energy consumption of Bangladesh is around 60 per cent. The major sources of traditional biomass are agricultural residues, wood and wood wastes, and animal dung, and their shares in energy supply are approximately 45, 35 and 20 per cent, respectively. Industrial and commercial use of biomass accounts for 14 per cent of total energy consumption. 63 per cent of energy required in the industrial sector comes from biomass fuel. In areas without natural gas and electricity, biomass is used to meet the household cooking needs.

Natural gas is currently the only indigenous non-renewable energy resource of the country, which is being produced and consumed in significant quantities since 1970. Gas, the main source of commercial energy, plays a vital role in the economic growth of Bangladesh. The gas market is dominated by power and fertilizer (using gas as feedstock) sectors, which account for 46.65 per cent and 21.71 per cent of the demand respectively. According to the 2008 BP Statistical Energy Survey, Bangladesh had 2007 proven natural gas reserves of 0.39 trillion cubic metres. Therefore, using biomass energy might be the sustainable option of using renewable energy to electrify the rural Bangladesh in the present context.

The economy of Bangladesh depends principally on agriculture. Agricultural crops generate large quantities of residues. Such residues represent an important source of energy both for domestic and industrial purposes. Other sources of biomass in the country are farm-animal waste and poultry droppings produced by the national herds, fuel wood from existing forests, tree residues and saw dust from the forest-based industries. The 15 million citizens of Bangladesh produce huge amounts of human waste and municipal solid waste (MSW) annually.

Therefore, there is a huge potential of producing electricity using biogas in Bangladesh. According to IDCOL, Bangladesh has currently 215,000 poultry farms and 15,000 cattle farms. By establishing biogas plants in these farms, electricity could be generated. So far 35,000 biogas plants have been established across the country and these plants are producing gas, which is being used for cooking purposes in the rural areas. The agency has set a target of establishing 60,000 biogas plants by 2012. One plant produces on an average 94.22 sq. ft. gas. At present 3.3 million sq. ft. biogas is being produced in the country daily which can produce about 1,000 MW electricity and if this opportunity could be seized, the growing shortage of electricity could be greatly met in the country (Al-Muyeed & Shadullah, 2009).

2.2 The response strategy

2.2.1 General environmental strategy

The following adaptation and mitigation initiatives in response to climate change and environmental degradation in Bangladesh have either been taken or being taken (GOB, 2008).

(i) National Environmental Management Action Plan (NEMAP)

The NEMAP was developed in 1996. It has prioritized 57 concrete action programmes and interventions aimed at promoting better management of scarce resources and reversing present trends of environmental degradation in Bangladesh. Currently, the government is in the process of creating a second-order priority list (e.g. public participation and awareness campaigns, holding national and regional seminars etc.) for immediate implementation. NEMAP recognizes that environmental issues cannot be solved by the government alone. It is essential that people from all walks of life participate in NEMAP to assist the government in not only identifying the environmental issues but also in proposing solutions and bringing about desirable outcome.

(ii) Sustainable Environment Management Programme (SEMP)

As a follow up of Rio Earth Summit in 1992, the Bangladesh Government has undertaken a UNDP assisted SEMP in 1997 and started implementation since December 1999. The SEMP is a

national umbrella programme for the implementation of environment projects. It is a multidimensional follow-up to the National Environment Management Action Plan of Bangladesh. This programme consisted of 26 components executed by the Ministry of Environment and Forests (MEF) and was implemented by 22 government and non-government agencies. The 26 components fall into five categories:

- (a) policy and institutions,
- (b) participatory ecosystem management,
- (c) community-based environmental sanitation,
- (d) advocacy and awareness, and
- (e) training and education.

Of these five components, (b), (c) and (e) are most relevant for skills development. No specific programmes for skills development, however, have taken place as yet (GOB, 2008a).

The SEMP has been designed to prevent and reverse the trend of environmental degradation as well as to promote sustainable development. It is expected to benefit grass-roots level population in the eco-specific intervention areas. It targets to support community capacities for sustainable management of environmental resources. The programme aims at strengthening the capacity of the public sector on policy development in support of enhanced community participation and sustainable management of the country's environment and natural resources.

The SEMP, through its component "Sustainable Rural Energy", is intended to address the recent concern for environmental degradation by the conventional fossil fuels that has drawn the attention of energy planners to increasingly tap renewable energy source for energy production. Local Government Engineering Department (LGED), with its major mandate for sustainable rural development, has been entrusted to implement "Sustainable Rural Energy" component of SEMP for demonstration and transfer of technologies related to the use of renewable energy in Bangladesh (GOB, 2008b).

(iii) National Adaptation Programme of Action (NAPA)

NAPA was prepared by the MEF in November 2005, as a response to the decision of the Seventh Session of the Conference of the Parties (COP7) of the United Nations Framework Convention on Climate Change (UNFCCC). The basic approach to NAPA preparation was along with the sustainable development goals and objectives of the country where it has recognized necessity of addressing environmental issue and natural resource management with the participation of stakeholders in bargaining over resource use, allocation and distribution. Therefore, involvement of different stakeholders was an integral part of the preparation process for assessing impacts, vulnerabilities, adaptation measures keeping urgency and immediacy principle of the NAPA (GOB, 2008a).¹⁰

It is revealed that adverse effects of climate stimuli including variability and extreme events in the overall development of Bangladesh would be significant and highly related to changes in the water sector. Most damaging effects of climate change are floods, salinity intrusion, and droughts that are found to drastically affect crop productivity almost every year. Climate change induced challenges are:

- (a) scarcity of fresh water due to less rain and higher evapo-transpiration in the dry season,

¹⁰ unfccc.int/resource/docs/napa/ban01.pdf

- (b) drainage congestion due to higher water levels in the confluence with the rise of sea level,
- (c) river bank erosion,
- (d) frequent floods and prolonged and widespread drought,
- (e) wider salinity in the surface, ground and soil in the coastal zone (GOB, 2008a).¹¹

The strategic goals and objectives of future coping mechanisms are to reduce adverse effects of climate change including variability and extreme events and promote sustainable development. Future coping strategies and mechanisms are suggested based on existing process and practices keeping main essence of adaptation science which is a process to adjust with adverse situation of climate change. Sharing knowledge and experiences of existing coping strategies and practices to other areas would come under similar problems related to climate change. Development of techniques for transferring knowledge and experiences from one area/ecosystem is also necessary (GOB, 2008a).¹²

Addressing future problems related to sea level rise appear to be a complex issue for Bangladesh and therefore integrated approach both in terms of sectors and technologies need to be analyzed along with acceptability by the communities for whom the technologies would be suggested. It is evident from the science of climate change and impacts studies that severity of impacts and frequency will increase in future and therefore limitation of existing coping strategies need to be assessed. Moreover, preparation for this on regular basis will reduce impacts but will not solve the problem.¹³

Response to industrial pollution

In the present time, many industries are causing air and water pollution through smoke emission and dumping of untreated effluent. Industrial wastes have notably polluted the water of the Buriganga, the Shitalakhya, the Karnaphuli and the Rupsha rivers as well as the land and air of the adjacent places. The moot question is inadequate policy response and the failure of the existing laws and their enforcement to prevent industrial pollution.

Since the early 1960s, of necessity, industries of various kinds started to spring up slowly in Bangladesh, the then East Pakistan. The Factories Act, 1965 was passed as a precautionary measure against possible industrial accidents than as a deterrent to any threat of pollution. Subsequently, Factories Rules 1979 and East Pakistan Water Pollution Control Ordinance, 1970 (Ordinance V of 1970) were disseminated to provide for the control, prevention and abatement of pollution of waters in the then East Pakistan.

After liberation of Bangladesh, this Ordinance was rightly repealed and replaced by the Environment Pollution Control Ordinance, 1977 for providing, stricter protection. The Government found it necessary to upgrade the Environmental Pollution Control Ordinance 1977 recognizing the changed circumstances and the potential degradation of the environment. The Environmental Conservation Act 1995 (ECA) was passed by the Parliament in February 1995 and came into force in June 1995 repealing the Environmental Pollution Ordinance Act 1977. Subsequently, the Government in exercise of its rule making power conferred by Section 20 of

¹¹ <http://unfccc.int/resource/docs/napa/ban01.pdf>

¹² <http://www.fao.org/docrep/009/ag257e/AG257E09.htm>; bangladesh-ecosystem.blogspot.com/

¹³ unfccc.int/resource/docs/napa/ban01.pdf

the Act, promulgated the Environment Conservation Rules, 1997 (ECR). The Rules lay down the procedure for achieving the objectives provided for in the Act.¹⁴

The DOE headed by the Director General (DG) under the Ministry of Environment and Forests (MEF) was established in 1989 and is the Regulatory Body responsible for enforcing the ECA and ECR. To prevent the industrial pollution the DG can give order, direction or issue notifications, to the owner of an industrial unit for improvement of the surrounding environment by controlling and mitigating any pollution caused by the activity of the industry. However, this body looks useless with no strict regulation, supervision and enforcement by the GOB. The present legislations remain vague with no real application.

Interestingly, there are several weaknesses in the existing laws to prevent industrial pollution:

- (a) The discharge standards of emissions, discharge and noise fixed in the ECR for industries are less stringent compared to the developed countries. The industry should know the period of constancy of the discharged standards stipulated in the ECR because the design and investment in the Effluent Treatment Plant (ETP) will be based on the present values. Thereby, any change either will increase the operating cost of the ETP or may render it ineffective.
- (b) There is no specific criterion of locating industrial plants in the ECA and ECR. However, a general guideline is provided. This guideline is very vague and it is not enough to keep the present industrialization in balance with the eco-system.
- (c) ECR does not have any specific and precise provision to work as guidelines and directions on an Environmental Impact Assessment (EIA).
- (d) The ECA specifies that a notice is to be given, in case of any investigation, to the industry to enter but does not specify a minimum period of notice (Clause 11 subsection 3 of ECA).

So far, Bangladesh Environment Lawyers Association (BELA) has contributed a lot in removing these weaknesses. BELA pursued two pioneer cases so far to go against industrial pollution.

Part III of the Constitution of Bangladesh enshrines the basic right of the people under the heading "Fundamental Rights". Article 26 declares the laws inconsistent with the fundamental right to life and personal liberty as per Article 32. However, if the lives of the inhabitants living around the concerned factories are in jeopardy, the application of Article 32 becomes inevitable because not only a right to life but also a meaningful life is an inalienable fundamental right of the citizens of this country.

In spite of the Constitutional provisions and the provisions of the Act and the Rules, the hiatus remains as before between the letters of law and the implementation thereof in the field of environmental pollution due to lack of right knowledge and skills of the concerned officials to implement policies (Hashim, 2009). According to the environmental experts, there is a skill gap among the government officials responsible for governmental and regulatory administration for greening the economy, especially in the new and emerging occupations of Air Quality Control Specialists, Chief Sustainability Officers, Compliance Managers, Energy Auditors, Greenhouse Gas Emissions Permitting Consultants, Greenhouse Gas Emissions Report Verifiers, Regulatory Affairs Managers, Regulatory Affairs Specialists, Sustainability Specialists and Transportation Planners.

¹⁴ Downloaded from <http://www.thedailystar.net/law/2009/10/03/analysis.htm>

Energy policy response

The government plans to add 450 MW power by 2013 using renewable energy technology like solar and wind energy. Currently, renewable energy sources contribute less than 1 per cent of the total electricity generation. But the government has targeted to augment contribution of the renewable energy sources to 5 per cent by 2015 to generate around 450 MW and 10 per cent by 2020 to generate a total of 1,600 MW from renewable sources. By installing wind turbines, the government has planned to generate at least 200 MW of electricity by 2013. It has targeted to generate around 100 MW of electricity from solar power projects by 2013 next.

To meet the current power deficit partly, Bangladesh currently is producing 16 MW solar power daily and the number of beneficiaries is around three million people. Bangladesh has enough opportunity to produce solar energy as the country gets sunlight on an average 340 days of 365 days of the year.

Power-starved Bangladesh has decided to use solar power in all new public buildings now to save electricity as a means of stop-gap period since the country has signed agreement for nuclear power with several countries. The government's decision came at a meeting of the Executive Committee of the National Economic Council (ECNEC), the highest policy making body of the government. In view of cost, the solar energy will be installed first in new buildings and then gradually in old ones. If usage can be matched with production, 10 to 30 per cent of electricity can be saved. The government has undertaken plans to set up solar power plants to generate 280 MW by 2013. The country, which has now a shortage of about 1,200 to 1,700 MW power, would get rid of the power crisis by 2011.¹⁵

Infrastructure Development Company Limited (IDCOL), a government partner non-bank financial institution, has planned to set up multipurpose Solar Irrigation System (SIS) in off-grid areas of the country. IDCOL is working to introduce mini-power plants within a year. It will be a large-scale investment and its benefit in the rural areas will be comprehensive. IDCOL now promotes solar home system (SHS) in the rural areas of Bangladesh. There are some 1.3 million irrigation pumps across the country which consume about 750 MW of electricity everyday during irrigation season. Installation of solar panels for all the irrigation pumps will help save some 750 MW of power.

The Grameen Shakti (GS), a sister organization of the Grameen Bank, is producing 14 MW solar power across rural Bangladesh covering all the 64 districts and providing electricity to 280,000 rural households, where there is no supply of electricity. Fifteen other agencies are generating solar power, but GS is the largest. At present they are setting up on average 10,000 solar panels monthly. Energy experts believe that solar power system can be the best power option to get over the country's vexing power crisis. Solar power system has a bright prospect in Bangladesh, but the country's potential still remains untapped simply for lack of initiatives. 50 per cent people of the country could be brought under the solar power network within the next seven years if the government plans to do so.

The Renewable Energy Policy of Bangladesh published in 2008 states that renewable energy will take a vital role for off grid electrification in the country. The main renewable energy resources in Bangladesh are biomass, solar, wind and hydropower. The hydropower potential of Bangladesh is low due to the relative flatness of the country. Wind power generation in Bangladesh has certain limitations due to the lack of reliable wind speed data and the remarkable seasonal variation of wind speed. The country has good prospects of utilizing solar photovoltaic (PV) systems for electricity generation, but the high capital investment cost is a big barrier for adopting such systems. Biomass is the major energy source in Bangladesh and biomass

¹⁵ <http://www.solarplaza.com/news/bangladesh-decides-to-use-solar-power-to-save-elec>

utilization systems represent a proven environment-friendly option for small- to medium-scale decentralized electricity generation.

Progress of Bangladesh with climate adaptation

In response to the global concerns, Bangladesh became a signatory to the UNFCCC in June 1992. Bangladesh has participated in both the Asia Least Cost Gas Abatement Strategy (ALGAS) and the US Country Study on Climate Change. These studies are being carried out by the GOB in partnership with NGOs and academia as part of its obligations as a signatory to the UNFCCC. The GOB embarked on a series of national activities to confront climate change. These have included GHG inventories, vulnerability and adaptation analyses, and more recently, participating in the Clean Development Mechanism (CDM) of the Kyoto Protocol. A Climate Change Cell has been established within the DOE linked to the Ministry of Disaster Management under the Comprehensive Disaster Management Programme. Bangladesh has further fulfilled its commitment under UNFCCC by submitting its Initial National Communication (INC) in October 2002. Currently, the Second National Communication on reporting climate information to the UNFCCC and community-based adaptation to climate change are under preparation.

As mentioned earlier, Bangladesh prepared NAPA in 2005, which was the beginning of a long journey to address adverse impacts of climate change including variability and extreme events and to promote sustainable development of the country. NAPA follow-up action such as adaptation to climate change through coastal afforestation has been initiated. The INC and NAPA highlighted climate change impact studies which focused on the following sectors: water resources, agriculture sector, forest and biodiversity, coastal zone and coastal resources, human health, infrastructure and socioeconomic impact.

In addition, the GOB has shown its commitment to adaptation to climate change by implementing a number of policies and programmes that address key aspects of vulnerability. For example, following the cyclone and storm surges of 1991, the GOB created a “Green Belt” in the 12 coastal districts in 2001 (GOB, 2008a).

Agro-ecological zones have been delineated for selecting agro-climatic appropriate crops and soil conservation has been promoted for the enhancement of agricultural productivity. A Geographic Information System (GIS) based national data bank has been created to assist in planning appropriate cropping pattern. Moreover, programmes of the Barind Multipurpose Development Authority (BMDA) on risk reduction in drought prone areas have commenced implementation, the National Watershed Development under the MACH programme and the Flood Action Plan has commenced, the gazetting of the Forest Conservation Act (1995), Wild Life Act, Protected Areas and other policies which lead to forest and biodiversity conservation and reduction of forest fragmentation have been implemented. Bangladesh has extensive experience in involving local communities in forest protection and regeneration as well as the creation of long-term interests in maintaining forestry resources through, for example, a Social Forestry Programme that promotes a unique benefit-sharing arrangement. Finally, the Coastal Islands Development and Settlement Programme (CDSP) is being implemented in collaboration with the Water Development Board, Department of Forest (DOF), LGED and the Department of Agricultural Extension. Several other measures are in place to strengthen climate adaptation (GOB, 2008a).

CDM Projects in Bangladesh

CDM can help reduce industrial pollution. CDM projects can earn saleable credits for reducing/avoiding emission and Certified Emission Reduction (CER). A CDM Executive Board has been established in the country. CDM projects are needed to be vetted by the DOE. Very few individuals or institutions are involved with the CDM project activities in Bangladesh.

Only eight CDM projects have so far been approved in Bangladesh by the Designated National Authority. Of these, only two projects have been approved by CDM Executive Board, one of which has been registered and the other is under implementation. In order to encourage more CDM projects and to reduce the impact of GHG emissions on environment, products like quality energy-efficient industrial motors, industrial boilers etc. may be allowed duty exemption benefits. Bangladesh is very keen to save energy and the government has decided to procure 30 million Compact Fluorescent (CFL) Bulb. Lack of general awareness especially among the producers of goods and services, limited capacity of the DOE to develop baseline information, inadequate understanding of the CDM or limited capacity to develop the methodology and to develop project design document etc. are some of the reasons why CDM projects are very few in Bangladesh.

The measures forming the cornerstone of Bangladesh's efforts to combat climate change may include:

- (i) investing in renewable energy;
- (ii) initiating quantitative targets for carbon reduction;
- (iii) improving energy efficiency;
- (iv) rewarding conservation, innovation, and mitigation efforts;
- (v) developing domestic and non-fossil energy sources;
- (vi) conducting research and promoting an alternative low-carbon development strategy;
- (vii) instituting cost-benefit approach for mitigation and abatement projects;
- (viii) imposing a carbon tax on imported fuel;
- (ix) raising the voice of Bangladesh in international climate change forums and participating in sequestration projects; and
- (x) appointing a "Climate Change Adviser" to the Prime Minister to advise and coordinate policies.

2.2.2 Green response to the current economic crisis

The impact of current global economic crisis on the Bangladesh economy is still not as visible as one would expect. The greening components of the country strategy in response to the current economic crisis relate primarily to improvement in energy situation of the country. Information on the amount of green investments and the total amount allocated to the crisis response strategy is not available. However, presently, the demand for power in Bangladesh is about 5,200 MW a day, while generation ranges between 3,200 MW and 4,000 MW recording a daily shortage of 1200 MW to 2000 MW. To mitigate the power crisis, the government has undertaken several policy measures. These include:

- (i) importing environment-friendly energy technology,
- (ii) setting up hydroelectric power plants in high stream rivers from where 10 MW to 15 MW electricity could be produced,
- (iii) building wind power plants in the coastal areas which could help add 50 MW of electricity to the national grid,

- (iv) granting duty and tax benefits to promote renewable energy in the current budget for FY 2009-10 e.g. lifting the custom duty on the import of solar panels from the existing 3 per cent,
- (v) providing clean power to 230,000 rural families from 7000 biogas plants, and
- (vi) implementing the Renewable Energy Policy-2008 to develop the green energy resources and meet 10 per cent of the national demand for power by 2020.

However, no estimate on the number of green jobs that are going to be created as a consequence of these measures is available.

The issues over renewable energy development comes to the fore in Bangladesh as the supply of non-renewable energy sources, such as gas, is abundant ensuring the future energy security of the country. The GOB has framed a renewable energy policy and fixed some specific targets. But it is yet to plan its implementation. The budget for FY 2009-10 proposes to lift the custom duty on the import of solar panels from the existing 3 per cent. VAT at all stages of import, domestic production and supply has also been waived. The policy envisions meeting 5 per cent of the total power demand by 2015 and 10 per cent by 2020, by developing renewable energy sources, such as solar, biogas, biomass, wind and hydropower. Under the policy, the Sustainable Energy Development Agency (SEDA) is supposed to be established as a focal point for development and promotion of sustainable energy.

Although the crisis response strategy of the GOB does not include any skills development component, it has skills implications for developing new green collar occupations in response to increasing demand for renewable energy and also for greening existing occupations prevailing in the non-renewable energy sector.

2.3 The skills development strategy in response to greening

National Capacity Self-Assessment (NCSA) for global environmental management

With a view to developing capacity building for global environmental management in Bangladesh, the NCSA Project was approved by the Global Environment Facility (GEF) on 12 November 2004 for a period of 16 months. The Project Document was signed between the Economic Relations Division and MEF of the GOB and UNDP on 29 December 2005. The MEF approved the Technical Project Proposal (TPP) on 18 September 2005 for implementation of the project commencing from February 2006. The overall goal of NCSA is to provide Bangladesh with the opportunity to identify priority capacity needs in order to effectively address crosscutting global environmental issues and the development of the corresponding strategy and action plan for capacity building in the environmental sector in the context of the three Conventions relevant for NCSA: the Convention on Biological Diversity, the UNFCCC and United Nations Conventions for Combating Desertification (IUCN, 2006).¹⁶ This strategy has skills implications mainly for:

- (i) Climate Change Analysts to conduct research and analyze policy developments related to climate change, make climate-related recommendations for actions such as legislation, awareness campaigns, or fundraising approaches;
- (ii) Environmental Restoration Planners to collaborate with field and biology staff to oversee the implementation of restoration projects and to develop new products, process and synthesize complex scientific data into practical strategies for restoration, monitoring or management;

¹⁶www.iucnbd.org/ncsa/about.html

- (iii) Environmental Certification Specialists to guide clients such as manufacturers, organic farms, and timber companies through the process of being certified as green;
- (iv) Environmental Economists to assess and quantify the benefits of environmental alternatives, such as use of renewable energy resources;
- (v) Industrial Ecologists to study or investigate industrial production and natural ecosystems to achieve high production, sustainable resources, and environmental safety or protection;
- (vi) Water Resource Specialists to design or implement programmes and strategies related to water resource issues such as supply, quality, and regulatory compliance issues; and
- (vii) Water/Wastewater Engineers to:
 - design or oversee projects involving provision of fresh water, disposal of wastewater and sewage, or prevention of flood-related damage;
 - prepare environmental documentation for water resources, regulatory programme compliance, data management and analysis, and field work; and
 - perform hydraulic modelling and pipeline design (Dierdorff et al, 2009).¹⁷

The skills required for all these occupations already exist in Bangladesh, but there is shortage of these skills requiring further skills development programmes.

The ongoing solar energy programmes of IDCOL, GS and other agencies have important skill implications for transition to greener economy. But the training provided for such skill development is taking place very informally, especially on the job with very little coordination nationally.

The strategies followed in strengthening climate adaptation in Bangladesh in terms of implementing several projects noted earlier have skills implications mainly for:

- (i) Climate Change Analysts to conduct research and analyze policy developments related to climate change, make climate-related recommendations for actions such as legislation, awareness campaigns, or fundraising approaches;
- (ii) Environmental Restoration Planners to collaborate with field and biology staff to oversee the implementation of restoration projects and to develop new products, process and synthesize complex scientific data into practical strategies for restoration, monitoring or management;
- (iii) Environmental Certification Specialists to guide clients such as manufacturers, organic farms, and timber companies through the process of being certified as green;
- (iv) Environmental Economists to assess and quantify the benefits of environmental alternatives, such as use of renewable energy resources;
- (v) Industrial Ecologists to study or investigate industrial production and natural ecosystems to achieve high production, sustainable resources, and environmental safety or protection;
- (vi) Water Resource Specialists to design or implement programmes and strategies related to water resource issues such as supply, quality, and regulatory compliance issues; and
- (vii) Water/Wastewater Engineers to:
 - design or oversee projects involving provision of fresh water, disposal of wastewater and sewage, or prevention of flood-related damage;

¹⁷ http://www.onetcenter.org/dl_files/NewEmergingList.pdf

- prepare environmental documentation for water resources, regulatory programme compliance, data management and analysis, and field work; and
 - perform hydraulic modelling and pipeline design;
- (viii) Brownfield Redevelopment Specialists and Site Managers to participate in planning and directing cleanup and redevelopment of contaminated properties for reuse;
- (ix) Geospatial Information Scientists and Technologists to carry out research and develop geospatial technologies, producing databases, performing applications programming or coordinating projects and specializing in all areas of climate adaptation.

Most of these skills acquired through foreign and local education and training already exist but they are inadequate in supply requiring further skill development programmes. As reported by the DOE, there are skill gaps in (viii) and (ix) which need to be filled with specialized skills development programmes.

Bangladesh has no skills development strategy as a part of a coherent country policy response to climate change and environmental degradation. There is very little or no policy coherence, complementarity, relevance and coordination as such. No skills response strategies are incorporated into a larger greening policy agenda. Nor is there a coherent national strategy/policy targeting to meet the skill needs for greening the economy. The national HRD strategy in the provision of skills for green jobs is non-existent. In fact, the national HRD strategy is market-driven, not environmental policy-driven. There is no role of skills identification in the HRD strategy development. National Skills Development Council (NSDC) established in 2008 under the Prime Minister's Office is expected to fill the gap.

In the context of greening the economy, skills development policies and strategies are not coordinated with and linked to industrial, trade, technology, macroeconomic and environmental policies. Although ongoing TVET Reform Project is trying to establish training network between the public sector training institutions and the industrial employers, there is no contents on developing skills for green jobs. The Project has targeted to meet market-driven skill demand. In the same vein, there is no role of social dialogue in skills development for greener economy.

The biggest institutional bottlenecks that hamper skills development for a transition to green economy seem to be:

- (i) lack of awareness and inadequate appreciation of the Department of Technical Education (DTE), Bangladesh Technical Education Board (BTEB), Bureau of Manpower Employment and Training (BMET) and, above all, the Ministry of Education and MLE; and
- (ii) lack of clear policy agenda for developing skills for greening the economy.

Although there is a divided opinion, compulsory level education is considered crucial in promoting green skills among the population by most of the experts. However, initial TVET and continuing vocational training (CVT) are also considered instrumental in greening the economy. There is virtually no role of business management education and training in promoting sustainable entrepreneurship. Generic skills, such as leadership, communication, problem solving etc., in the skills provision for green jobs have proved important, especially in the case of the NGOs. The existing education and training system including general schooling does not follow a strategy to "mainstream" sustainability and environment protection issues within the education and training system. However, although there is no explicit policy in place, the government has introduced several chapters on environmental issues in pollution, adaptation and mitigation in the syllabus of the students from Grade-III to Grade-VIII in the general schooling system. Besides, the government is planning to widen the base of environmental education at the higher levels, although environmental education constitutes a separate department in all the public universities

of engineering and technology and forms a part of the geography department in all the public general universities.

3. Anticipation and provision of skills

3.1 Green structural change and (re)training needs

This section and all its subsections deal with (re)training needs which derive from:

- (a) major employment shifts within and across sectors and economic activities due to climate change and demands for greening the economy i.e. green structural change, and
- (b) identification of skills, trades and occupations that become obsolete as a result of green structural changes on the labour market.

3.1.1 Green restructuring and its impact on the labour market

Broad economic sectors / economic activities with major employment growth potential for green jobs in Bangladesh encompass energy supply, manufacturing, materials (waste) management, construction, trade, transport and telecommunication, agriculture and forestry. Employment in agriculture has declined from 51 per cent in 1999-2000 to 48 per cent in 2005-06 while employment in manufacturing has increased from 9.5 per cent to 11 per cent during the same period. Similarly, while employment in mining and quarrying, electricity, gas and water, and community and personal services has declined respectively from 0.51, 0.26 and 13.08 per cent to 0.21, 0.21 and 5.49 per cent, employment in trade, transport and communication and other services has increased from 6.41 per cent in 1999-2000 to 8.44 per cent in 2005-06 (BBS, 2008). The change in employment of these sectors is not driven by government policy but by technology implementation and innovation by the individual not-for-profit companies.

It appears that environmental pressure has a role in causing this change (Unnayan Shamannay, 2004). The structural transformation is derived not merely from economic growth but also from spontaneous green structural change. However, current and future employment shifts and trends are likely to take place due to anticipated green structural change notably in energy and telecommunication. Green employment shift to renewable energy is gaining momentum. The structural transformation is derived not merely from economic growth but also from green structural change.

Telecommunication

In telecommunication, Grameen Phone (GP) targets massive carbon cut. According to Star Business Report, GP has set a target for reducing carbon emission by 30 per cent from its entire operations by 2015. The mobile operator started adopting green technology in 2007 and so far has set up 12 solar and one wind power network sites. With an aggressive move, the company targets to set up 100 more base stations using green technology in off-grid areas. GP has so far managed to reduce carbon dioxide (CO₂) emission by 9 per cent from its entire operations like networks, transports and offices. GP estimates that the successful results will save approximately 1,202 MW of electricity every year amounting to an equivalent reduction of over 700 tonnes of CO₂. The operator's CO₂ emission until end-October 2009 was 140,458 tonnes. With the target achieved by 2015, the emission amount will stand at around 99,814 tonnes. In Bangladesh, currently there are 22,000 base stations of six mobile operators. Emission factors are being considered under international standards set by the United Nations.

GP and telecom equipment vendor Huawei partnered in 2008 to build a green mobile network in Bangladesh to transform the operator's core network environment-friendly with

layered architecture solutions, and reduce the energy requirements of its base stations. According to estimates by Ericsson, a telecom equipment maker, around 0.14 per cent of global CO₂ emission and around 0.12 per cent of primary energy use are attributed to mobile telecom technology. For instance, this compares to 20 per cent of CO₂ emission and around 23 per cent of primary energy use for travel and transport.¹⁸

However, after all the structural changes taking place, greening telecommunication has considerable implication on both current and future employment in this sector which is thriving very fast. Skills for green jobs, especially for network engineers and technicians, in telecommunication are still in their formative stage initiated by GP. This state of affairs points to the need for (re)training of the workforce currently employed in telecommunication. To this end, Bangladesh Telecommunication Company Limited (BTCL) and GP may join their hands to retrain the existing workforce in the BTCL on a regular basis.

Organic waste recycling through composting

In Bangladesh, most of the organic waste remains unutilized. There is inadequate legislation in the country to address the growing problems of the organic waste. Waste as well as organic waste management is entrusted with the urban local government bodies. The responsibility of removal and disposal of municipal organic waste lies with the City Corporations and municipalities. The six City Corporation Ordinances and Pourashava Ordinance 1977 are the only local laws that give some idea about disposal of municipal waste. But most of the times they are not implemented properly. Very recently, the Waste Concern and WWR Bio Fertilizer Bangladesh Ltd. Plant, an organic waste recycling project near Dhaka, are actively involved in the greening initiative. Under this project vegetable waste from Dhaka's market is being collected using project's own transport networks, and taken to compost plant. 800 new jobs have been created through this plant during 2008-09. In addition, about 120,000 people are involved in the recycling occupation in Dhaka city and it is also being replicated in other cities of the country. Community Initiatives of house-to-house waste collection in the neighbourhood of big cities have started. These occupations belong to the urban informal economy. For these tasks, as many as 400 new jobs for collecting organic waste from municipal markets and 800 new jobs for aerobic composting have been created (Boone, 2009). Through utilizing organic waste in composting plant like Waste Concern, Bangladesh can reduce gas emission and can get extra money from carbon trading. Major occupations in this sector include: garbage cleaners, garbage collectors, supervisors, machine men, truck drivers, Conservancy Inspectors etc. This sector has a huge potential for greening environment and creating new green collar jobs in waste recycling and at once replacing some old ones in waste collection through retraining.

Organic cultivation: Naya Krishi (New Farming)

Present cultivation in Bangladesh is characterized by use of modern inputs like chemical fertilizer, pesticides and irrigation which are harmful to environment. The country's irrigation (deep tube-well) dependent cultivation destroys crop diversity. Withdrawal of underground water for such irrigation is causing serious water crisis in the rural areas and the water level is going down every year. There are so many varieties and species which are tolerant in different climatic conditions, soils and topography. For example, many varieties of rice (Aus) and millets grow well in dry weather condition but some are water demanding and prefer wet condition.

Some crops are shade loving, some are partial but some requires long sunshine hours. The farmers need to know which crops grow in what condition and also about their crops' interrelationship among themselves and with other species. Therefore, the farmers should know

¹⁸ www.deshimobile.com/news_main.php?nid=1179

the use practices and the ideal conditions for growing crops and must bring more species under cropping culture to save biodiversity and to maximize the use of land and productivity.¹⁹

Dams for withdrawal of water from the upstream changes the habitats of both upstream and downstream, creating disturbance in the natural water flow that causes impedance, rising of the catchments bed by silt. Moreover, it changes the natural cycle of dry and winter flora of the soil and ultimately affects the soil texture and structure. Decreased catchments reduce the water holding capacity and thus cause floods frequently during the wet monsoon. Expansion of agricultural land by replacing the forests, cutting the hills and filling the catchments, although facilitates managing agriculture, decreases land area, biodiversity, and catchments or water reservoirs.

This causes floods frequently and damages crops. Excess surface water due to flood during the hot season absorbs solar radiation and increases the temperature of the water bodies and thus raises inland atmospheric temperature. It is one of the reasons for global warming. Plantation of Rain trees, Mahogany and Acacias should be banned as they disturb the growth of other crops.

Nowadays, organic cultivation is not only a demand for health but also a greening demand for land fertility. After severe flood in 1988, farmers of Tangail District approached Unnayan Bikalper Nitinirdharoni Gobeshona (UBINIG) – Policy Research for Development Alternatives – for help and began a new agricultural movement (Naya Krishi – New Farming) to produce food in harmony with the nature. Women and then small poor farmers were responding as they had to come face-to-face with excessive chemical use in agriculture and could not afford to buy chemicals. Now it has spread over all types of farmers. It is important to take note of the greening beauty of the farmers who are joining the Naya Krishi. The socio-economic classification of the farmers is the following:

- poor farmers having land of less than 1 acre: 617 (80 per cent)
- middle farmers having land of 1-3 acres: 130 (17 per cent)
- surplus farmers having land of 3-5 acres: 23 (3 per cent).

Through this agricultural practice farmers do not depend on modern inputs, but use organic and bio-inputs for their cultivation. The farmers utilize their communal agricultural knowledge and get relevant support through UBINIG, an NGO set up to promote, preserve and update traditional skills in Bangladesh and to implement organic farming and weaving training programmes in order to improve working possibilities for women and help them become independent. UBINIG organic farming training centre (Ecological Agricultural Centre) is located at the Pathrail village (Delduar) close to Tangail town. The farmers' training is based on promoting organic farming and seed preservation. The training is provided mainly by UBINIG own staff. The farmers can take seeds free of cost from UBINIG Community Seed Wealth Centre (CSWC) and after production house their seeds in CSWC ensuring regular availability of seeds. In different seed units there are 2,000 different types of seeds preserved in different categorized ceramic pots. Farmers come together at the seed centre twice a day. UBINIG thus contributes greatly in retraining the farmers for overcoming the green restructuring from modern practice to organic practice.

This sector has very high potential for greening stemming from both environmental and economic considerations. In economic aspect, this agricultural practice creates new employment opportunities especially for the women (because they are mainly involved in preserving organic manure and seed) and save a lot of foreign exchange through not utilizing chemical fertilizers and pesticides which are mostly imported. The major occupations involved in this activity include agricultural workers, agricultural advisors, chemists, traders and farmers. This sector has huge

¹⁹ <http://www.thebangladeshtoday.com/archive/November%2009/21-11-2009.htm>

potential for creating new green collar jobs through retraining traditional agricultural workers and farmers in organic farming. But the practice of organic farming remains limited only within Tangail district reflecting huge green skill gaps among the farmers and agricultural workers all over the country.

Shrimp cultivation

Shrimp cultivation began in Bangladesh in the mid-1970s when exports totalled US\$ 4.7 million a year. Over the last two decades, shrimp cultivation has emerged as a major industry in Bangladesh. The traditional form of shrimp cultivation was Bheri/Gher (shrimp farm/pond) aquaculture that had been practiced in the coastal areas of Bangladesh during pre-independence and post-independence period. The GOB recognized shrimp farming as an industry under the Second Five-Year Plan (1980-85) and adopted measures necessary for increased shrimp production (Haque, 1994). In 1979-80, slightly more than 20,000 ha were under shrimp cultivation (Ahmed, 1988). Bangladesh has currently one million-plus shrimp farms. The impact of shrimp cultivation has economic, social and environmental dimensions; especially it has a tremendous effect on the rural community in the coastal areas of Bangladesh. Currently, about 1 million people are employed in this sector and 6 per cent of total export earnings of the country come from this sector. People are moving from agriculture to shrimp cultivation because of surplus labour in agriculture and high profit in shrimp farming. The practice of shrimp culture needs saline water as an input to the shrimp pond. Sluice gates are normally allowed to open two or three times when the salinity in the shrimp pond decreases and saltwater exchange from the river is necessary. As a result, heavy sedimentation from upstream water settles in the riverbed and canal bed, causing water logging in the shrimp ponds and on agricultural land and because of the salt the land quality is degrading. Water in the shrimp ponds is also polluted because of the application of feed and fertilizer for the development of the shrimp. Thus, the by-products of the shrimp ponds and shrimp industry pollute water and soil and degrade the quality of the overall environment. Vegetation, crops, fish and livestock are seriously damaged by the process of shrimp cultivation making it imperative to intrude new technology in shrimp cultivation so that the degradation of land quality and pollution of water do not occur. Major occupations in shrimp cultivation include shrimp-fry catching fishermen, hatchers, fry traders, fry storekeeper, fry depot manager, fry commission agent, Gher makers, shrimp collectors, shrimp cleaners, beheading workers, shrimp packers, sluice gates operators, shrimp plant managers, grading workers, production workers, lab assistants, refrigeration assistants, processing operators, supervisors etc. So there is an urgent need for retraining of the workers who are involved in the shrimp production, processing and export in order to protect the environment and make the sector environment-friendly and sustainable. Retraining is needed here due to restructuring in agriculture and fisheries (Alauddin and Hamid, Undated).²⁰

3.1.2 Identification of (re)training needs

The retraining needs were identified by the researchers in consultation with the organizations and enterprises initiating and/or dealing with greening the economy. No labour market information service (LMIS) is still in place in Bangladesh to collect information on the retraining needs for green jobs. Bangladesh Bureau of Statistics (BBS) conducts Labour Force Survey at an interval of 4-5 years with a pre-designed questionnaire eliciting information on the traditional variables of the labour market, e.g. employment, unemployment, underemployment, labour force participation rate etc. by sectors, occupations and regions. If the existing indicators could be further split into existing green and non-green as well as prospective green by occupations across sectors, this could enable to collect information on green jobs in future.

²⁰ www.aciar.gov.au/system/files/sites/.../pr90chapter09.pdf;
<http://www.google.com/hostednews/afp/article/ALeqM5hxIGRTe96TA23coq-EqDCGNg1YwQ>

3.1.3 Skills response

The skills response (retraining, TVET) to meet the challenge of the green economic restructuring remains limited. There are no active labour market policy measures and planning of initial and continuing training. Institutional frameworks, delivery channels and ad hoc skills responses remain limited mostly to IDCOL, NGOs, some CNG and non-renewable energy companies and waste management companies.

There are no special skills development programmes to cushion the effects (displaced workers, need for skills upgrading, etc). They are delivered on-the-job by, for example, RREL, GS, GP, NAVANA CNG and Waste Concern and funded by the NGOs with donor assistance.

3.1.4 Case studies

Two case studies are identified to illustrate (re)training needs deriving from identification of skills and occupations that become obsolete as a result of structural changes on the labour market and major employment shifts within and across sectors due to climate change and demands for greening the economy. These case studies are:

1. refuse/waste collectors and dumpers, and
2. agricultural workers and inspectors in organic farming.

These cases are rather good illustrations of green restructuring from traditional jobs to green jobs. From the analysis above, restructuring process rather impacts the materials/waste management sector and to a great extent agriculture.

(1) Case study on refuse/waste collectors and dumpers

There are mainly three types of occupation category involved in the process of waste management. These are: (a) waste collectors, (b) waste dumpers, and (c) drivers of the waste carrier, which are traditional jobs. The jobs of the people who are involved in these three categories are becoming obsolete due to change of the traditional way of collecting waste and dumping. In traditional way, waste is collected from different houses and different points of the municipal cities and then it is thrown or dumped in some fixed open places, which creates negative impact on the environment like emission of vermin (spreading more than 40 diseases), Methane gas (bad odour and GHG), Leachate (polluting grass and surface water) etc. In 1995, Waste Concern, a private company, has been established to achieve a common vision to contribute to waste recycling, environmental improvement, renewable energy, poverty reduction through job creation and sustainable development. In 2008, it introduced a new way of collecting waste and dumping that is known as community-based waste management by mobilizing local people. In order to cope with the new way of collecting waste it requires (re)training of existing employees who are actively involved in the process of waste collection and dumping. Waste Concern professionals are conducting training programmes/workshops on solid waste management, recycling, composting, clinical waste management, urban environmental management, municipal infrastructure planning and environmental impact assessment, but this is not sufficient for the large number of households.

In order to promote the idea and practice of converting waste into resources, Waste Concern established a Recycling Training Centre at Katchpur, Dhaka. This was formed under the SEMP, which was implemented in 2006 by the MEF with support from UNDP. Currently, in collaboration with World Wide Recycling B.V. (Netherlands), Waste Concern is establishing a monitoring system for composting linked with carbon emission reductions at the Katchpur centre. Waste Concern has been imparting training to a range of target groups with specific focus on community-based solid waste management and resource recovery. The training programme is

divided into two modules – one is targeted to Municipal and other local governmental officials and the other is targeted for NGOs and community-based organizations. The training programmes have been and are being conducted by Waste Concern in Dhaka and other cities of Bangladesh since 2008. It is currently (November 2009-June 2011) preparing Solid Waste Management Plan for 19 towns of Bangladesh based on 3R principle and carbon financing. It is also preparing 3R Manuals for five key sectors (municipal waste, business and SMEs, hospital and medical sectors, agricultural waste and hotel and tourism. It also trains the trainers with manuals describing how to facilitate the farmers to process composting and utilize the produced compost. After getting the training from Waste Concern, the trained people disseminate their knowledge (through teaching and hands-on training for the inhouse plant operators for composting) to the people who are employed in waste collection, dumping and recycling. The entire cost of the training programme is borne by Waste Concern funded by donor agencies, e.g. Asian Development Bank (ADB), United Nations Centre for Regional Development (UNCRD), Institute for Global Environmental Strategies (Japan), Dutch Government etc. (Waste Concern, 2009).

Table 3.1. Trend of urban population

Year	Total urban population	Per cent of urban population	Average annual growth rate (per cent)
1951	1,819,773	4.33	1.69
1961	2,640,726	5.19	3.75
1974	6,273,602	8.78	6.62
1981	13,535,963	15.54	10.63
1991	20,872,204	20.15	5.43
2001	28,808,477	23.39	3.27
2025	78,440,000	40.00	-

Source: Quoted in Sinha (2006).

From the Tables 3.1 and 3.2, it is evident that urban population is growing over time and it is expected that with the increase of urban population the waste generation rate will increase. From Table 3.2, it is clear that waste generation rate is high in Dhaka city compared to other cities of the country. It has been estimated that average per capita urban waste generation rate is about 0.41 kg/capita/day (Sinha, 2006).

Table 3.2. Total waste generation in urban areas of Bangladesh in 2005

City/Town	*WGR (kg/cap/day)	No. of City/Town	Total population (2005)	Population** (2005)	TWG*** (Ton/day)		
					Dry season	Wet season	Average TWG (Ton/day)
Dhaka	0.56	1	6,116,731	6,728,404	3,767.91	5,501.14	4,634.52
Chittagong	0.48	1	2,383,725	2,622,098	1,258.61	1,837.57	1,548.09
Rajshahi	0.3	1	425,798	468,378	140.51	205.15	172.83
Khulna	0.27	1	879,422	967,365	261.19	381.34	321.26
Barisal	0.25	1	397,281	437,009	109.25	159.51	134.38
Sylhet	0.3	1	351,724	386,896	116.07	169.46	142.76

Pourashavas	0.25	298	13,831,187	15,214,306	3,803.58	5,553.22	4,678.40
Other urban centers	0.15	218	8,379,647	9,217,612	1,382.64	2,018.66	1,700.65
Total	-	522	32,765,516	36,042,067	10,839.75	15,826.04	13,332.89

Notes: *WGR= Waste Generation Rate

** Including 10 per cent increase for floating population

***TWG= Total Waste Generation, which increases 46 per cent in wet season from dry season

Source: Sinha (2006)

As mentioned earlier, 120,000 urban poor from the informal sector are involved in the recycling trade chain of Dhaka city. The number of poor people involved in this process in other cities of the country works out at 0.3 to 0.4 million. Most of these poor people are involved in the dumping process and do not apply any sustainable scientific method. As a result, they including city dwellers suffer from many diseases. In order to create an environment-friendly way of waste collection, waste dumping and to produce some product through recycling of waste, it is necessary to train them. Specifically, in order to convert organic waste into Compost Using Community Based Decentralized Approach integrated with house-to-house waste collection and to produce as well as to use compost/enriched compost in agriculture, rigorous training of those poor people are needed. The probable impact of this training will be that existing waste collectors will not lose their jobs. Instead, new job opportunities will be created for these hardcore poor people. In addition, it will help to improve quality of life and environment.

According to Labour Force Survey (LFS) (2005-06), there are 130,432 garbage collectors and related labourers in the country. They are not familiar with clean garbage collection and disposal pointing to the need for their training to develop environment-friendly skills. According to Waste Concern, this workforce is likely to grow at the rate of 1 per cent annually.

The practice of environment-friendly collection of wastes and recycling them is a very recent phenomenon initiated by Waste Concern. The persons in the three traditional occupations are adapting to new methods of waste collection and recycling and are gradually shifting their jobs but on a limited scale. Fresh recruits are also entering the emerging green jobs market to meet the skill needs and bridge the skill gaps especially in the occupations, e.g. Sustainable Design Specialists, Hazardous Waste Management Specialists and Solid Waste (Energy) Engineers/Managers. These recruits are trained on-the-job mostly by Waste Concern. In the cases where skill gaps are critical, foreign training is also arranged with the assistance of partner donors, especially UNDP and the Dutch government. Among green enhanced occupations required for the future are: Hazardous Materials Removal Workers, Hazardous Waste Management Specialists, Solid Waste (Energy) Engineers/Managers, Green Building/Recyclable Materials Distributors, Recycling Collections Drivers, Recycling Coordinators and Sustainable Design Specialists. All of these skills are growing in Bangladesh with the assistance of the donor agencies, but at a very slow pace.

Waste Concern is actively involved in imparting training to a wide range of target groups, with specific focus on community-based solid waste management and resource recovery. It has successfully developed two training modules regarding community-based solid waste management and resource recovery. These training modules have been utilized by Waste Concern for training workshops in Dhaka and other Bangladeshi cities. One module is targeted towards municipal and other local governmental officials, while the second module will be targeted for NGO and community based organizations (CBOs).

Waste Concern started a community-based composting project in 1995 to promote the concept of the '4 Rs' – reduce, reuse, recycle and recover waste – in the urban areas. It is based on the idea that the organic content of Dhaka's household waste, which accounts for more than 70 per cent of total waste, can be efficiently converted into valuable compost. This reduces disposal costs and prolongs the lifetime of landfill sites. It also reduces the harmful

environmental impact of landfill sites, because organic waste is responsible for groundwater contamination and methane gas emissions. By turning the organic waste into compost, the soil in urban areas can be improved.

The project involved setting up a number of small-scale enterprises in different neighbourhoods. Activities include house-to-house waste collection, composting of the collected waste and marketing of the compost and recyclable materials. The project was so successful that in 1998 the government selected Waste Concern to extend the project to five other communities of Dhaka, supported by the United Nations Development Programme (UNDP).

Waste Concern asked government agencies to provide land, water and electrical connections to establish the community-based composting plants. It also built up relationships with private companies to market the compost and recyclable materials. Waste Concern sets up community waste management committees and provides technical assistance and training to help them manage, operate and maintain the services. Members of the committees are mostly women. They are trained in collection, waste separation, composting and marketing. After a year of community mobilization and training, Waste Concern hands over the project to the community but continues to monitor it for three years.

Rickshaw vans are modified to collect waste from each house. Each van has a part-time driver and one or two waste collectors, and serves 300–400 households. Households pay on average 20–35 cents per month to have their waste collected. This covers the salary of the van drivers and waste collectors as well as operation and maintenance costs. Households report that the house-to-house waste collection service is convenient. Some said that previously they could not rent out their houses due to the large, overflowing waste bins in front of them. After a few months the communities got rid of all the bins.

In order to promote the idea and practice of converting waste into resources, Waste Concern established a Recycling Training Centre at Katchpur, Dhaka. This was formed under the Sustainable Environment Management Programme, which was implemented in 2006 by the MEF with support from UNDP. Currently, in collaboration with World Wide Recycling B.V. (Netherlands), Waste Concern is establishing a monitoring system for composting linked with carbon emission reductions at the Katchpur centre.

Main goals are to promote the concept of the 3R principle (Reduce, Reuse, Recycle) and to demonstrate efficient technology and provide hands-on training with respect to:

- (a) organic waste recycling,
- (b) rain water harvesting, and
- (c) solar power generation eco-sanitation.

To introduce a small-scale CDM model for urban waste recycling projects, the Recycling Training Centre at Katchpur contains the following facilities: an aerobic compost plant with a processing capacity of 7 tons/day; a conference room; compost enrichment facility; rain water harvesting system; waste water recycling; solar lighting system, and eco-sanitation composting facilities.

(2) Case study on agricultural workers and inspectors in organic farming

Organic farming is a form of agriculture that relies on crop rotation, green manure, compost, biological pest control, and mechanical cultivation. This is the production of crops and animals without the use of synthetic inputs (such as manufactured pesticides and artificial fertilizer) or genetically modified organisms. It is a modern farming system which deliberately eschews the use of chemical inputs to the farm. It is crop or stock farming where only natural fertilizers,

pesticides and nutritional supplements are used. Hormones and synthetics chemicals are not used at all. Organic farming is free of synthetic chemicals. Organic farming means produced in soils of enhanced biological activity, determined by the humus level, crumb structure and feeder root development, so that plants are fed through the soil ecosystem and not primarily through soluble fertilizers added to the soil. It is agricultural practices which promote biodiversity, biological cycles and biological activity within the soil, accompanied by using, where possible, agronomic, biological and mechanical methods, as opposed to using synthetic materials.

In simple terms, organic farming is the process of producing food naturally. This method avoids the use of synthetic chemical fertilizers and genetically modified organisms to influence the growth of crops. The main idea behind organic farming is 'zero impact' on the environment. The motto of the organic farmer is to protect the earth's resources and produce safe and healthy food.

Farmers and gardeners plan to grow their crops without the aid of artificial fertilizers and harmful chemical pesticides. Organic ranchers and dairymen raise their livestock free of drugs and animal hormones. Supporters of the organic lifestyle believe that food produced in this manner is of higher quality and possesses higher nutritional value in comparison to food produced by conventional chemical-based methods. Organic farming and organic food production have some other basic rules. These are:

- (i) no use of chemical fertilizers or synthetic drugs;
- (ii) no use of genetically modified organisms;
- (iii) prevention from soil loss and erosion; and
- (iv) promotion of 'bio diversity' – support a range of crops, not a single species.

These technical requirements of organic farming point to the need for green restructuring from traditional jobs to green jobs.

Bangladesh is a small country of around 144,000 sq. km. According to Population Census 2001 (the latest available census), its population was about 123 million and 76 per cent of this population are living in the rural areas. Despite the significant effort in order to reduce poverty undertaken by the GOB, around half of the rural population are still poor. The agricultural sector is the main livelihood strategy for the vast majority of the rural people in Bangladesh. It contributes around 20.6 per cent of the country's GDP and provides about 48 per cent of its employment (BBS, 2007). Thus, in order to reduce rural poverty, it is necessary to boost up agricultural production. Over the last couple of years, due to an increase in the cost of production of rice compared to others rice farming is currently a non-profitable enterprise for farmers. As a result, farmers are moving from rice production to other profitable crop like maize and searching new variety of crops which will be profitable.

Commercial organic farming has emerged in Bangladesh as an alternative highly profitable farming enterprise for farmers. "A three-year long economic analysis of FiBL (a research institute of organic agriculture) on organic and conventional farms has shown that, due to high premium prices, organic farming is as profitable as compared to conventional farming" (FiBL 2004).

With few exceptions, organic farming in Bangladesh still occurs largely on an experimental basis. Total land area under organic cultivation in Bangladesh has been estimated at 0.177 million hectares (IFOAM, 2006), representing only 2 per cent of the country's total cultivable land. By 2005, only 100 of its traditional farms have shifted to organic agriculture. Since the introduction of organic farming in Bangladesh by the nongovernmental organizations (NGOs), the movement is still being largely driven by the NGOs. According to IFOAM (1996), of the 138 NGOs that are members of the Forum for Regenerative Agriculture Movement (FORAM) in

Bangladesh, 47 are engaged in practicing organic agriculture, 87 are intending to practise sustainable agriculture, and 3 are involved in advocacy, lobbying and campaign for sustainable development. Among these NGOs, PROSHIKA, with its “Ecological Agriculture Program” (EAP), is the top organic body in the country. “Since 1978 PROSHIKA began to spread ecological practices among its group members by growing varieties of seasonal vegetables. According to PROSHIKA (2002), its EAP is expected to involve around 0.8 million organic farmers in organic cultivation across 0.22 million acres of land by the next ten years. Out of these, 0.22 million farmers started to practice organic farming on 0.08 million acres of land in the last five years. PROSHIKA has also introduced an organic vegetable marketing project to promote the consumption of organic vegetables. Currently, one marketing channel of PROSHIKA is selling eco-friendly produce to the public in Mirpur area of Dhaka city. Furthermore, mobile vans are being used to sell organic vegetables in some areas, including apartment complexes, mega shops and departmental stores” (PROSHIKA 2004). Between July 1999 and March 2003, PROSHIKA received some funding support from the World Bank.

The involvement of the farmers in organic farming through training programmes provided by PROSHIKA or UBINING is increasing and today spans over 16 districts and over 100,000 farming families (with an average of five members per family). Ecological Agriculture Training by PROSHIKA in 2000-2001 included:

- (i) Group Training Centre-based training covering 364 courses and 8304 participants,
- (ii) Village-based training covering 1,476 courses and 32,165 participants, and
- (iii) Staff Training covering 17 courses and 501 participants (PROSHIKA, 2002).

The farmers or agricultural workers responded and accepted this agricultural practice so well that the number of farming families has significantly increased. Agricultural inspectors (currently numbering about 12,500 throughout the country) can also play significant role to boost up organic farming. The areas where organic farming is expanding are mainly based on the communal agricultural knowledge of workers and some support from different NGOs like UBINIG.

Skill needs for organic farming are identified through the local level staff of the Department of Agriculture and the NGOs who are actively engaged in spreading the organic farming. Initially, the staff of the NGOs try to convince the local farmers that every one should adopt organic farming as it is much environment-friendly and more profitable. Then, it requires training of those farmers who are willing to adopt organic farming as they are not familiar with organic farming. The training is organized and conducted by the NGOs, notably UBINOG, which conducted a number of hands-on training programmes on organic farming initially for its own staff and subsequently for the local farmers. The entire cost of the training is borne by the NGOs.

But proper skill development of agricultural workers and inspectors through different training, workshops for improved agricultural knowledge and its dissemination are urgently needed for the rapid expansion of organic farming and for greening the economy. As result of this training, the rapid expansion of organic farming will happen and the country will be potentially benefited in terms of both environmental and economic benefits. In economic aspect, this agricultural practice will create new employment opportunity (green job) especially for the women and save a lot of foreign currency through not utilizing chemical fertilizers and pesticides which are totally import based. Organic farming is also relevant for women because they actively participate in the major processes of organic farming including seed and manure preservation, sowing and plantation. Besides, organic farming is more employment-intensive than traditional farming.

According to the LFS (2005-06), there are 7,057,853 agricultural workers and about 12,500 agricultural inspectors in the country. Hardly 1 per cent of them practice organic farming. While

agricultural workers are likely to grow at the rate of 2.4 per cent, agricultural inspectors are likely to grow at the rate of less than 1 per cent annually. This workforce badly requires training in organic farming.

Among major green increased demand occupations in organic farming are: Energy Crop Farmers, Agriculture Extension Specialists, Biologists - Marine/ Fisheries, Soil Conservation Technicians, Restoration Ecologists, Agricultural Inspectors, Farm Product Purchasers, Food Product Inspectors, Sustainable Agriculture Specialists and Precision Agriculture Technicians. These occupations exist in Bangladesh, but the people employed in these occupations are limited in supply requiring extensive training.

3.2 New and changing skills needs

The section and its subsequent subsections deal with skill needs for newly-emerging green collar occupations, and with new and changing skills requirements for existing occupations (skill gaps) in the context of greening the economy. In the skill needs identification and analysis and in the case studies it is necessary to distinguish between skills needed for:

- (i) reactive and remedial environmental measures, and
- (ii) pro-active measures in order to develop strategies for appropriate skill responses.

3.2.1 New green collar occupations

This subsection deals with green collar occupations which emerge newly as a result of adaptation to climate change and mitigation of its negative impacts. Such occupations are new on the labour market meaning that the actual change has occurred recently or is occurring now, no matter whether such occupations have already been listed in the national catalogue of occupations or may be considered for the inclusion in the catalogue in future. These are new as well as 'hybrid' occupations (e.g. carbon traders, solarteur, bioenergy technicians, energy assessors, compressed natural gas (CNG) conversion technicians and green accountants).

These new green collar occupations are concentrated in energy and transport sectors. SMEs are dominant companies in both rural and urban centres. Workforce involved in such occupations is quite sizable now and is expected to increase substantially in future.

The role of technological change and innovation is remarkable for new occupations demands. Qualifications and levels of educational attainment vary widely from primary technical courses to graduation in mechanical and electrical engineering.

Carbon trading – Brick manufacturing

According to *The Financial Express* (FE, 2009), the Industrial and Infrastructure Development Finance Company Limited (IIDFC), a leading non-banking financial institution in Bangladesh has entered into billion dollar carbon trading aiming to improve energy efficiency through adoption of new technology in different carbon-emitting industries. The IIDFC signed two emissions reduction purchase agreements (ERPA) on 25-08-2009 for the first time with the World Bank and the Danish Government to transfer 249,000 tonnes carbon dioxide (CO₂) reduction from brick fields. The World Bank has also agreed to sign an ERPA with IIDFC on reporting the quantity of emission reduction, certification of emission reduction and receipt of bulk payment from the Carbon Fund for distributing to the various sub-project entities. The World Bank has also negotiated with IIDFC to purchase 189,000 tonnes of carbon saved though less emission.

Under the deals, the IIDFC will act as the bundling agent to facilitate implementation of a project titled improving kiln efficiency in the brick making industry in Bangladesh. At least 20 new energy efficient kilns will be constructed to produce 300 million high quality bricks annually and are expected to reduce emissions of CO₂ in Bangladesh by approximately 115,000 tonnes per year, according to the project proposal.

According to the IIDFC project proposal, at present, brick making is a highly energy-intensive and carbon-emitting activity. It is one of the largest sources of GHG emission in the country, which is estimated to be in the order of 8.75 million tonnes of CO₂ annually. The success of the project of emission reduction in the brick manufacturing industry will encourage other brick manufacturers to come forward and switch to environment-friendly Hybrid Hoffman Kilns (HHK) technology. The success of the project will not only have a sustainable positive impact on the environment of Bangladesh but also encourage development of other potential CDM projects in different sectors including construction materials production, power and renewable energy sectors. At least two brick fields are now under production using HHK technology. The proposed project will support brick-making sector of Bangladesh through purchasing the certified emission reductions (CER) generated from adoption of energy efficient HHK. The project will reduce an estimated 881,000 tonnes of CO₂ during project period from 2010 to 2020, the IIDFC estimated.

Within this sector, new and emerging green occupations primarily include:

- (i) Carbon Credit Traders who represent bricks manufacturing companies in the sale and purchase of carbon emissions permits; and
- (ii) Carbon Trading Analysts who analyze pricing and risks of carbon trading bricks and develop solutions to help client's hedge carbon exposure and risk.

Creation of solar energy

Renewable energy (non-conventional energy) is defined as energy derived from resources that are regenerative or for all practical purposes cannot be depleted. The prime source of renewable energy is solar radiation, i.e. sunlight. Because of the lack of available easy alternative source of energy and vulnerable situation of current energy in Bangladesh huge demand for solar energy has been created. As a new green technology or type of activity solar energy has significant impact on environment and economy through creating huge employment opportunity. According to the estimates of the experts, currently, around 20,000 solar engineers and technicians and more than 100 green entrepreneurs are involved in this sector. According to Grameen Shakti (GS), an NGO, reported in June 2009 that there is also scope for 100,000 new green jobs especially for women in this sector. The occupations that will be more in demand include Solar Energy Engineers and Technicians. Technical skills for the installation and maintenance of solar panels are needed. GS will provide training in collaboration with local and foreign partners.

Providing power without intensifying the effects of climate change is a priority for Bangladesh. The GOB has set a goal of providing electrical power to all its citizens, especially the 85 per cent of the country's population who live in the rural areas. Renewable energy, especially solar energy, is the key component of the initiative. To help speed up that process, the Global Environment Facility (GEF), launched in February 2006, has undertaken an ambitious task with the GOB, the World Bank, and IDCOL to increase the spread of off-grid, renewable energy technologies, such as solar home systems. The project is building capacity through access to financing, business skills, training and technical skills, institutional capacity, and consumer awareness. It has already reached its goal of connecting 50,000 households with solar home system (SHS) three years ahead of schedule. Solar PV programme of GS is also working in this area, especially promoting small SHS to reach low income poor households.

During 1993, Rural Electrification Board (REB) started to electrify the rural areas through solar energy. Since 1996, different private organizations have tried to produce solar energy and to market it to the public. GS, probably the first private solar pioneer in Bangladesh, has started operations in 1996 with a view to supplying solar electricity in the rural areas.

In Bangladesh, more than 60 per cent of the total population and more than 80 per cent of the rural population do not have access to grid electricity. In the near future, it is unlikely that those people, mainly people of rural area, will get access to conventional electricity. Even though the GOB becomes able to provide electricity to those people, it will not be environmentally sustainable because most of the power grid are dependent on gas and oil (non-renewable), which emits GHG and pollute environment. In this context, solar energy can solve all the problems of traditional power grids and can provide renewable energy for rural people and low income group.

Rahimafrooz Renewable Energy Limited (RREL) has very recently introduced solar-powered irrigation system. The system will help save 760 megawatt (MW) power and 800 million litres of diesel every year if conventional power-and diesel-run irrigation pumps are converted into solar power. RREL has introduced the system through converting a 10HP diesel-run irrigation pump on solar power. The pump will supply water for irrigation of 20 acres of Boro rice field. It is the largest installation of its kind in Bangladesh from RREL. It is a lifetime project with one single major investment as solar panels, the major part of the system is warranted for 20 years.

The training is mainly organized and conducted by the NGOs. Firstly, most of the staff, mainly the engineers who work in the field, are trained at the head office under senior managers and consultants and then deployed to the field to work under their supervisors. Regular trainings are conducted at the head office and in the field. At the field level, additional training is organized for the users or customers of solar energy. Specially, women from solar energy users' families are trained on basic maintenance of SHS which is a new green collar occupation. In addition, children are also getting familiar with renewable energy technologies through different awareness programmes. The cost of the training and other programmes are borne by the NGOs mainly funded by different donor agencies like the World Bank (WB), GTZ (Deutsche Gesellschaft für Technische Zusammenarbeit (German Agency for Technical Cooperation)), Asia Development Bank (ADB), etc.

RREL launched solar PV project back in 1985 in Bangladesh. Around 500,000 households are already enjoying the comfort of SHS designed by RREL, among which, 70,000 are actually supplied and monitored by the company employing 350 persons. Besides, another 100 kwp medium- and large-scale solar installations are also supplied by RREL. The company introduced solar water pump in 2004, pioneering the service in Bangladesh. Since then hundreds of beneficiaries are enjoying solar-based water pumping service for drinking and irrigation water.

During the Boro season, 120 million acre rice field in Bangladesh is irrigated by 1.33 million different types of water pumps, among which 87 are diesel operated requiring 800 million liter diesel per year. The government provides Taka 5,400 million cash subsidy on diesel operated water pumps. Seasonal crisis and price volatility of diesel are common hazards that are associated with diesel pump-based irrigation in Bangladesh.

Bangladesh Agricultural Development Corporation (BADC) gave RREL the opportunity to demonstrate a large solar powered irrigation scheme for the Boro season. As a proactive initiative to reduce solar solutions price, RREL is also planning to set up a solar panel assembling plant.

The number of conventional pumps replaced by the solar pumps each year will save significant amount of fossil fuel consumption as well as the government subsidy, which will not recur for the next 20 years. There is, however, no direct government subsidy for solar-powered pumps as yet.

RREL demonstrated a solar-powered irrigation pump to government officials on 17 October 2009 as part of its plan to embark on installing such devices countrywide. It launched a 10-horse-power water pump in Kaishar Char village in Savar, which could pump out five-lakh-litre water a day using sunlight. It can save one-litre diesel an hour. The initial cost of installing the solar pump was Tk.0.3 million and is warranted to serve for 20 years without requiring any running or maintenance cost. Even if the installation cost of a solar pump is high, there is no maintenance cost as such, which makes it cost-effective over the years it operates.

A 10-horse-power-diesel engine consumes 1,350 litres of diesel a year and requires over Tk.0.3 million in total costs to run for one year, which does not include government subsidy on diesel. But running a solar pump for one year costs only Tk.0.15 million. The pump would reduce 36 tonnes of GHG emissions a year. Through carbon trading, a pump owner will be able to earn \$10 against reducing each tonne of gas emission.

The initial cost of setting up a solar energy pump is high, which is not possible for farmers to afford. But cooperatives and government financing can be a solution. In Boro season, 1.33 million pumps irrigate paddy fields in the country, with 80 per cent run by diesel that consumes 800 million litres of diesel a day, according to RREL. The government provides Tk.5,400 million in cash subsidy on diesel-run pumps a year. But solar pumps will be able to save a huge amount of public money. The government would examine financial benefits of such pumps, but the question remains that the initial installation cost is unaffordably high for the farmers.

Solar power is seen as one of the more promising sources of renewable energy for Bangladesh, whose demand for electricity is expected to increase fivefold over the next two decades. The policy may underline how resource-poor Bangladesh may be galvanized into embracing renewable energy when there is increasing pressure on it to cut its emissions.

Solar energy interventions replace fossil fuel and directly reduces considerable amount of GHG eventually keeping the environment healthy. But the cost of installing one megawatt of solar power is between five and eight times that of conventional technology making government subsidies a key part of any solar development plan.

According to available sources, renewable energy leader GS has launched its service in Dhaka and major urban centres in June 2009 to meet the fast-growing electricity need in the country's major cities. The social business enterprise would make the much-expected foray by selling SHS to two of the capital's top restaurants. The company has also designed a raft of new solar energy packages for the city's thousands of households. It will sell SHS that can ensure uninterrupted power for at least four hours in the night. There is already a big queue for its services. GS is making entry into the capital as it sees huge demand for solar power among the middle and upper class people. The Instant Power Services (IPS), powered by fossil fuels, is no longer a viable solution for power cuts in the capital. If there were not enough grid power, IPS battery cannot even be charged, which is prompting people to think of alternative solution.

The move comes amid acute power shortages in the capital Dhaka and across the country. The electricity crunch has become so severe that in some areas the costly IPS cannot cover the outages. Experts believe that the move would change the country's renewable energy landscape, boosting their growth in areas left unexplored by the country's top solar energy leaders.

The GS company would sell SHS package between Tk.60,000 and Tk.114,000, depending on the need of the clients. The minimum package would power two ceiling fans and two energy saving bulbs. The Tk.114,000 package would power three ceiling fans, a 21-inch colour television and three bulbs. The company can now compete with IPS providers, given the severity of the power situation in the capital. Unlike IPS, GS solar panel is warranted for 20 years, and it is not taking any energy from the grid for conservation. Bangladesh has enough solar power and there is ample room for just making maximum use of it. The city packages have become costlier

as GS is not getting any soft-loan refinancing from the state-owned renewable energy lender, IDCOL. It was partly due to IDCOL's easy refinancing scheme launched in 2003 that made GS a big success story in the country's move towards renewable energy. The GS has so far sold around 300,000 SHS employing 7,500 persons.

According to Governor of Bangladesh Bank every bank in its annual report should bring out the amount of green investment it made during the year for refinancing in solar energy, biogas plants and effluent treatment plants. The banks were advised not to invest in any project that destroys the environment. Instead, they have to be more enthusiastic in making investment in environment-friendly projects. For solar energy, the banks can give Tk.70,000 to Tk.175,000, for biogas plant Tk.36,000 to Tk.300,000, and for ETP the loan may amount to Tk.10 million. Meanwhile, the Governor of Bangladesh Bank has already allocated Tk.5,000 million for the small and medium enterprises (SMEs), who want to start or already started business of renewable energy. The environment-friendly investment is expected to increase significantly in the country in the near future.

The present government has decided to install individual solar power units in all government offices including the Prime Minister's Office (PMO) and Bangladesh Bank as part of its initiatives of promoting use of renewable energy in the country. BPDB on 7 September 2009 signed an agreement with RREL to install independent solar power units at the PMO. As per the agreement, RREL has completed the installation work within 60 days. In the same vein, the government has initially asked the non-government and private schools and colleges in the capital city to install solar panel to be replicated in other areas and educational institutions of the country.

The entrepreneurs seek alternative energy policy and suggested the government to make right policy and pricing for renewable energy, as investment is pouring into the sector to meet demand for power. The suggestions were made at a roundtable on 'Sustainable Energy for All' on the sidelines of a four-day fair on renewable energy and its technology in Dhaka beginning from 30 October 2009. The fair provided a knowledge sharing experience for local producers and consumers, as it brought all industry professionals under a single roof to exchange information and discover new products and services. The government should fix the tariff for renewable energy and attract private sector investors to install the SHS under public-private partnership.

In order to expand this sector significantly, it is essential to build up institutional capacity, training of the workers on new technology etc. According to the existing literature and interviews with the experts, major occupations in this sector include: solar engineers, solarteurs,²¹ bioenergy technicians, energy assessors, masons, sales persons, marketing, maintenance and repair etc. Skills for these new green collar jobs are provided by a number of organizations.

According to GS sources, GS training programme focuses on developing both in-house and local capacity:

- (i) training of users so that they can take effective care of their systems;

²¹ The Solarteur concept was created in 1993 by Werner Rausch CE - a pioneer in solar technology. It specializes in renewable energy and provides training in solar and other renewable energy technologies to craftsmen and students from technical colleges. The schools offering training in the technologies are being developed to extract heat from biomass photovoltaic, solar and wind resources. To date, 3,000 people have graduated and been awarded a Solarteur certificate which is internationally accepted.

A solarteur is a well trained craftsman who is able to work out the best conception or design for power supply by renewable energy. After apprenticeship, advanced studies are required to become a solarteur, a specialist for renewable energy. A solarteur is able to associate the principles of electrical and heating engineering with the new applications to heat and power generation. A solarteur knows how to design, scale and install a solar-, heatpump- or biomass plant.

- (ii) training of local technicians and masons so that cost effective and efficient after sales service is available at the doorsteps of rural clients;
- (iii) training of in-house staff both at home and abroad to develop them into both effective technical and social engineers;
- (iv) training of women technicians through Grameen Technology Centers (GTCs) to decentralize GS's production, marketing and repair, and maintenance services;
- (v) diversification and scaling up GS Activities through Entrepreneur Development.

GS has set up 45 GTCs under a pilot programme to scale up its solar programme, especially production of SHS accessories by manufacturing these locally. GS plans to set up 105 GTCs by 2010. These GTCs act as resource centers for developing renewable energy entrepreneurs at the local level. These resource centers help to adapt renewable energy technologies to the Bangladeshi context and then pilot test them for commercialization. At the same time, these GTCs train renewable energy entrepreneurs and link them up with different technical and financial institutions.

GTCs are also contributing to women empowerment by developing Solar Technicians. GS help these technicians to sign annual contracts with its clients for after-sales maintenance and become entrepreneurs in the future. More than 60,000 people each year are installing SHSs all over Bangladesh for business or household purposes. GS alone plans to install one million SHSs by 2015. GS envisages a future where there would be a huge demand for SHS accessories as well as maintenance services to keep the installed SHSs in working order. GTCs are also running a very successful Renewable Energy Exposure Program for rural school children and more than 5,000 school children have participated in the programme.

GS plans to use the GTCs to meet the projected demand for repair/maintenance services and SHS accessories at affordable costs. The GTCs will train women technicians and use them to produce the accessories. They will also strengthen and expand the back-up services at the local level. GS will also use the GTCs to train women members from the user households. GS feels that it would be able to look after the SHSs because in Bangladesh, women are responsible for managing household activities. More than 1000 women technicians have already been trained, many of whom are assembling SHS accessories at local GTCs, others are providing after-sales service.

Among other existing training programmes include:

- (i) Renewable Energy Technology (RET) Training Programme, and
- (ii) Short Course on Renewable (Solar) Energy and its Applications, organized by Renewable Energy Research Centre (RERC), University of Dhaka, in collaboration with Bangladesh Solar Energy Society (BSES) and Faculty of Engineering and Technology, University of Dhaka.

These programmes cover preferably graduates in science/diploma in engineering, post-graduate students, researchers, architects, policy makers, stakeholders, engineers, economists and all other working people related to this field. Course duration is one week each with course fee of Tk.1,000.

The RERC is actively working on research, development and dissemination activities on RET from the early 1980s. The RERC is also playing the pioneering role for the promotion of solar energy in Bangladesh. RERC is working relentlessly for the promotion of solar thermal, solar photovoltaic applications and maintains the only solar energy dissemination park in the country, popularly known as "Energy Park" at the campus of the University of Dhaka. The main objective of this centre is to organize research activities in the field of solar, wind and other

alternative sources of energy; to encourage research projects for utilization of renewable energy in Bangladesh; to train, coordinate and establish links between students, scientists, engineers, stakeholders and policy makers, individuals working in institutions inside and outside the country. Every year RERC along with BSES organizes national seminars, exhibitions and training as a part of its annual activities. Students from related departments are doing their M.Sc, M.Phil and Ph.D research and thesis work with the support of BERC (the Bangladesh Energy Regulatory Commission). The training courses have been initiated as a social responsibility to alleviate energy crisis. Among the resource persons are renowned teachers and researchers from energy related departments. Some of the courses include:

- (i) Grid-off Grid Solar Photovoltaic System and Application for three days,
- (ii) Training of Trainers (TOT) Programme on SHS.

Infrastructure Development Company Limited (IDCOL) under the Rural Electrification and Renewable Energy Development Project (REREDP) finance Renewable Energy programme in Bangladesh. In this connection IDCOL launched second time 3-day TOT Programme on SHS. Training is imparted to experts/technicians of working under different organizations. Objectives of the TOT is to have a capacity on design and deploy SHS.

Besides, Center for Energy Studies (CES), Bangladesh University of Engineering and Technology (BUET) and German Technical Cooperation (GTZ) jointly organized a short course on Energy Efficiency for six days in 2008. The CES works at promoting education and research, organizing seminars, symposia, training workshops, short courses and outreach programmes and publishing journal, monographs, and books on energy related interdisciplinary matters. The objective of CES is to provide the energy professionals an insight into the importance, methodologies and financial benefits of implementing energy efficiency programmes in existing or planned garments and textile industries, and pharmaceutical industries and electrical mechanical industries, plants, hotels, shopping malls, high rise buildings, etc. The courses will illustrate how energy efficiency in any planned/existing industrial and commercial enterprise can be achieved. The contents of training are:

- (i) lighting principles and energy saving through lighting
- (ii) experience of retrofits in garment industries
- (iii) energy efficient technologies in electrical system
- (iv) fundamentals of electric motors and transformers
- (v) boiler principles and energy saving
- (vi) fundamentals of solar water heaters
- (vii) experience of improved boilers in rice per boiling
- (viii) HVAC (Heating, Ventilating, and Air Conditioning), refrigeration system and cooling towers
- (ix) cogeneration and waste heat recovery
- (x) financial analysis of energy savings-case studies, applications
- (xi) energy issues in factories
- (xii) energy auditing and energy management.

Besides, technical tours in a modern energy efficient industry are arranged to show the latest technology to the participants. The target groups are: managers, management personnel from garment and textile industries, food and pharmaceutical industries, steel re-rolling mills, cement factory, big electrical and mechanical industries. Key resource persons for the

courses comprise industry practitioners, experts and academics from BUET. Course duration is six days with a fee of Tk.2000 for each participant payable in advance. The course registration fee includes tea/coffee during breaks, and course materials.

Training on Practical Manufacturing of Solar Lighting System was organized by BUET for 12 days in 2007 and sponsored by GTZ, GS, and Phocos. Participants were 25 experts from different organizations including GS, Rural Services Foundation, Shubashati, LGED, Bangladesh Rural Advancement Committee (BRAC), Center for Mass Education in Science (CMES), Prakaushali Sangsad Ltd, BCAS, Rahimafrooz Batteries Ltd, and Micro Electronics Ltd. Objective of training was to provide technical details about steps of SHS hardware manufacturing. Training Module for Solar Photovoltaic Technology was organized by LGED funded by UNDP under SEMP component 226. Six hundred forty-one trainee days have been completed by LGED officials and other sub-implementing agencies (SIAs) of SEMP/UNDP. Course objectives were: to familiarize participants with solar PV technology and to gather practical knowledge of trouble shooting and safety procedure. Target groups were: the Society of Automotive Engineers (SAE), Community Organizers of LGED and other technical persons from SIAs.

In order to build capacity on Renewable Energy Technologies (RETs) training courses are designed to persons who are interested in learning Solar PV Technology and how to produce electricity from the sun. Participants learn the practical Operation and Maintenance (O&M) of photovoltaic power systems for a wide variety of applications. Participants learn system sizing, site analysis, hardware specification and component selection and also learn how to evaluate costs and compare life-cycle costs of alternative designs. The course covers typical applications and case study examples. Training courses include:

- (i) energy status in Bangladesh and significance of renewable energy use;
- (ii) prospects and application of renewable energy development in Bangladesh;
- (iii) commercialization of Solar PV technology in Bangladesh;
- (iv) basic concept on PV technology;
- (v) site selection, designing and installation of PV technology;
- (vi) operation and maintenance of lead acid storage battery;
- (vii) trouble shooting , operation and maintenance of PV System.

Expert level training on Practical Manufacturing of Solar Lighting System, Training Module for Solar Photovoltaic Technology and TOT Training Programme are in place. User level training is conducted by LGED with UNDP support. Beneficiary training on use, operation & maintenance of 5Kwp Centralized Solar (AC) System is conducted in different places of the country. User level training is conducted by GS and BRAC, TOT Training Programme for three days on Solar Photovoltaic Technology is organized by Sustainable Rural Energy (SRE) Project of LGED. Participants include 30 engineers of LGED. User level training on use, operation & maintenance of 5Kwp Centralized Solar (AC) System is organized by SRE. Participants are 275 beneficiaries with 34 in each batch from different places of the country. Objectives of training include: operation & maintenance of Solar PV system including battery, panel, lamps, etc for daily use of the field installations.

Fuel-efficient vehicles: Compressed natural gas (CNG) conversion

CNG technology contributes to greening the economy. It is one of the most viable alternatives to traditional fuel energy for automotive industry. CNG is low in pollutants, high in calorific value and heat yield, economical and available in abundance in Bangladesh. According to the Managing Director of Rupantarita Prakritik Gas Company Limited (RPGCL) – a

subsidiary of Petrobangla established in 1987 – CNG conversion activities commenced in Bangladesh in the early 1980s. Since then RPGCL took the challenges of popularizing the CNG as alternative vehicles fuel in the country. In 2000, the government privatized the CNG sector and initiated some remarkable steps, such as conversion of all government vehicles into CNG, duty-free import facilities for all items of CNG/natural gas vehicle (NGV) related plants and equipment, phasing out of two-stroke three-wheelers from Dhaka City, implementation of one-stop service for setting up CNG stations and conversion workshops, allocation of government land to the private entrepreneurs for CNG business. These policy measures started boosting up CNG activities and creating new green jobs mainly for Fuel Retrofitting/ Conversion Technicians, Supervisors and Workshop Technicians and need for CNG conversion skills.

In view of the present day extent of air pollution in the major cities of Bangladesh, CNG is considered as an ideal environment-friendly fuel, causing minimum pollution and GHG effect compared to other conventional vehicular fuels. Up to 2007, the total number of registered motorized vehicles in Bangladesh was 1,054,057 and it is increasing day by day. Between 2000 and 2007, the growth rate of 3-wheeler (52.65 per cent), mini bus (58.51 per cent) and bus (34.12 per cent) is significant and they generate most of the employment of the land transport sector. According to the LFS 2005-06, the transport, storage and communications sector employs 3,976,000 persons with a growth rate of 9.66 per cent. These are traditional jobs which need to be converted into green jobs with immense implications for skill development through training. Tables-3.3 and 3.4 indicate an increasing trend of jobs created through CNG conversion of vehicles since 1983.

Table 3.3. CNG expansion activities in Bangladesh

Fiscal Year	CNG filling stations	Conversion workshops	Converted vehicles	Total CNG-run vehicles
2008-2009	213	17	24,516	26,141
2007-2008	85	13	22,718	24,042
2006-2007	42	28	25,974	38,454
2005-2006	23	31	23,374	38,353
2004-2005	41	22	10,135	10,525
2003-2004	41	19	8,575	9,308
2002-2003	6	3	188	10,571
2001-2002	3	3	4,516	4,516
2000-2001	2	1	839	839
1983-2000	7	1	1,379	1,379

Source: http://www.rpgcl.org.bd/exp_act.php?ltype=exp_stat, date 03.09.2009

Table 3.4. Number of CNG converted vehicles in Bangladesh, by type (July 2009)

Vehicle	Total number
Jeep / car / mini bus / three-wheelers	124,723
Auto-rickshaw	25,773
Taxicab	12,000
Bus	4,176
Total number of CNG driven vehicles	166,672

3.2.2 Greening existing occupations

This subsection deals with new types of skills, competences and skill gaps which need to be incorporated into existing occupational profiles (i.e. greening existing occupations e.g. new skills for improved energy efficiency).

Tannery

Tanneries with major waste disposal problem are one of the major polluters in Bangladesh. According to the DOE, nearly 22,000 cubic meters of untreated and highly toxic liquid waste is discharged by the tanneries every day into the water bodies including the River Buriganga, the lifeline of Dhaka City. Around 30 to 40 types of heavy metal chemical compounds and acids are used to process rawhides. Among them the most dangerous are chromium, sulphur, manganese, copper compound and lead. The tannery chemicals and working condition of the tanneries are very poor and hazardous for health.

Dissolved Oxygen (DO) level, an indicator of measuring river health and aquatic life in its water, stands at zero milligram (per litre) at different points of Buriganga, Turag, and Balu rivers and Tongi Khal during dry season. Ideally, it should remain seven to eight milligram (per litre) in the river water. But the DO level is dropping significantly due to unabated dumping of wastes and toxic substances into rivers and water bodies. While DO level is alarmingly low in the rivers of Dhaka, load of Biochemical Oxygen Demand (BOD) – amount of oxygen used for decomposition of organic matters – is high in the Buriganga and Shitalakhya rivers. Tolerable BOD load may remain three milligram (per litre) at best but it remains many times higher than the tolerable level and may escalate further if pollution continues in the rivers.

Interestingly, most of the tanneries (about 220) of Bangladesh are located in Hajaribagh (Dhaka) with very few located in different areas of the country. To reduce existing pollution in the tannery sector, change in technology as well as in knowledge and practice of the employees can play a pivotal role. Existing traditional skills in different occupations do not contribute to sustainable tannery. New types of skills required include improving the competences of managers, supervisors and technicians that need to be incorporated into existing occupational profiles.

Brick manufacturing

The Bangladesh Brick Manufacturers Association (BBMA) estimates that there are approximately 4,000 brickfields in Bangladesh, each producing about 1 million bricks/year on average. The largest units can produce about 5-6 million bricks/year. The brick-making industry in Bangladesh is best described as a "footloose" industry. Production is seasonal, confined to the six dry months of the year; technology is outdated; labour productivity low; capitalization non-existent and mostly operating on equity capital; and management is informal. Total brick production in Bangladesh is estimated to be about 8.7 billion bricks annually with an estimated sale value of around US\$450 million, almost one per cent of the country's gross domestic product (GDP).

According to an estimate by the Bangladesh Atomic Energy Commission, one brick needs 430 grams of wood fuel for it to be burned. The DOE estimates that every 100,000 bricks need 430 MT of wood fuel. Of the total wood fuel burned annually in the country, 22.03 per cent are in the brickfields (SEHD, 1998). It is clear that brick manufacturing is a substantial contributor to the emission of GHG in our country as they burn wood fuel, coal, fuel oil (crude oil) and tires for brick manufacturing. Moreover, brickfields are one of the key contributors of deforestation because they use huge amounts of wood fuel. The brick industry is energy intensive in Bangladesh and energy accounts for close to 50 per cent of production cost. Bricks are fired

using various sources of energy. These include wood fuel, coal, and very little amount of natural gas.

Brickfields are operated almost all over the country during the dry season (December to April) in Bangladesh. Traditionally, brick making is a small-scale businesses mostly located in peri-urban areas where the clay is obtained. But at present most of the clay is transported by boat or other means to the factories which are often located close to roads or waterways. Till now, most of the bricks are still hand moulded. Mechanical equipment driven by motive power are now used in clay preparation. While almost all the brick factories operate only during the dry season, a few mainly mechanized factories which use extrusion or dry pressing, operate the year round.

The manufacturing of bricks is seasonal (five to six dry months per year). The 4,000 plus fixed chimney kilns form the largest stationary source of GHG emissions in Bangladesh which is around 5.4 million tonnes of CO₂ annually. Besides the air pollution, brick making industries contributes to three other serious environmental concerns: land degradation, deforestation and depletion of water resources. According to the Environment Conservation Act 1995 (ECA) and Environment Conservation Rules, 1997, brick industry is Orange B category industry, which is not environment-friendly. The goal of the ECA is to phase out or change all Orange B industries.

A study (Miah and Alam, 2000) finds considerable radioactivity concentration of 226Ra, 232Th and 40K measured by using gamma ray spectroscopy in different types of brick samples (bangla, ceramic and picket) fabricated and used in the urban areas of Dhaka city and its suburbs. Knowledge of gamma radioactivity is necessary to adopt preventive measures to minimize the harmful effects of ionizing radiation. The radium equivalent activity concentrations, external and internal hazard indices (Hext and Hint) in these brick samples were determined and were found to be comparable with those of other countries.

By considering all wood fuel and fossil fuel, it was estimated that the total emissions from all the brickfields of Bangladesh would be 54,09,480 t CO₂, 23,600 t CH₄, 206,560 t CO, 164 t N₂O, 5,880 t NOx and 3840 t NO per annum while the total carbon released in the atmosphere would be 14,755,320 t annually.²² In Bangladesh, two billion bricks are produced every year. Out of which, one billion and 375 million are burnt with wood, 400 million with coal and 225 million with natural gas. Every year the total quantity of wood fuel available in Bangladesh is 204 million cft, out of which 52 million cft are burnt in the brickfields (SEHD, 1998). Wood fuel and fossil fuels (coal and crude oil) are responsible for the emissions of the trace and non-trace greenhouse gasses, such as CO₂, CH₄, CO, N₂O, NOx and NO (WB, 1998). So, brick industries are important sources of GHG as they use wood fuel, coal, fuel oil (crude oil), tremendously for brick burning. Brickfields in Bangladesh solely burn fossil and wood fuels to produce bricks releasing a huge amount of GHG (Annex 3) in the atmosphere and declining a large quantity of wood volumes from the forests.

According to DOE (2009), while only 19 out of 325 brickfields in Chittagong abide by the environmental rules, 306 of them do not. 19 brickfields use modern technological "Jig Jag" chimney. This was revealed at a recent operation conducted by the DOE. It was found that 45 brickfields use extremely polluting 'drum' chimneys, while 231 have 120 feet high chimneys, which is severely causing pollution to air, and they burn woods to make bricks. Of the total brickfields, 164 did not have environment clearance and so the DOE ordered their closure within ten days. But they would be allowed to continue production if they are given approval from the DOE. Notices have been sent to the owners of these brickfields, of which three are in Mirersarai, five in Sitakunda, 13 in Fatikchhari, 32 in Raozan, 12 in Hathazari, 56 in Rangunia, one in Boalkhali, one in Anwara, 19 in Chandanish, 17 in Satkania and five in Banskhali. Besides, the

²² Following the estimation of Miah and Alam (2000).

DOE has warned 31 brickfields who have been violating different environment rules for a long time. According to DOE (Chittagong), no brickfield harmful to the environment would be allowed to run any more.

Most of the chimneys of Bangladesh are temporary and not so high which affect the nearest community, especially the trees and plants. The height of a chimney should be more than 100-150 feet high and permanent. However, if the regulations change, a significant shift in employment is not expected.

The main occupations in bricks manufacturing are: labour contractors, wood suppliers, brick field managers, mud mixers, brick makers and chimney kiln operators. With shift to green technology, wood suppliers are expected to disappear and the chimney kiln operators will have to adapt to new technology with implications for their retraining in skills for green jobs.

According to National Forest and Tree Resources Assessment (2005-2007), currently total forest area in Bangladesh is 1.48 million hectares accounting for 9.8 per cent of total land area in the country declining from 14.85 per cent in 1995-96. Table 3.5 shows that one unit (tdm) wood-fuel consumption by the brickfields leads to an alarming deforestation at about 4.5 m³. Deforestation is much more prominent in the branches than in the round wood which is more harmful to environment. However, the government is planning to bring 20 per cent of total land area under afforestation programmes by 2015.

Table 3.5. Deforestation due to the consumption of woodfuel by the brickfields (4,000)

Mean and total observations	Woodfuel consumed (tdm) per year	Deforested round wood (m ³)/ woodfuel consumed (tdm)	Deforested branches (m ³)/ woodfuel consumed (tdm)	Total deforested wood (m ³)/ woodfuel consumed (tdm)
Mean of observations	317.42	1.54	2.92	4.46
Total from 4,000 brickfields	1,269,680	1.54	2.92	4.46

Source: Calculated following the estimation of Miah and Alam (2000).

Greening buildings

Green building is a new concept in Bangladesh which might be a promising sector with high urbanization in Bangladesh. The construction sector is growing rapidly in the country generating considerable employment for the poor. The greening of construction firstly depends on its design and the sole responsible actor is the architect. The energy saving potential can be as high as 40-50 per cent, if addressed right at the design stage. In Bangladesh, there exist tremendous opportunities to introduce new materials, equipment and technologies which can help enhance energy efficiency of buildings. But the potential owners are not demanding green buildings from consultants and architects which adversely affects the industry as a whole in greening efforts because the architects are not induced to design green building.

Present building design in Bangladesh is more energy consuming and hence green buildings initiative should be undertaken. But it is frequently argued that green buildings are costlier, have to be air-conditioned and take more time. But in reality, this is not true in all instances. The incremental cost is always relative and depends on the extent of eco-friendly features already considered during design. There is a general perception that going the green way may affect the project schedules. Now, there is absolutely no difference in the time involved in constructing a green building vis-à-vis a normal building. The experts of this sector argue for changing curricula and raising awareness and training programme for different stakeholders: architects, developers, consumers of ready flat and plot and the policy makers. There is now a need for skilled and

knowledgeable professionals who have adequate understanding of architecture and energy systems. Bangladesh University of Engineering and Technology is planning to address greening buildings through their curriculum and practical application. This, however, is likely to have limited employment implications in the immediate future because the course will be four-year long with annual enrolment not exceeding 50 students.

3.2.3 Identification of skill needs

In Bangladesh, there is no system in place and institutional responsibilities for identification of current and future skill needs for any kind of jobs – non-green or green – in the labour market. Conventionally, companies on their own identify their own skill requirements and provide on-the-job training for the blue collar jobs, while they recruit trained people from the open market for white collar jobs. In the present exercise, however, the assessment of skill needs and gaps was made in consultation with the existing players (especially the companies involved) in greening the economy.

3.2.4 Skills response

The organizations involved in skill response primarily include Waste Concern, Grameen Shakti, IDCOL, Bangladesh Council of Scientific and Industrial Research (BCSIR). They are effective on a limited scale. The organization of the skills response in relation to the challenge of greening the economy remains weak. Existing education and training system do not react to the green skills needs. Hence limited new courses, curriculum development and occupational standards have been developed to this end.

For all practical purposes, the main channels of current response in skills provision should be TVET, CVT and public-private collaborative training measures within active labour market policy implementation, on-the-job training or other forms of training supported by enterprises, etc. Technical assistance in this regard may be provided by the ILO in collaboration with other donors.

There is enormous potential for future training in greening the economy. In order to meet this challenge, there is a crucial need for a clear policy on skill development for greening the economy which would embody strategic interventions for improving the existing education and training capacity to meet the needs sufficiently. Side by side, feed-back mechanisms between business and the education and training systems should be put in place. In the same vein, future changes in skills requirements should be communicated and translated into timely supply of relevant skills.

3.2.5 Case studies on new green collar occupations

Three case studies have been selected to illustrate new green collar occupations which emerge in the context of adaptation to climate change and mitigation of negative impacts in the country. These are:

1. carbon trading,
2. solar energy engineers/technicians, and
3. mechanical engineers and CNG conversion technicians.

(1) Case study on carbon trading

Carbon trading is emissions trading specifically for carbon dioxide (calculated in tonnes of carbon dioxide equivalent or tCO₂e) and currently makes up the bulk of emissions trading. It is one of the ways countries can meet their obligations under the Kyoto Protocol to reduce carbon

emissions and thereby mitigate global warming. The development of carbon markets is taking place through implementation of mandatory cap and trade systems. Carbon trading is an administrative approach used to control pollution by providing economic incentives for achieving reductions in the emissions of pollutants.

Carbon trading is a trading in energy and is a new and emerging green occupation which includes:

- (i) Carbon Credit Traders who represent companies in the sale and purchase of carbon emissions permits;
- (ii) Carbon Trading Analysts who analyze pricing and risks of carbon trading products and develop solutions to help client's hedge carbon exposure and risk;
- (iii) Energy Brokers who purchase or sell energy for customers;
- (iv) Investment Underwriters (occupations that are linked to multiple sectors) who are intermediate between corporate issuers of securities and clients regarding private equity investments, underwrite the issuance of securities to provide capital for client growth, and negotiate and structure the terms of mergers and acquisitions; and
- (v) Securities and Commodities Traders (occupations that are linked to multiple sectors) who buy and sell securities and commodities to transfer debt, capital, or risk and establish and negotiate unit prices and terms of sale.

In Bangladesh, in all these occupations there are skill gaps not only because carbon trading is still in its infancy in Bangladesh, but also because the emerging companies feel that their existing workforce have inadequate skill types and competence levels to meet their requirements.

Very recently, West Concern has embarked on a project in order to start carbon trading on a rather mini scale. RREL is planning to start commercial carbon trading from May 2010 for the first time in the country by achieving CER standard with an aim to earn \$100 million a year. Carbon trading is expected to provide monetary reward and facilitate the focus to reduce emission in every activity in the economy and bring the country to the global carbon commerce market worth \$100 billion. This will also help the country's role in addressing global warming and climate change issues.

Bangladesh Carbon, a CDM-based carbon trading service of RREL, and Carbon Planet, an Australian company, signed an agreement in this regard on 19 May 2009. Initially the project design document of CER is to be submitted to the government for approval and then Designated Operational Entity, a UN-approved agency, will validate it. The CDM Executive Board in Geneva, Switzerland, then registers the project. Currently, there are two companies – BCAS and Waste Concern BD – working with CDM projects in the country. Another two projects are under validation from CDM Executive Board. According to the MEF, the government would consider a public-private partnership (PPP) to promote carbon trading in the near future.

Among new and emerging occupations in carbon trading are: Carbon Credit Traders, Carbon Trading Analysts, Energy Brokers, Investment Underwriters, and Securities and Commodities Traders, Carbon Capture Power Plant Installation, Operations, Engineering and Management Staff, General and Carbon Sequestration Plant Installation, Operations, Engineering and General Management Staff, Carbon Capture and Sequestration Systems Installers. Of these occupations, only Carbon Sequestration Plant Installation, Operations, Engineering and General Management Staff, and Carbon Capture and Sequestration Systems Installers exist in Bangladesh on a limited scale (only in Waste Concern involved in carbon saving devices). Waste Concern is a small company and is coping with its critical skills needs by foreign training. While for high

green-collar jobs required training is obtained from abroad, especially from the European Union, for the low green-collar jobs the company itself is providing on-the-job training.

Carbon Credit Trader is selected as an example of a new green collar occupation. The origin of this occupation may be traced to the emergence of WWR Bio Fertilizer Bangladesh Ltd., a Bangladesh and Dutch joint venture company (Waste Concern and World Wide Recycling of the Netherlands), on 21 March 2009 and formally releasing its first high quality organic fertilizer, produced from fruits and vegetables waste from the markets of Dhaka City. It has launched the bio fertilizer to the market and has given the first compost to local dealers and farmers. The newly born bio fertilizer (Jaiba Sar) is being produced on the organic waste composting plant at Bhulta (Narayanganj) with 700 tons/day capacity compost plants with a compost production capacity of 50,000 tons/year, reducing CO₂ emissions by 560,000 tons over the next 6 years and benefiting more than 3.6 million people each year. Waste Concern has five composting plants in Dhaka: one 10-12 tons/day capacity plant, two 3 tons/day capacity plants, and two 1 ton/day capacity plant. Annual financial saving amounts to US\$7,218 for a 3 tons/day capacity plant (both from plants and carbon credits). The project is expanding. Composting all organic waste in Dhaka would create new jobs for 16,000 people from lower socio-economic backgrounds, especially women, with a promise for robust growth in employment in the future.

The plant is the first of its kind in the country with a huge capacity. The project aims at setting up two more plants by 2010 to have a total capacity of handling 700 tonnes of waste from the Dhaka City Corporation (DCC) markets on a daily base. Waste Concern is a non-profit organization partnered with a for-profit private Dutch company using CO₂ emissions trading of CDM.

This is an easy model that can be replicated in any city. Waste Concern partners with community/private sector and/or municipal government reflecting public-private-community partnership. It has established a Regional Recycling Training Center located in Dhaka, where it offers training programs, instructing local officials to learn the process and undertake full operational activities.

Several other companies are also planning carbon credit trading. According to the *Daily Star* (2009), Rahimafrooz will start commercial carbon trading from May 2010 for the first time in the country by achieving carbon emission reduction (CER) standard with an aim to earn \$100 million a year. Carbon trading will provide monetary reward and facilitate the focus to reduce emission in every activity in the economy and bring the country to the global carbon commerce market worth \$100 billion. Bangladesh Carbon, a clean development mechanism (CDM)-based carbon trading service of Rahimafrooz Renewable Energy, and Carbon Planet, an Australian company, signed an agreement in this regard on 19-05-2009.

The project design document of CER is to be submitted to the government for approval and then Designated Operational Entity, a UN-approved agency, will validate it. The CDM Executive Board in Geneva, Switzerland, then registers the project. Currently, there are two companies – BCAS and Waste Concern BD – working with CDM projects in the country. Another 2 projects are under validation from CDM Executive Board. Four bricks manufacturing companies employing around 4,500 people are also getting involved in carbon credit trading. The government would consider a public-private partnership to promote carbon trading in the near future.

The companies feel that new entrants to the labour market are apparently trained and qualified for carbon credit trading, but still lack a variety of the related skills required by them. These skill needs were identified by the emerging companies through their own assessment and market information flows. Although there is no provision of skills, there is potential of the existing education and training system for skills provision for this occupation. Carbon credit trading curricula and training programmes can be adopted. There is no skills policy response to

the situation. The policy/legal framework and level of decision making are non-existent. The policy response remains inadequate. The skills provision in response to the identified need remains incidental to the emerging companies. This process looks effective because it works.

(2) Case study on Solar Energy Engineers/Technicians

There are mainly four types of occupation category involved in the process of implementing SHS: These are:

- (a) Branch Manager,
- (b) Service Engineer,
- (c) Financial Assistant, and
- (d) Solar Energy Technician.

Among these category, solar energy technicians are directly involved in setting the solar systems. But, without appropriate training or schooling, it is difficult to implement the SHS on a larger scale because there is no appropriate training or schooling. At present, the training on solar energy is taking place only on a small scale and only through some NGOs like GS and Waste Concern, and REB, LGED, BPDB, BCSIR and IDCOL. The appropriate skill of solar energy technicians on the solar systems is a crucial factor for the rapid expansion of SHSs in the future.

Skills for green jobs have been growing robustly in the renewable energy sector of Bangladesh compared to other sectors of the economy where green initiatives are still in their infancy. According to anecdotal evidence, green jobs seems to have increased by over 29.5 per cent annually from 1950 in 2000 to 20000 in 2009, compared to less than one per cent for the overall economy. This trend is expected to continue as investment in new green energy is expected to double over the next 5 years.

Currently about 622,000 SHS have been installed in different regions of the country. More than 3 million people currently benefit from this SHS. Number of jobs related to solar energy is about 15,000 most of who are solar energy technicians. Few of them get access to institutional training, as no independent training centre on solar energy is prevailing in the country. By 2014, it is expected that the installation of SHSs will be more than 2 million. In this situation, there is a huge demand for solar energy technicians to gear up the expansion of SHSs. The ever-growing renewable energy industry is expected to provide jobs for at least 100,000 persons by 2014, according to estimates by the experts. The following are the estimates on current and future demand for SHSs (source: Grameen Shakti and IDCOL):

(A) Current situation

- Total installation of SHS: About 622,000
- Total beneficiaries: more than 3 million
- Total employment: About 20,000

(B) Future scenario

- Total installation of SHS by 2012: more than 2 million
- Green Jobs Creation in solar energy by 2014: about 0.1 million (majority are solar energy technicians) from the current 20000.
- Carbon emission significantly.

New green collar occupations in solar energy most demanded in the country in terms of greening the economy include:

- (i) Solar Energy Installation Managers who direct work crews installing residential or commercial solar PV or thermal systems;
- (ii) Solar PV Installers who assemble, install, or maintain solar PV systems on roofs or other structures in compliance with site assessment and schematics, including measuring, cutting, assembling, and bolting structural framing and solar modules, and performing minor electrical work such as current checks;
- (iii) Solar Power Plant Technicians who monitor and repair the instrumentation, controls, and electrical systems in a utility-scale solar power generating facility;
- (iv) Solar Sales Representatives and Assessors who contact new or existing customers to determine their solar equipment needs, suggest systems or equipment, or estimate costs;
- (v) Solar Energy Systems Engineers who perform site-specific engineering analysis or evaluation of energy efficiency and solar projects involving residential, commercial, or industrial customers; design solar domestic hot water and space heating systems for new and existing structures, applying knowledge of structural energy requirements, local climates, solar technology, and thermodynamics;
- (vi) Solar Thermal Installers and Technicians who install or repair solar energy systems designed to collect, store, and circulate solar-heated water for residential, commercial or industrial use; and
- (vii) Solar Thermoelectric Plant/Concentrating Thermal Power (CSP) Plant Operators who direct the operations of a commercial solar-generated power production plant.

In all these occupations, mostly the NGOs (GS, Waste Concern etc.) provide training. Among other training organizations, Rural Electrification Board (REB), BCSIR and RREL are important. The training for the rural areas is organized by the NGOs and REB, while for the urban areas primarily by RREL. Initially the staff of the companies and subsequently the users of solar energy are provided training on the submission of their application for solar energy installation. The sponsors cover all training costs.

Future demand for green enhanced skills occupations in solar energy primarily include: PV Power Systems Engineers, PV Solar Cell Designers, Solar Designer/Engineers, Solar Energy Engineers, Solar Energy Systems Designers and Solar Operations Engineers. Among new and emerging occupations are: Solar Energy Installation Managers, Solar PV Installers, Solar Power Plant Technicians, Solar Sales Representatives and Assessors, Solar Energy Systems Engineers, Solar Thermal Installers and Technicians and Solar Thermoelectric Plant/CSP Plant Operators, Solar Hot Water Heater Manufacturing Technicians, and Solar Lab Technicians.

Solar Energy Technician is selected as an example of a new green collar occupation. REB introduced solar energy programme in the rural areas in 1993. GS has started operations in 1996 with a view to supplying solar electricity in the rural areas through SHS. Currently, there are around 10000 Solar Energy Technicians in the country. Qualification and competence of this workforce are adequate. This workforce is growing rapidly so much so that GS is exporting this workforce even to the Middle East and Africa, according to GS sources. There is no evidence of skill gaps measured in terms of qualitative mismatch between the availability of Solar Energy Technicians and labour market requirement. The need for this workforce is identified by the renewable energy companies on the basis of market demand. It is also the institutional responsibility of the government agencies involved in the development of renewable energy.

Although there is no provision of skills development for this workforce in the existing education and training system, there is huge potential for skills provision for this occupation

especially for overseas employment. Curricula and training programmes relating to the installation of solar panels and related skills may be adopted. Skills policy response to the situation in terms of the policy/legal framework and level of decision making is robust. It looks more than adequate. Process of existing skills provision in response to the identified need is effective and efficient.

Several GO-NGO (Governmental Organizations/Non-governmental Organizations) training programmes for this workforce are on board. According to GS sources, during 2005-08, GS has trained more than 1,000 women technicians through 20 GTCs to install and maintain SHS and assemble crucial components of the SHSs with technical support of the United States Agency for International development (USAID). This programme has trained 10,000 students, 5,000 women users of SHS, and 300 engineers/technicians. It has provided employment and income generating opportunities to women who otherwise would have remained in poverty in the absence of this training. The Mowna GTC has trained 79 women technicians in eight batches. The GTC also imparted daylong training to 249 users and 536 students as part of awareness building.

(3) Case study on Mechanical Engineer and CNG Conversion Technician

Up to June 2008, a total of 138 legal and authorized CNG conversion workshops have been set up and are working in several districts where natural gas link is available. Along with this, 200 unauthorized CNG conversion workshops are running in several areas of Bangladesh. Till July 2009 the number of CNG-run vehicles stood at 166,672. Nowadays, many CNG filling, retesting and conversion stations have been set up for meeting the increased demand for fuel-saving vehicles.

To convert a vehicle into CNG mode, CNG technician plays a vital role along with other technical persons under the supervision of a mechanical engineer. The occupational categories in CNG conversion workshop vary according to its size. But the most common occupations include: workshop manager, field officer, supervisor and technician. Normally, the workshop manager is a graduate from any reputed engineering institution. The field officer is an automobile diploma engineer, the supervisor is a certificate holder of higher secondary education , and the technician is minimum Grade-VIII standard. On average, a big CNG conversion centre has 20 technicians and only one mechanical engineer. But still, mechanical engineers are short in supply in this sector and automobile diploma engineers are working in their position. The new skills needed in relation to CNG technologies include Gas Cylinder Engineers and toolkit makers.

Two types of technicians work in CNG conversion workshop: senior technician and junior technician. In a CNG conversion workshop, when a vehicle comes for CNG conversion the senior technician checks the firsthand particulars of the vehicle, such as the model of the vehicle, type of work needed for converting it and the size of gas cylinder needed.

The mechanical engineers graduate from engineering institution and are knowledgeable about the basics of CNG conversion through automobile education. After taking the job, the engineer receives additional training from abroad provided mainly by the CNG equipment suppliers/manufacturers, especially in case of improved technology for adaptation. Very recently, some CNG companies (e.g. Navana CNG, Intraco CNG) have introduced job specific training programme for the engineers, but limited only for their own employees. After receiving training from different technical and vocational training institutions, the engineer provides job-specific trainings and briefings to the subordinate staff in the workplace. The technicians learn their jobs through doing in the workshop. Very few of them get hands-on training on CNG conversion tasks from senior technicians in the workshops. In addition, for trouble shooting, they get support and technical assistance from the supervisor or the engineers. The CNG technicians are responsible for adapting petrol/diesel-run engine to gas-run engine. Normally, the junior technicians assist the senior technicians by doing the manual part of work and the senior technician performs the sensitive parts of the work like electrical and mechanical functions. If

any new model vehicle comes to the workshop, the supervisor handles it. In case of failure, it is the field officer and then the workshop manager who is responsible for doing the job. In short, the chain of command is as follows:

Workshop manager Field officer Supervisor Technician

Currently, as many as 2,898 CNG technicians and 338 mechanical engineers are working in various CNG conversion centres located in 15 districts of the country. However, the number of these technicians is increasing day by day. Available evidence shows that the current demand for CNG conversion is very high. During 1983-2000, only one conversion centre was in operation and only 1379 vehicles were run by CNG. But in 2008-09, the number of authorized CNG conversion centres has increased to 138 and total number of CNG vehicles has reached 166,672. According to Bangladesh Road Transport Authority (BRTA), the total number of vehicles (both CNG and non-CNG) at present is 1,054,057 with a growth rate of 51 per cent annually. This statistics indicates very high prospect of CNG conversion workshop as well as the employment of CNG technicians and other staff. FGDs with the stakeholders, especially the technicians and engineers, reveal that existing training system is effective, although there is no formal institution for training them in greening the transport sector.

Major players of the sector are:

- Navana CNG for CNG conversion, refuelling, cylinder retesting and others;
- RREL for CNG conversion, refuelling and others;
- Intraco CNG for CNG conversion, refuelling, cylinder retesting and others;
- Shohag Motors for CNG conversion, refuelling and others;
- Southern Automobiles for CNG conversion and cylinder retesting;
- Anudip CNG for CNG conversion and refuelling;
- Comet CNG for CNG conversion and others; and
- Shanji Automobiles for CNG conversion and direct sale.

Services provided by these companies include:

- (a) conversion of petrol/octane driven vehicle into CNG;
- (b) conversion of diesel driven vehicle into CNG;
- (c) conversion of diesel generator into diesel gas system;
- (d) conversion of 4-stroke/3-wheeler vehicle into CNG;
- (e) selling gas through CNG refuelling stations;
- (f) selling CNG refuelling station on turn-key basis;
- (g) selling CNG conversion kit, cylinder, valve, refuelling nozzle, receptacle and other CNG conversion spare parts;
- (h) offering package maintenance programme for CNG refuelling station;
- (i) CNG cylinder retesting facility; and
- (j) providing training to the internal staff by the companies on CNG conversion and refuelling station (NAVANA, 2009).

A typical CNG company with nine CNG conversion workshops and 15 CNG refuelling stations employs 878 persons, of whom 16 are managers; 269 are officers; and 593 are

supporting staff including technicians and helpers. According to the Secretary General of Bangladesh CNG Filling Station and Conversion Workshop Owners Association, CNG sector currently employs 10,000 people with an investment of Tk.20,000 million. In the near future, employment in the CNG sector will increase to 16,000 because another Tk.12,000 million investment is in the pipeline. Existing occupations of mechanical engineers, supervisors, managers, accountants and workshop technicians tend to become greener.

According to CNG companies, future demand for green enhanced skills occupations primarily include: Fuel Retrofitting/Conversion Technicians, Workshop manager, Field officer, supervisors and workshop technicians. Among new and emerging occupations are: Automotive Engineering Technicians, Automotive Engineers, Fuel Cell Engineers, Fuel Cell Technicians, Logistics Analysts, Logistics Engineers, Logistics Managers, Supply Chain Managers.

The training facilities for CNG conversion in Bangladesh have not developed yet. Formal training system is still not in place. From its inception, the foreign companies and traders who sell their machinery, equipment and spare parts for CNG conversion provide training to the engineers and the engineers provide training to their followers later. This virtually remains the only source of skills development. RPGCL organizes very few training programme and with very little coverage. Most of the technicians get training on-the-job. Usually, the senior employees of the CNG conversion centres come mainly from five public universities of engineering and technology and 21 technical training institutes with background in automobile, electrical and mechanical engineering. In addition, along with 38 government technical training centres under Bureau of Manpower, Employment and Training, 60 polytechnic institutes and 64 public sector technical schools and colleges under the Ministry of Education, there are 97 private sector polytechnic institutes with a number of other private training centres like German Technical Training Institute which provide vocational training in automobile. But they get very little practical knowledge on automobile as well as CNG used engine and conversion. However, skills in this sector are becoming more widely available primarily due to the aggressive marketing drive of foreign companies of CNG machinery and equipment manufacturing and trading.

CNG converted vehicles involves high risk due to accident-prone CNG fuel. Few accidents took place in the past for using substandard, non-specified and old cylinders which caused loss of lives and property. To keep such loss to a minimum, the activities of the CNG sector should be closely monitored and safety codes and standards in every step should be ensured. This requires adequate training of the CNG engineers and technicians in safety measures.

3.2.6 Case studies on greening existing occupations

For greening existing occupations, three case studies have been selected to illustrate new types of skills, competences and skill gaps which need to be incorporated into existing occupational profiles (greening existing occupations). For the selection of occupations, these illustrative case studies respect:

- (a) greening potential in terms of reducing GHG emission or non-renewable resources;
- (b) contribution to adaptive capacity of communities;
- (c) skills development record; and
- (d) contribution to national economy and as source of employment.

The selected case study occupations include:

1. architects, civil engineers, designers and masons in greening buildings;
2. supervisors and machine operators in tannery; and

3. brick field managers in brick making.

(1) Case study on Architects, Civil Engineers, Designers and Masons in Greening Buildings

According to LFS (2002-03) about 463,000 people are involved in architecture and town planning profession. Every year about 500 new architects and town planners enter the job market. According to the LFS (2005-06), 1,524,000 (male 1,421,000 and female 104,000) persons are employed in the construction sector. The construction industry in the country is growing rapidly with real estate growth rate at 3.81 per cent in 2008-09. Around 1,200 real estate developers work in Bangladesh for building construction and related projects. Most of them are working in the big cities like Dhaka, Chittagong and Sylhet with huge potential for greening existing occupations in the construction sector.

The main occupations in building construction include: architect, engineer, mason, helper and site manager. But for greening buildings, architect has the central role to play because he is responsible for the building design. New skills needed, therefore, include green architects, green town planners, green civil engineers, green supervisors and masons. The Bangladesh Labour Law 2006 accords special importance to occupational safety and health of the workers in the workplace buildings. Both, ECA, 1995 and ECR 1997 recognize the importance of environmental impacts of building, structures and any polluting industries or any activities which require environmental clearance from them.

Energy simulation programmes are excellent tools to design energy efficient buildings. The tools typically used are Visual DOE, Energy Plus and Lumen Micro. As of now, building professionals trained in the use of green tools and techniques are scarce. Along with the competence of professional groups some technical and logistic requirements, e.g. availability of green construction materials, equipment and technologies also need to be taken into account. The availability and affordability of materials/equipment which contribute to energy efficiency is another major challenge. Tremendous potential exists for the use of materials and equipment like heat resistive paints, fly ash blocks, insulation materials, high efficiency chillers, variable frequency drives, high efficiency cooling towers, building management systems, lighting controls, Building Integrated PV, etc. New technologies like wind towers, geothermal systems etc. are gaining increasing importance for greening existing occupations in construction of buildings.

For promoting green jobs in the construction sector, the DOE has initiated a commendable initiative of Green Building in 2008. A National Workshop on Eco-housing/Green Building was jointly organized by the DOE, MEF, Housing and Building Research Institute (HBRI) and UNEP RRC.AP. This national workshop has set a green skills development strategy for the workers who are tending to become redundant as a result of green structural change on the labour market caused primarily by growing obsolescence of traditional building technology and newly emerging green building technology. The green skills development strategy for workers entails:

- (i) undertaking short on-the-job training courses on green jobs for the existing construction workers;
- (ii) undertaking awareness campaigns among real estate developers, contractors and building dwellers; and
- (iii) forming green jobs skills development committees representing workers' union and employers' associations.

There appears to be already employment effects from the Green Building Policy, so that traditional building workers tend to become redundant. The workshop came up with concrete recommendations focusing on changing the existing building codes to fit into green building

construction, saving non-renewable energy and introducing solar and other renewable energy, provision of adequate ventilation in the new buildings and implementation of the Green Building Policy.

The greening process of buildings has been introduced in Bangladesh and may be replicated everywhere in a sustainable manner. The main occupations in this sector include: architects, civil engineers, designers, masons, helpers and site managers. So there is a huge potential for greening the existing occupations in this sector.

According to the construction experts, future demand for green enhanced skills occupations in building construction primarily include: Architecture Technicians, Boilermakers, Carpenter Helpers, Carpenters, Cement Masons, Construction Equipment Operators, Installation Helpers, Insulation Installers, Insulation Workers, Iron and Steel Workers, Metal Fabricators and Fitters, and Welders, Cutters, Solderers & Brazers. By greening existing occupations, the new occupations which are expected to emerge in this sector include: Building Inspectors, Commercial Green Building and Retrofit Architects, Cool Roofing Installers, Energy Efficient Site Foremen, Environmental Construction Engineers, Environmental Maintenance Workers, Green Building Architects, Green Building Design Specialists, Green Building Designers (commercial and residential), Green Plumbers and Pipe fitters, Retrofit Designers, Solar Commercial Installation Electrician Foremen, Solar Installation Manager/Project Foremen. These skills are available in Bangladesh but they are limited in supply pointing to the need for extensive skill development programmes for greening buildings.

Architect is selected as an example of an existing occupation which typically undergoes 'greening' in reaction to the demands of economy. The 'Grameen Phone Headquarters Building' at Bashundhara constructed in 2008 presents the first ever unique example of a green building in the country which illustrates incorporating building features promoting energy efficiency. In line with the climate change programme, an energy-efficient GP headquarters building has been constructed requiring around 20 million kilowatts of electricity per hour. GP has set a target to reduce its energy requirement by 40 per cent.

At the launch of a contest titled "Holcim Green Built Bangladesh" organized by Holcim Bangladesh (cement maker) in Dhaka on 20 August 2009, speakers including the Finance Minister put emphasis on the need for green construction to save resources and urged young professionals to come up with new ideas to make construction eco-friendly and sustainable. In this context, adequate training in green construction was stressed. It was noted that the competition was meant to encourage architects, engineers, students and all others involved in the construction and building sector to strive to build a Green Bangladesh.

With these maiden initiatives, the occupation of an architect is tending to become green, though on a mini scale. However, greening concerns a large proportion of existing occupations. The role of technological change and innovation is positive. It is taking place in the construction of office buildings of the NGOs mostly in Dhaka City. According to the sources from Holcim Bangladesh, 10 to 25 architect workforce are already performing a greener version of this occupation, about one-third of them being women. They are graduate architects. It is guessed by Holcim Bangladesh that the volume of this workforce would transit into a greener version of this occupation in the coming years.

According to Grameen Bank and Holcim Bangladesh, there is no skill gaps for greening the occupation because existing architects are well equipped with knowledge and skill in green architecture. Existing provision of skills may simply prioritise the importance of green architecture in sustainable buildings. Existing education and training system has huge potential for skills provision for greening this occupation. Green curricula and training programmes in architecture may be adopted.

Skills policy response to the situation is positive in terms of legal framework but unclear in terms of decision making. Therefore, policy response remains inadequate. There is a pressing need for skills provision in response to the identified need. The process needs to be surfaced by the Ministry of Works and the Ministry of Education in collaboration with the existing educational and training institutions.

For greening buildings, it is necessary to:

- (i) have the commitment of the entire design team to deliver and define the role and accountability of each design member – a good strategy to ensure easy implementation;
- (ii) conceive green by design in order to ensure application for certain credits (e.g. it would be almost impossible to achieve daylight credit if the depth of the building design exceeds 4-5 m.);
- (iii) freeze the baseline costs right at the beginning so as to realistically evaluate incremental cost due to greening (e.g. green design can be an easy scapegoat to account for incremental cost due to other factors);
- (iv) use energy simulation tool right at design stage to decide on material and equipment selection; and
- (v) monitor closely and document properly certain material related credits viz., low VOC paints, adhesives, sealants, and also a few construction related credits like managing construction waste and building flush out.

Policy suggestions

- (a) Establish minimum green building standards for all new construction. This is especially important in Bangladesh where construction sector has become a potential sector. It is more cost effective to construct new green buildings than to retrofit projects at a later time.
- (b) Create regularly updated minimum standards and standardized labelling for equipment and appliances (water heaters, HVAC, cooking, appliances, lighting, electronics, office equipment, windows, and others). Government has initiated energy saving programmes but much more is needed. Inefficient lighting programmes must be phased out.
- (c) Target programmes that have immediate results and are very cost effective, especially lighting programmes, air conditioning, water heating, and building insulation. Provide incentives and funding opportunities for people to make these changes.

(2) Case study on Supervisors and Machine Operators in Tannery

In this sector, although no greening process is taking place, this sector has been included in the research because there is a huge potential for greening the existing jobs in this sector with substantial contribution to total manufacturing employment. According to different sources about 20,000 workers are employed in the tannery manufacturing sector. In addition, about 2,000 persons are involved in the process of collecting raw hides and skins and making them available to tannery units. Moreover, 100 organizations employing 10,000 persons import chemicals for use in tannery industry.

There is no training course for different occupations in tannery production or management. The persons engaged in the production and distribution of products learn through doing their jobs and only professional training for tannery and leather specialists is provided by College of Leather Technology (CLT). On-the-site research reveals that most of the tannery workers are not trained in environmental features. Among existing occupations in tannery are hides and skins cleaners, supervisors, machine operators, machine maintenance technicians and helpers. The existing occupations in tannery are totally non-green with huge potential for greening the existing

jobs. To this end, persons employed in different occupations in tannery need to be trained for greening their jobs. At present, there is no example of practicing greening of such occupations in tannery.

Among the main existing jobs in tannery are supervisor, machine operator, machine maintenance technician and helper. About 20 workers in a small tannery and 30 workers in large tannery work during lean season (9 months). During peak season (3 months), employment in tannery increases to around 70 in case of small and to around 100 in case of large units. About 16 different types of machine are found in a typical Bangladeshi tannery. About 16 machine operators and 4-5 supervisors work in a factory. Supervising the works and maintaining communication with the head office are the prime responsibility of the supervisors, while the operators run different machines and helpers carry out manual works and carry raw materials from one machine to another and assist the operators.

A machine operator's main responsibility is to handle raw hides in different machines. Generally, a supervisor joins the factory after completing minimum Higher Secondary Certificate degree while the machine operator need not be educated well but must be experienced in machine operation. Not all the machine operators become operators without learning and gaining experience through working in the factory. The helper mainly does manual work and transportation work. In the process of upgrading the job, a quick learner is given preference.

Some key machines used in tanneries are: Fleshing machine, Spirit machine, Trimming machine, Setting machine, Vacuum machine, Toggle machine, Spray machine and so on. Fleshing machine is used for separating raw hide from flesh and fat, which cause the most pollution. By shaving machine hides are cleaned by detergent and thickness of hide is maintained. Spirit machine is used for dividing hide into two parts called *ban pit* (*mainly exported*) and *spirit site* (*used for internal use*). In tannery, different chemicals are used for tanning and processing hides. The most used chemicals are sodium chloride, sodium carbonate, sodium sulphite, formic acid, sulphuric acid, nitric acid and acetic acid etc.

Appex Tannery made some abortive attempts to introduce the greening process in this sector. But these did not work primarily due to the planned shifting of all the tannery units from Hazaribagh area of Dhaka City to Savar primarily for environmental reasons. A deadlock is continuing for the last one decade. However, greening process in this sector is expected to occur once the relocation of tannery units is materialised.

In Bangladesh, there is no training course for the workers or managers for clean tannery production or management. The CLT conducts training in manufacturing leather and leather products and professional trainings related to research but have no curriculum and courses on tannery related pollution. New training manuals and curriculum relating to green processes in leather manufacturing to rise to the environmental needs should, therefore, be developed by the CLT.

Disappointingly, there is no ETP in the tanneries. As the location of almost all the tanneries is close to the river, most of the waste i.e. toxic water and solid waste are disposed into the river. The employees of tanneries are ignorant about the environmental impact of tannery production. This points to the need for raising their awareness about basic environmental concerns and concepts and training them with practical knowledge to overcome tannery produced pollution.

During the fieldworks, the research team talked with some machine operators, supervisors and key experts on leather technology. Most of the employees showed their keen interest in training on environment conservation, pollution control and so on. They expressed their dissatisfaction with the indifference of the tannery owners and relevant government agencies. It means that training and awareness programme should be introduced both for the employees and

the owners of tanneries. Experts argue more for technological change and upgradation than for training per se.

However, according to the Production Managers of the tannery companies, skill gaps linked to green process in tannery figure most prominently in the occupations of Chemical Equipment Operators and Tenders, Chemical Technicians, First-Line Production Supervisors, and Safety Investigators/ Cause Analysts. The companies in collaboration with the foreign leather buyers arrange overseas training to overcome the skill gaps. In several instances, the buyers post their technical staff in the companies for one to two weeks in order to ensure quality of products.

Machine Operator is selected as a case study to illustrate existing occupation which has the potential to undergo greening process in tannery. There is no evidence of greening this occupation in the existing companies. The process needs to be introduced. Potential greening concerns a large proportion of existing occupations. Introduction of effluent treatment plant in each tannery unit may play a vital role in the process of greening. The number of the current workforce which can potentially perform a greener version of this occupation is estimated in the region of 1,500. The volume of the workforce expected to transit into a greener version of this occupation in the coming years may increase at the rate of one per cent annually. Clearly, there are 100 per cent skill gaps for greening the occupation. This gap is assessed on the basis of available information flows.

There is potential of the existing education and training system for skills provision for greening this occupation. Green machine operation curricula and training programmes can be adopted. There is no skills policy response to the situation in terms of legal framework and level of decision making. The policy response is totally absent. The skills provision in response to the identified need is important in its own right. An effectiveness process needs to be put in place.

(3) Case study on Brickfield Managers in Brick Manufacturing

The BBMA estimates that more than 200,000 people are engaged in brick manufacturing. Total annual brick production is about 12 billion and the industry is growing at more than 5 per cent annually. The main occupational categories in the brickfields are: brick field manager, cleaner (mainly female), machine operator for blending mud, dice maker, brick dryer and brick burner. Normally, in a small brickfield about 140 and in a large unit up to 200 workers are employed during peak season. The gender composition of employment in the brickfields is undergoing change in recent years. Prior to 2000, female workers were very rare in brick industry but now their participation is very common. Almost 20 per cent of the workers in brick manufacturing are female. Out of 150 workers in a brickfield, about 1/3 are engaged in cleaning the field, 25-30 of them are involved in brick making through dice and about 40 are involved in carrying the bricks into the kiln and about 25 are involved in brick burning. To run a brickfield the manager plays the key role. He maintains a ready network with the owner, brick buyer and the labourers. In Bangladesh, a brickfield manager need not be highly educated but must be experienced in managerial works. To run a brick field successfully, a manager needs to understand the pulse of the workers and speculate the brick market.

According to the ECA 1995 and ECR 1997, brick industry is Orange B category industry, which is not environment-friendly. To set up a brickfield the industrialist needs to comply with certain rules and regulations. But unfortunately, most of the time The Environmental Act and Rules are not implemented. Environment-friendly brick making technologies, especially CDM, like: Vertical Shaft Brick Kiln (VSBK), HHK are available in other countries that can save energy and reduce emission. These types of technologies combine fuel injection brick making techniques with energy efficient kilns to produce high quality and lower cost bricks. This greening process has been introduced in Bangladesh through a pilot project of GEF/UNDP to develop a project to remove barriers to the dissemination of energy efficient technologies in brick making on an industry-wide basis. So far four companies have participated in the greening

process of bricks manufacturing. This needs to be replicated all over the country in a sustainable manner.

Brick making in Bangladesh is a highly energy-intensive and carbon-emitting activity and one of the largest sources of greenhouse gas emissions, estimated to be around 3 million tonnes of carbon dioxide annually. The World Bank and Denmark will buy 189,000 and 60,000 emission reductions respectively. IIDFC will act as the overall agent for the 20 brick kiln owners to sell the emission reductions. The deals will pave the way for purchasing greenhouse gas emissions reductions from 20 energy efficient HHK at various stages of production and construction.

The HHK use 50 per cent less coal than the regular brick kilns. The coal fired HHK will reduce green house gas emissions and other air pollutants. The project involves a community benefit plan, ensuring social improvement for the employees in the brick making sector such as making first aid room with regular visit by a medical practitioner, sanitary facilities and safety gears available. These agreements are important as Bangladesh adopts new technologies that are better for the environment and particularly that improve air quality.

According to IIDFC, the HHK owners can now earn revenues from sources, making and selling bricks and generating emission reductions and at the same time earn foreign exchange for the country. It is hopeful that this scheme would encourage other brick kiln owners to adopt HHK technology, which offers multiple benefits.

The HHK design combines a highly efficient kiln technology. Furthermore, wet clay and pulverized coal are mixed together when the brick is being made. The wet bricks are then first dried in a drying chamber using waste heat from the firing chamber. The dried bricks are then loaded into the firing chamber. In the firing chamber, the coal inside of the dry bricks then ignites and bakes the bricks. The combined use of waste heat and the internal combustion of coal reduce coal consumption per brick and greenhouse gas emissions. The project will reduce estimated 881,000 tonnes of CO₂ during project time till 2020.

Bangladesh has started making bricks using new technology, which cuts carbon emission almost by half and creates scope for earning huge foreign currencies. Entrepreneurs and financiers reported that Bangladesh would be able to sell per tonne of saved carbon at \$15 after June 2010. Diamond Auto Bricks at Aduria Saughat in Narayanganj has set up such a brick kiln.

On an on-the-site visit, it was found that black fumes were coming out from the pipes of nearby brickfields, while Diamond Auto was making bricks without any black fumes seen around. The new technology being used by Diamond Auto and the like is HHK technology imported from China. A single kiln that runs on HHK technology will produce 15 million bricks and cut carbon emission by 5,000 tonnes a year. A double unit kiln will produce 30 million bricks and reduce CO₂ emission by 10,000 tonnes every year.

IIDFC has so far funded four brick manufacturing units including Diamond Auto Bricks under the technology. Bangladesh has about 6,000 authorized brickfields and numerous illegal ones. According to IIFDC, the brickfields in Bangladesh emit around 87.5 million tonnes of CO₂ every year accounting for 30 per cent of air pollution in the country. HHK kilns will reduce carbon emission almost by half.

Most of the works at Diamond Auto are done without human intervention. Coal and clay are mixed automatically and then poured into a machine. In every piece of brick about 2-3 per cent coal is mixed. Bricks are prepared automatically and taken to a silo, and smoke of the kiln, which others use for burning bricks, is used for drying the raw bricks.

According to the owner of the Diamond Auto Brickfield, the smoke produced in his kiln is being trapped and used for drying raw bricks. So less CO₂ is emitted. The strength of the bricks produced in this field is more than double of that of the traditional bricks, and the price is also competitive. It fetches Tk.6 per brick as against the traditional bricks which are sold for Tk.5.50-5.80 each.

However, the new technology is expensive. A single unit brickfield of modern technology needs around Tk.100 million as against Tk.10 million required for a traditional brickfield. According to IIDFC, the traditional brickfields cause a huge environmental pollution. Those units should be converted into new technology-based ones to decrease pollution. If the Bangladesh Bank offers refinancing facility, the brick makers will get loan at lower interest and come forward to convert their traditional units. The licence renewal process for the exiting fixed chimney kilns will come to an end on 31 December 2010, and the owners will have to go for clean technology-based brick manufacturing. This will require a huge investment and so the central bank should consider the need for a refinancing scheme.

According to workers, Government should arrange training for brickfield managers because it is a widespread business and it is very difficult for the owners to individually arrange training for the managers. Besides, owners are not interested in expending money for their training. To implement such training programme mainly three measures may be undertaken: Firstly, the training programmes should be funded and implemented by the government. Secondly, training should be provided during off-season and free of cost. Thirdly, the training programme should be regular and should continue at least for five years. In the first year, 10 brickfield managers and 100 workers may be trained up. The same number of trainees may be picked up for training in the following four years. In addition, the Government should closely monitor the outcome of training in terms of greening the sector.

According to the experts and managers of brick manufacturing companies, the skill gaps in brick making occupations primarily include: Brick Making Technologists and *Supply Chain Managers* responsible for production and marketing of bricks and overall management of the brickfield including recruitment of workers. Interestingly, there is no formal training arrangement for the brickfield managers who conventionally learn the job through experience. In order to ensure greening brick making, the manager needs to be trained in environment conservation and use of green technology, especially CDM.

Brickfield Manager is selected as a case study illustrating existing occupation which typically undergoes ‘greening’ in reaction to the demands of the economy. This age-old occupation is undergoing greening process most recently, albeit on a limited scale. With innovation and the introduction of green technology, the ongoing greening concerns a large proportion of the existing occupations. The number of the current workforce already performing a greener version of this occupation is minuscule (around five). Generally, they are male and belong to the middle age group. They acquire brickfield management skills on-the-job. This workforce is expected to transit into a greener version of this occupation moderately in the coming years.

According to the owner of the Diamond Auto Bricks at Aduria Saughat in Narayanganj, there are skill gaps for greening the occupation. It was identified from existing information flows on the innovative technology. Although currently there is no provision of skills, there is large potential of the existing education and training system for skills provision for greening this occupation. Short training programmes for the Brickfield Managers may be adopted. The skills policy response to the situation is positive in terms of legal framework. The policy response remains inadequate. There is a need for the skills provision in response to the identified need. Existing process is partly effective.

4. Conclusions

4.1 Main 'greening' shifts in the economy and labour market

Skill and labour development is a key component of any restructuring in the transition of Bangladesh to a low-carbon economy. Main greening shifts in the economy and labour market of Bangladesh has taken place in renewable energy, materials management, telecommunication and transport sectors. But these greening shifts remain weak (except in renewable energy) primarily due to inadequate policy, institutional support, and implementation. The biggest institutional bottlenecks that hamper skills development for a transition to green economy seem to be inadequate appreciation of the DTE, BTEB, BMET and, above all, the Ministry of Education and MLE.

The effectiveness of the government initiatives for climate change mitigation and adaptation has been mixed partly due to inadequate appreciation by the policy makers of the need for greening the economy and partly, and more importantly, due to lack of skill development policy for green jobs.

National concerns such as climate change and loss of biodiversity require concerted efforts among various stakeholders and institutions at local, national and international levels along with Multilateral Environmental Agreements. With the right policies, institutional framework, partners, and immediate reinvestment on board, it is possible for Bangladesh to bring about the change it needs for greening its economy.

The use of alternative energy (solar, wind, hydroelectricity, geothermal energy) has a huge potential for Bangladesh. If properly tapped, these alternative sources can bring about revolutionary change for transition to green economy. There is a general consensus that cleaner technology is needed but the cost is too high to afford. Cost of implementing many of the available green technological solutions and alternative lifestyles are considerably higher than the "business as usual" practices.

4.2 Skills implications and development

4.2.1 Anticipation and identification of skill needs

Eight case studies illustrate anticipated change and provision of skills.

Two case studies: (i) refuse/waste collectors and dumpers, and (ii) agricultural workers and inspectors in organic farming) illustrate (re)training needs deriving from identification of skills and occupations that become obsolete as a result of structural changes on the labour market and major employment shifts within and across sectors due to climate change and demands for greening the economy.

There are mainly three types of occupation involved in the process of waste management. These are: (a) waste collectors, (b) waste dumpers, and (c) drivers of the waste carrier, which are traditional jobs. The jobs of the people who are involved in these three categories are becoming obsolete due to change of the traditional way of collecting waste and dumping. In order to cope with the new way of collecting waste it requires (re)training of existing employees who are actively involved in waste collection and dumping. Existing training programmes on solid waste management are not sufficient.

From the informal sector, 420,000 to 520,000 urban poor are involved in the recycling trade chain. As of 2005-06, there are 130,432 garbage collectors and related labourers in the country. They are not familiar with clean garbage collection and disposal pointing to the need for their training to develop environment-friendly skills. This workforce is likely to grow at the rate of 1 per cent annually. The persons in the three traditional occupations are adapting to new methods of waste collection and recycling and are gradually shifting their jobs but on a limited scale. Among green enhanced skills required for the future are: Hazardous Materials Removal Workers, Hazardous Waste Management Specialists, Solid Waste (Energy) Engineers/Managers, Green Building/Recyclable Materials Distributors, Recycling Collections Drivers, Recycling Coordinators and Sustainable Design Specialists. All of these skills are growing in Bangladesh with the assistance of the donor agencies, but at a very slow pace.

The involvement of the farmers in using organic and bio-inputs is increasing and today spans over 16 districts and over 100,000 farming families. The farmers have responded well and accepted this agricultural practice. This sector has very high potential for greening stemming from both environmental and economic considerations. The major occupations involved in this activity include agricultural workers, agricultural advisors, chemists, traders and farmers. Organic farming avoids the use of synthetic chemical fertilizers and genetically modified organisms to influence the growth of crops with 'zero impact' on the environment. Total land area under organic cultivation in Bangladesh has been estimated at 0.177 million hectares representing only 2 per cent of the country's total cultivable land. Agricultural inspectors (currently 12,500) can also play significant role to boost up organic farming. As of 2005-06, there are 7,057,853 agricultural workers and about 12,500 agricultural inspectors in the country. Hardly 1 per cent of them practice organic farming. While agricultural workers are likely to grow at the rate of 2.4 per cent, agricultural inspectors are likely to grow at the rate of less than 1 per cent annually. This workforce badly requires training in organic farming. Among major green increased demand occupations in organic farming are: Energy Crop Farmers, Agriculture Extension Specialists, Biologists - Marine/ Fisheries, Soil Conservation Technicians, Restoration Ecologists, Agricultural Inspectors, Farm Product Purchasers, Food Product Inspectors, Sustainable Agriculture Specialists and Precision Agriculture Technicians. These occupations exist in Bangladesh, but the people employed in these occupations are limited in supply requiring extensive training.

For new green collar occupations, three case studies ((i) carbon trading, (ii) solar energy engineers and technicians, and (iii) mechanical engineers and CNG conversion technicians) illustrate how these occupations emerge newly as a result of adaptation to climate change and mitigation of its negative impacts and are new on the labour market. These are new as well as 'hybrid' occupations e.g. carbon traders, solarteurs, bioenergy technicians, energy assessors, CNG conversion technicians and green accountants. These new green collar occupations are concentrated in energy and transport sectors. Workforce involved in such occupations is quite sizable now and is expected to increase substantially in future.

Carbon trading is an administrative approach used to control pollution by providing economic incentives for achieving reductions in the emissions of pollutants. It is a trading in energy and is a new and emerging green occupation which includes:

- (i) Carbon Credit Traders who represent companies in the sale and purchase of carbon emissions permits;
- (ii) Carbon Trading Analysts who analyze pricing and risks of carbon trading products and develop solutions to help client's hedge carbon exposure and risk;
- (iii) Energy Brokers who purchase or sell energy for customers;
- (iv) Investment Underwriters (occupations that are linked to multiple sectors) who are intermediate between corporate issuers of securities and clients regarding private equity

- investments, underwrite the issuance of securities to provide capital for client growth, and negotiate and structure the terms of mergers and acquisitions; and
- (v) Securities and Commodities Traders (occupations that are linked to multiple sectors) who buy and sell securities and commodities to transfer debt, capital, or risk and establish and negotiate unit prices and terms of sale.

In Bangladesh, in all these occupations there are skill gaps particularly because carbon trading is still in its infancy in Bangladesh.

Among new and emerging occupations in carbon trading are: Carbon Credit Traders, Carbon Trading Analysts, Energy Brokers, Investment Underwriters, and Securities and Commodities Traders, Carbon Capture Power Plant Installation, Operations, Engineering and Management Staff, General and Carbon Sequestration Plant Installation, Operations, Engineering and General Management Staff, Carbon Capture and Sequestration Systems Installers. Of these occupations, only Carbon Sequestration Plant Installation, Operations, Engineering and General Management Staff, and Carbon Capture and Sequestration Systems Installers exist in Bangladesh on a limited scale (only in Waste Concern involved in carbon saving devices). Waste Concern is a small company and is coping with its critical skills needs by foreign training. While for high green-collar jobs required training is obtained from abroad, especially from the European Union, for the low green-collar jobs the company itself is providing on-the-job training.

Because of the lack of available easy alternative source of energy and vulnerable situation of current energy in Bangladesh huge demand for solar energy has been created. As a new green technology or type of activity solar energy has significant impact on environment and economy through creating huge employment opportunity. Currently, around 15,000 solar engineers and technicians and around 100 green entrepreneurs are involved in this sector. There is also scope for 100,000 new green jobs especially for women in this sector.

Rural electrification through solar technology is becoming more and more popular in Bangladesh. Currently, about 622,000 SHS has been installed in different regions of the country. Solar power is seen as one of the more promising sources of renewable energy for Bangladesh, whose demand for electricity is expected to increase five-fold over the next two decades. Solar energy interventions replace fossil fuel and directly reduces considerable amount of GHG eventually keeping the environment healthy. But the cost of installing one megawatt of solar power is between five and eight times that of conventional technology making government subsidies a key part of any solar development policy. Major occupations in this sector include: solar engineers, solarteurs, bioenergy technicians, energy assessors, masons, sales persons, marketing, maintenance and repair etc. This sector is totally green and has ample scope for creating new green collar jobs.

Number of jobs related to solar energy is about 15,000 most of who are solar energy technicians. Few of them get access to institutional training, as no independent training institution on solar energy is prevailing in the country. By 2014, it is expected that the installation of SHSs will be more than 2 million. In this situation, there is a huge demand for solar energy technicians to gear up the expansion of SHSs. The ever-growing renewable energy industry is expected to provide jobs for at least 100,000 persons by 2014. There are mainly four types of occupation involved in the process of implementing SHS: These are:

- (a) Branch Manager,
- (b) Service Engineer,
- (c) Financial Assistant, and
- (d) Solar Energy Technician.

Among these categories, solar energy technicians are directly involved in setting up the solar systems. But, without appropriate training or schooling, it is difficult to implement the SHS on a larger scale. At present, the training on solar energy is taking place only on a small scale and only through some NGOs (e.g. GS and Waste Concern), REB, BCSIR and IDCOL. The appropriate skill of solar energy technicians on the solar systems is a crucial factor for the rapid expansion of SHSs in the future.

New green collar occupations in solar energy most demanded in the country include:

- (i) Solar Energy Installation Managers who direct work crews installing residential or commercial solar PV or thermal systems;
- (ii) Solar PV Installers who assemble, install, or maintain solar PV systems on roofs or other structures in compliance with site assessment and schematics, including measuring, cutting, assembling, and bolting structural framing and solar modules, and performing minor electrical work, e.g. current checks;
- (iii) Solar Power Plant Technicians who monitor and repair the instrumentation, controls, and electrical systems in a utility-scale solar power generating facility;
- (iv) Solar Sales Representatives and Assessors who contact new or existing customers to determine their solar equipment needs, suggest systems or equipment, or estimate costs;
- (v) Solar Energy Systems Engineers who perform site-specific engineering analysis or evaluation of energy efficiency and solar projects involving residential, commercial, or industrial customers; design solar domestic hot water and space heating systems for new and existing structures, applying knowledge of structural energy requirements, local climates, solar technology, and thermodynamics;
- (vi) Solar Thermal Installers and Technicians who install or repair solar energy systems designed to collect, store, and circulate solar-heated water for residential, commercial or industrial use; and
- (vii) Solar Thermoelectric Plant/Concentrating Thermal Power (CSP) Plant Operators who direct the operations of a commercial solar-generated power production plant.

In all these occupations, mostly the NGOs provide training. REB, BCSIR and RREL are also training providers.

Future demand for green enhanced skills occupations in solar energy primarily include: PV Power Systems Engineers, PV Solar Cell Designers, Solar Designer/Engineers, Solar Energy Engineers, Solar Energy Systems Designers and Solar Operations Engineers. Among new and emerging occupations are: Solar Energy Installation Managers, Solar PV Installers, Solar Power Plant Technicians, Solar Sales Representatives and Assessors, Solar Energy Systems Engineers, Solar Thermal Installers and Technicians and Solar Thermoelectric Plant/CSP Plant Operators. Solar Hot Water Heater Manufacturing Technicians, and Solar Lab Technicians.

CNG technology contributes to greening the economy. It is one of the most viable alternatives to traditional fuel energy for automotive industry. CNG is low in pollutants, high in calorific value and heat yield. The policy measures started boosting up CNG activities and creating new employment opportunities. Up to 2007, the total number of registered motorized vehicles in Bangladesh was 1,054,057 and it is increasing day by day. As of 2005-06, the transport, storage and communications sector employs 3,976,000 persons with a growth rate of 9.66 per cent. Up to July 2009, the number of CNG-run vehicles stood at 166,672. Nowadays, many CNG filling, retesting and conversion stations have been set up for meeting the increased demand for fuel-saving vehicles. The most common occupations in CNG workshop include: workshop manager, field officer, supervisor and technician. The new skills needed in relation to

CNG technologies include Gas Cylinder Engineers and toolkit makers. Two types of technicians work in CNG conversion workshop: senior technician and junior technician.

CNG sector currently employs 10,000 people. In the near future, employment in the CNG sector will increase to 16,000. Existing occupations of mechanical engineers, supervisors, managers, accountants and workshop technicians tend to become greener. Future demand for green enhanced skills occupations primarily include: Fuel Retrofitting/Conversion Technicians, Workshop manager, Field officer, supervisors and workshop technicians. Among new and emerging occupations are: Automotive Engineering Technicians, Automotive Engineers, Fuel Cell Engineers, Fuel Cell Technicians, Logistics Analysts, Logistics Engineers, Logistics Managers, Supply Chain Managers. Formal training system is still not in place. The foreign companies and traders who sell their machinery, equipment and spare parts for CNG conversion provide training to the engineers who provide training to the junior staff later. This virtually remains the only source of skills development. Most of the technicians get training on-the-job.

Three case studies ((i) supervisors and machine operators in tannery, (ii) brickfield managers, and (iii) architects, civil engineers, designers and masons in greening buildings) illustrate greening existing occupations and new types of skills, competences and skill gaps which need to be incorporated into existing occupational profiles. Tanneries with major waste disposal problem are one of the major polluters in Bangladesh. Nearly 22,000 cubic meters of untreated and highly toxic liquid waste is discharged by the tanneries every day into the water bodies. To reduce existing pollution in the tannery sector, change in technology as well as in knowledge and practice of the employees can play a pivotal role. Clean technology can significantly reduce the costs of environmental compliance by reducing effluent loadings and chemical costs in leather manufacture while the change in employees' knowledge and practice is very crucial for reducing environmental pollution.

About 20,000 workers are employed in the tannery manufacturing sector. In addition, about 2,000 persons are involved in the process of collecting raw hides and skins. Moreover, 100 organizations employing 10,000 persons import chemicals for use in tannery. Most of the tannery workers are not trained in environmental features. Among existing occupations in tannery are hides and skins cleaners, supervisors, machine operators, machine maintenance technicians and helpers. The existing occupations in tannery are totally non-green with huge potential for greening the existing jobs. To this end, persons employed in different occupations in tannery need to be trained for greening their jobs. Among the main occupations in tannery are supervisor, machine operator, machine maintenance technician and helper. There is no training course for the workers or managers for clean tannery production or management. The CLT conducts training in manufacturing leather and leather products and professional trainings related to research but have no curriculum and courses on tannery related pollution. New training manuals and curriculum to rise to the environmental needs should, therefore, be developed by the CLT. However, skill gaps in tannery figure most prominently in the occupations of Chemical Equipment Operators and Tenders, Chemical Technicians, First-Line Production Supervisors, and Safety Investigators/Cause Analysts.

There are approximately 4,000 brickfields in Bangladesh contributing to deforestation. The brick industry is energy intensive and energy accounts for close to 50 per cent of production cost. The 4,000 plus fixed chimney kilns form the largest stationary source of GHG emissions in Bangladesh which is around 5.4 million tonnes of CO₂ annually. Beside air pollution, brick making industries contributes to land degradation, deforestation and depletion of water resources. Brick industry is Orange B category industry, which is not environment-friendly. The goal of the ECA is to phase out or change all Orange B industries. The main occupations in bricks manufacturing are: contractors, wood suppliers, brick field managers, mud mixers, brick makers and chimney kiln operators. With shift to green technology, wood suppliers are expected to disappear and the chimney kiln operators will have to adapt to new technology with implications for their retraining.

More than 200,000 people are engaged in brick manufacturing. The main occupational categories in the brickfields are: brick field manager, cleaner, machine operator for blending mud, dice maker, brick dryer and brick burner. Environment-friendly brick making technologies, especially CDM, like: Vertical Shaft Brick Kiln (VSBK), Hoffman Kiln are available in other countries that can save energy and reduce emission. This needs to be replicated all over the country in a sustainable manner. The skill gaps in brick making occupations primarily include: Brick Making Technologists and Supply Chain Managers responsible for production and marketing of bricks and overall management of the brickfield including recruitment of workers. There is no formal training arrangement for the brickfield managers who conventionally learn the job through experience. In order to ensure greening brick making, the manager needs to be trained in environment conservation and use of green technology, especially CDM.

A green building can have tremendous environmental benefits, both tangible and intangible. The immediate and most tangible benefit is in the reduction in operating energy and water costs right from day one, during the entire lifetime of the building. The energy savings could range from 25 to 40 per cent depending on the extent of green specifications. Several corporate bodies are now using Green Building Rating as a tool for enhancing marketability. Present building design in Bangladesh is more energy consuming and hence green buildings initiative should be undertaken. About 463,000 people are involved in architecture and town planning profession. Every year about 500 new architects and town planners enter the job market. As of 2005-06, 1,524 thousand persons are employed in the construction sector. The construction industry in the country is growing rapidly with real estate growth rate at 3.81 per cent in 2008-09. Around 1,200 real estate developers work in building construction and related projects. The main occupations in building construction include: architect, engineer, mason, helper and site manager. But for greening buildings, architect has the central role to play because he is responsible for the building design. New skills needed, therefore, include green architects, green town planners, green civil engineers, green supervisors and masons.

As of now, building professionals trained in the use of green tools and techniques are scarce. Along with the competence of professional groups some technical and logistic requirements also need to be taken into account. The availability and affordability of materials/equipment which contribute to energy efficiency is another major challenge. New technologies like wind towers, geothermal systems etc. are gaining increasing importance for greening existing occupations in construction of buildings. The greening process of buildings has been introduced in Bangladesh and may be replicated everywhere in a sustainable manner. The main occupations in this sector include: architects, civil engineers, designers, masons, helpers and site managers. So there is a huge potential for greening the existing occupations in this sector.

Future demand for green enhanced skills occupations in building construction primarily include: Architecture Technicians, Boilermakers, Carpenter Helpers, Carpenters, Cement Masons, Construction Equipment Operators, Installation Helpers, Insulation Installers, Insulation Workers, Iron and Steel Workers, Metal Fabricators and Fitters, and Welders, Cutters, Solderers and Brazers. Among new and emerging occupations are: Building Inspectors, Commercial Green Building and Retrofit Architects, Cool Roofing Installers, Energy Efficient Site Foremen, Environmental Construction Engineers, Environmental Maintenance Workers, Green Building Architects, Green Building Design Specialists, Green Building Designers, Green Plumbers and Pipe fitters, Retrofit Designers, Solar Commercial Installation Electrician Foremen, Solar Installation Manager/Project Foremen. These skills are available in Bangladesh but they are limited in supply pointing to the need for extensive skill development programmes for greening buildings.

In the early stages, despite scarcity skills happen to trigger off development. In the later stages, however, skills and development become mutually reinforcing. Economic growth and development cannot be sustainable without a sustainable environment. Skills for green jobs are

instrumental in bringing about the desired change and are inseparable from sustainable development.

4.2.2 Response policies and programmes

At the policy making level, there is a lack of appreciation of the need for a policy targeting the identification and development of skills for green jobs. Although Bangladesh has embarked on several policies and programmes for adaptation to climate change and mitigation of its adverse impact, it has no policy for the formation and development of skills for greening the economy. In this regard, isolated and sporadic efforts are taking place in different sectors in informal way with very little impact.

The existing education and training system including general schooling does not follow a strategy to “mainstream” sustainability and environment protection issues within the education and training system. However, although there is no explicit policy in place, the government has introduced several chapters on environmental issues in pollution, adaptation and mitigation in the syllabus of the students from Grade-III to Grade-VIII in the general schooling system. Besides, the government is planning to widen the base of environmental education at the higher levels.

Ongoing TVET Reform Project is trying to establish training network between the public sector training institutions and the industrial employers, but there is no contents on developing skills for green jobs. The Project has targeted to meet market-driven, but not environment-driven, skill demand. In the same vein, there is no role of social dialogue in skills development for greener economy.

The skills response to meet the challenge of the green economic restructuring remains limited. There are no active labour market policy measures and planning of initial and continuing training.

4.2.3 Effective delivery mechanisms

In the absence of any policy agenda and support, the delivery mechanisms of the existing institutions for developing skills for green jobs remain weak. Shortage of skills and expertise largely explains weak delivery mechanisms of these institutions. Generally, training in skills for green jobs takes place only informally.

Institutional frameworks, delivery channels and ad hoc skills responses remain limited mostly to IDCOL, NGOs, some CNG and renewable energy companies and waste management companies. There is no special skills development programmes to cushion the effects. They are delivered on-the-job by, for example, RREL, GS, GP, NAVANA CNG and Waste Concern and funded by the NGOs with donor assistance.

5. Recommendations

5.1 Policy recommendations

Bangladesh does not have sufficient strategies in terms of policy instruments and implementation mechanisms to promote a cleaner environment. A coherent policy for the formation and development of skills for green jobs should be formulated and put in place within the overall framework for HRD. For greening purposes, the policy should target the implementation of the environment-driven skills needs in various sectors. Existing education and training policies should incorporate provision for environmental education and training at all levels. At the primary level, it should be made mandatory.

Synergy among the existing institutions (both public and private) for greening the economy should be established, promoted and strengthened. An integrated effort, involving all relevant sectors and covering all the relevant technologies, is needed to mitigate the problem of GHG. A consensus among all the stakeholders should also be built. This is a challenging job as the country lacks appropriate technologies to combat GHG effects. At the same time most of the industrial entrepreneurs are not fully aware of the consequences of environmental pollution and thus are not equipped to meet these challenges.

In order to introduce carbon free and climate resilient policy and to strengthen technical capacities of Bangladesh it is crucially important to integrate climate change risks and opportunities into HRD based planning and programming. The purpose of the climate change mitigation and adaptation skills for the professionals it is necessary to develop and integrate robust understanding of the implications of climate change into education and training for professionals involved in developing planned mitigating and adaptive responses to the impacts of climate change.

There is a critical need for creating demand for green skills through market-based instruments, market standards and regulation, and public investment. Market-based instruments may include:

- (a) national emissions trading scheme: economy-wide incentive for low-carbon markets,
 - (b) renewable energy target (20 per cent, 2020): demand for near-to-market renewable energy technologies,
 - (c) energy efficiency trading: financial incentive for solutions to barriers to cost-effective energy efficiency,
 - (d) feed-in tariff: solar PV, and
 - (e) waste levy: levy on landfilled waste driving development of recycling industry.
- Incentives-based policy instruments include tax, subsidies, and tradable permits.

Policy-makers may consider a market-based policy of imposing carbon tax to reduce carbon emissions. Some of the factors that make a carbon tax a serious contender are its international acceptability, high elasticity and transparency. It is also easy to implement, and offers an incentive for the development of alternative and renewable sources of energy in Bangladesh. Market standards/regulation may encompass:

- (i) minimum energy performance standards,
- (ii) basics: all new residential buildings/major renovations must reduce GHG emissions by 40 per cent leading to jobs/skills in cutting edge building design, and
- (iii) phase-out old technologies e.g. electric hot-water, CFL light bulbs. Public investment should take place in infrastructure and R & D in renewable energy technologies.

There is a growing momentum for green jobs, particularly as a component of mitigation response. The possibility of ‘jobless growth’ (i.e. improving energy efficiency, but ‘losing’ jobs) needs to be prevented. Green jobs development strategy may consist in the following:

- (i) The pursuit of a sustainable, low carbon, low waste economy will contribute strongly to meeting Government targets for sustainable development and environment.
- (ii) This will stimulate the growth of the supply of what is often known as “Environmental Goods and Services” or “Environmental Industries”, but increasingly referred to as “Green Jobs” or “Green Collar Workers”.
- (iii) One may identify “Environmental Management” as a “core enabling sector”.

The green jobs strategy provides us with an opportunity to respond to the twin challenges of climate change and the credit crunch. It will be a critical element in the transition of Bangladesh to a sustainable nation. The current economic environment presents a unique opportunity for all employers to change their working practices, taking not only the environmental and energy sectors into the future, but also presenting an opportunity for all employers to future-proof themselves, making all jobs ‘green jobs’.

Bangladesh, along with many of its development partners already has some tools already in place that can assist employers, providing a high quality of consistent training, grants, loans and advice. One may propose the ‘integration’ of these as a coherent network, as well as some new initiatives to fill the gaps. It is also necessary to look closely at the ways that government makes financial and policy decisions and set about changing these to provide a stronger market in Bangladesh for the green sector.

Renewable energy industries are more labour intensive than the traditional energy sector. Energy efficiency measures need to be closely linked to all the sectors. There is also an opportunity to invest in packages to stimulate the economy to ensure that actions contain incentives and checks for greening the economy. Opportunities will arise to integrate activities designed to assist the economy with those designed to assist in the transition to a low carbon, low waste economy. This strategy will set the long-term vision and values, and direction of travel. Bangladesh should continue to set emissions reduction targets with invigorated environmental management and stimulate demands for the goods and services provided by the environmental management sector.

The transition to a sustainable (low carbon/low waste) economy will have impacts on all jobs. There will be the threat of job losses, as patterns of consumption change and new legislation outlaws old products. It will be necessary to act to minimize these losses. It will be needed to provide support for businesses in Bangladesh to help them capture green opportunities for Bangladesh.

There will be a transformation in the whole economy of Bangladesh affecting all jobs. All businesses will need to take action to increase their resource efficiency, improve their process efficiency, develop new products fit for the future, and identify opportunities to diversify. The opportunities will arise across all sectors, as all jobs become greener.

Public sector investment in the environmental sector is a means to create green jobs. Energy efficiency may be a priority. This would work in two ways: firstly creating local jobs by stimulating expenditure on a range of specific greening measures, particularly energy efficiency and waste management, and secondly by ensuring that infrastructure and other measures in the plan have greening and adaptation measures fully designed in, which also in turn adds to job creation.

Environmental management is a core enabling factor. Role of the environmental sector is not an end in itself, but it supports and enables the overall greening agenda. Much of the job potential will be indirect within other sectors. Green Jobs are not just in the environmental sector, but as a supply chain it is also found in other sectors, especially manufacturing. The outcomes of the environmental sector will be downstream, and accrue to businesses in the mainstream economy in meeting compliance, efficiency improvements, reducing carbon footprint, etc, and to government in terms of meeting policy objectives on energy, waste, housing standards, sustainable regeneration, etc. These environmental/green jobs cannot just be pursued in isolation from the rest of the economy; it is effectively a supply sector serving the overall transition to a sustainable economy. The vision of the future dictates that this will happen, but it is necessary to reap added value from the transformation.

Skilled people are a fundamentally necessary part of any economic and employment growth strategy, and re-establishing the linkages between learning and working is a condition for growth. The success of the skills development strategy for green depends on the active participation and commitment of all the stakeholders. There is a need to build an effective partnership in this critical venture.

5.2 Recommendations for education and training

The overall vision should be an integrated national skills development system which promotes economic and employment growth and social development through a focus on education, training and employment services. The skills development strategy should constitute an integral part of the government's commitment to overall HRD which includes education reform and the transformation of health and welfare services. The core strategy should be to create an enabling environment for expanded strategic investment in skills development for green jobs.

Existing TVET system needs to be recast in the light of environment-driven curriculum and courses and more effective PPP in the formulation and implementation of the training programmes targeted towards establishing and improving the skill base for green jobs. Curriculum for greening the economy should be incorporated in the education and training programmes down from the primary level.

Systemic and institutional arrangements should be put in place for early implementation of the skills needs for green jobs in various sectors as reported in Section 4.2.1 and for the transfer of the findings into the occupational profiles, curriculum design and education and training provision for greening existing occupations and for developing emerging and new green occupations. Best skills policy can aim for is “islands of excellence” amidst skill gaps/shortages.

NSDC, in collaboration with BMET, DTE, BTEB, MLE, DOE, DOF, MEF, Ministry of Education, IDCOL, NGOs, employers and workers associations, should play the central role in the formation and development of skills for green jobs in Bangladesh. Proposed SEDA as a focal point for development and promotion of sustainable energy should be put in place to steer the country towards a cleaner environment.

The organizations involved in skills response primarily include RREL, Waste Concern, GS, REB, IDCOL and BCSIR. They are effective on a limited scale primarily due to their informal

training arrangements. In order to meet the challenges of greening the economy, formal training institutions and programmes may be put in place. For all practical purposes, the main channels of current and future response in skills provision should be TVET, CVT and PPP training measures within active labour market policy implementation, on-the-job training or other forms of training supported by the enterprises.

There is enormous potential for future training in greening the economy. In order to meet this challenge, there is a crucial need for a clear policy on skill formation and development for greening the economy which would embody strategic interventions for improving the existing education and training capacity to meet the skill needs for green jobs adequately. Simultaneously, feed-back mechanisms between business and the education and training systems should be put in place.

5.3 Recommendations for further research and data collection

Bangladesh should develop information and technological knowledge base and conduct research on GHG emission to combat the impacts of climate change and search for suitable strategies to cope with the changing environment and the changing requirement for HRD.

In order to improve upon the ongoing policies and programmes relating to greening HRD, further research and regular data collection should be undertaken with a view to updating knowledge and monitoring progress in greening the economy. To this end, there is a need for capacity building in research for greening the economy and skill development for green jobs.

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Annex 1. List of key resource persons (interviewees, participants in the focus groups, expert panels etc.)

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1. Dr. M S Islam	Head, DICD	Grameen Shakti Grameen Bank Bhaban (19 th floor) Mirpur-2, Dhaka-1216
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3. Dr. Mahmudul Karim		Bangladesh Shrimp & Fish Foundation
4. Dipal Chandra Barua	Managing Director	Grameen Shakti
5. Munawar Misbah Moin	Managing Director	Rahimafrooz Renewable Energy Ltd., Rahimafrooz Corporate Office, Gulshan-1
6. Nazmun Nahar	Marketing Executive	Rahimafrooz Renewable Energy Ltd., 260/B Tejgaon I/A (Beside Nabisco)
7. Md. Nurul Islam	Manager, Human Resources	Rahimafrooz Renewable Energy Ltd., 260/B Tejgaon I/A (Beside Nabisco)
8. Prof. Ainun Nishat	Professor	BUET
9. Kamran T. Rahman	President	Bangladesh Employers' Federation, Chamber Building, 122-124 Motijheel C/A, Dhaka-1000
10. Farooq Ahmed	Secretary General	Bangladesh Employers' Federation, Chamber Building, 122-124 Motijheel C/A, Dhaka-1000
11. A.H. Md. Maqsood Sinha	Executive Director	Waste Concern House-21 (Side B) Road-7, Block-G Banani Model Town Dhaka-1213
12. Iftekhar Enayetullah	Director	Waste Concern House-21 (Side B) Road-7, Block-G Banani Model Town Dhaka-1213
13. Moushumi Ahmed	Program Officer	Waste Concern House-21 (Side B) Road-7, Block-G Banani Model Town Dhaka-1213
14. Dr. Fazle Rabbi Sadeque Ahmed	Director (Technical)	Department of Environment E-16 Agargaon, Dhaka-1207
15. Md. Billal Hossain	Director (Admin & Dev)	Department of Environment E-16 Agargaon, Dhaka-1207
16. Islam Sharif	CEO	Infrastructure Development Company Limited (IDCOL) Bashundhara City
17. Md Shah Alam	Supervisor	Progoti Leather Complex Limited, Hazaribag, Dhaka.
18. Md Ali Akbar	Machine Operator	Aziz Tannery, 150 Hazaribag, Dhaka
19. Mr Kabir Ahmed	BSC Engineer (Mechanical, DUET) Assistant Manager (Workshop)	Navan CNG Limited, Kollanpur, Dhaka
20. Dr. Nizamuddin Ahmed	Professor	Department of Architecture Bangladesh University of Engineering and Technology(BUET)
21. Md. Abdus Sattar	Assistant Manager	Assistant Manager, Sohag CNG, Malibag, Dhaka
22. Dr. Md. Fazlul Karim	Professor	44-50, Hazaribagh, Dhaka-1209, Bangladesh
23. Md Ruhul Amin	Manager	Khokan Bricks, Amin Bazaar, Dhaka
24. Md Harun ur Rashid	Manager	New Mohiudding and Hanif Bricks, Amin Bazaar, Dhaka
25. Md Khalilur Rahman	Manager	Akota Bricks, Gabtoli, Dhaka

Name	Position	Organization
26. M A Gofran	Biogas Consultant	Grameen Shakti Grameen Bank Bhaban (19 th floor) Mirpur-2, Dhaka-1216
27. S.M. Formanul Islam	Director (Legal) and Company Secretary	Infrastructure Development Company Limited (IDCOL)
28. Mr. Shafiqur Rahman Majumder	President	Jatiya Sramik Federation 76/1/Q North Jatrabari, ((Bibir Bagicha))
29. Mr. Jalal Ahmed	General Secretary	Jatiya Sramik Federation 76/1/Q North Jatrabari, ((Bibir Bagicha))
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45. Dr. Shahidul I. Khan	Director	Centre for Energy Studies, Bangladesh University of Engineering and Technology, Dhaka-1000.

Annex 2. Organizations involved in the development of solar energy in Bangladesh

1. Local Government Engineering Department

- **Name of Project / Title:** Sustainable Rural Energy
- **Source of Funding/Donor:** UNDP
- **Year of Installation:** From 1998 to 2006
- **Type of Installation:** Centralized AC system for marketplace, coastal communities, biodiversity research laboratory, standalone solar system for rural clinics, tourist resorts, local govt. office, tribal temple and households, IT facility in remote LGED office, solar PV pumping, solar home lighting system, LED lanterns, etc.
- **Total System Capacity:** 40.5 kWp
- **Total Project cost (US\$):** US\$1.99 million
- **Number of Beneficiaries/ Buyers:** 4,500 direct and about 50,000 indirect beneficiaries
- **Objectives:** Demonstration and technology transfer in the field of renewable energy in Bangladesh
- **Key output:** Community-based diversified demonstrations of solar energy (PV) technologies have been successfully completed on the basis of available resource in the off-grid areas. Replication potentials have been observed from diversified applications

2. Bangladesh Power Development Board (BPDB)

- **Name of Project / Title:** Renewable Energy Development & Energy Efficiency Measure of BPDB.
- **Type of Installation:** SHS, Solar Vaccination, Solar water pump, Solar Street light, Centralized Solar PV Power Plant
- **Total System Capacity:** 123.55kWp (1.23 MW)
- **Project amount/Installation cost (US\$):** US\$ 4.0 million
- **Number of Beneficiaries/ Buyers:** 625,000
- **Objectives:** Provide PV electricity at remote off-grid Chittagong Hill areas of Bangladesh
- **Key output:** PV system provided to 2,344 rural households under Phase – II at Juraichari Upazilla Sadar, Bonjogichara, Moidong, Dumduma Union, Shijak College of Baghachari Upazilla under Bandarban District and 600 SHS under Phase – III at Thachi Upazila, Bandarban District

3. Rural Electrification Board (REB)

- **Name of Project / Title:** Diffusion of Renewable Energy Technologies/ Rural Electrification Through Solar Energy
- **Source of Funding / Donors:** World Bank, GEF, GTZ, French Grant
- **Year of Installation:** Started From 1993
- **Type of Installation:** Solar Home System (SHS) Sys#1 = 36wp to 40wp, Sys#2 = 50wp , Sys#3 = 72wp to 80wp, Sys#4 = 100wp
- **Total System Capacity:** 233.095 Kw (0.233 Mw) by June 2007
- **Number of Beneficiaries/ Buyers:** Solar electricity provided to 4220 rural by June 2007
- **Objectives:** Diffusion of Renewable Energy Technologies, Rural Electrification through solar energy
- **Key output:** Solar PV electricity provided to the remote and isolated areas of the country Austogram thana of Kishoreganj district, Singra thana of Natore district, Kotalipara thana of Gopalganj district and among the islands Moheshkhali, Kutubdia, Sandip, St. Martin etc. But in implementing the project the location included areas of Kishoreganj, Jamalpur, Narayanganj, Manikganj, Barisal-2, Patuakhali, Bagerhat, Kustia, Magura, Sathkhira, Natore-1, & Nababganj PBS. Serajganj PBS, Natore

PBS-2, Pabna PBS-2, Barisal PBS-1, Cox's Bazaar and Sunamganj PBS. Battery Charging Station based and Stand Alone System) including Health Centre, bazaar and sports club etc

4. Infrastructure Development Company Limited (IDCOL)

- **Name of Project / Title:** Rural Electrification and Renewable Energy Development Project (REREDP)
- **Partner Organizations at Field Level (Implemented the programme):** Grameen Shakti , BRAC Foundation, SRIZONY, COAST, TMSS, CMES, IDF, Shubashati, UBOMUS, BRIDGE, RSF, PDBF, PMUK, HF, Mukti, Others.
- **Source of Funding / Donors:** World Bank, GEF, GTZ, KfW
- **Year of Installation:** Started from 2003
- **Type of Installation:** Over 260,000 households brought under SHS (**Nov. 2008**). IDCOL has revised the target of Solar Home System Installation Programme to 240,000 worth of 7.4 MW-peaks, which it plans to achieve over an approximate period of four years [Sep. 2005-Dec. 2009].
- **Total System Capacity:**
- **Project amount/Installation cost (US\$):** US\$62 million
- **Number of Beneficiaries/ Buyers:** 625,000
- **Objectives:** To fulfill basic electricity requirements in the rural areas of Bangladesh and supplement government's vision of electrifying the whole of Bangladesh by the year 2020
- **Key output:** 200,000 rural households (by 2009) will have electricity access through renewable energy, pollution free electricity generation, employment generation to Partner Organizations, positive impact on socio-economic condition of rural people. Promotion of indigenous technology.

5. Grameen Shakti (GS)

- **Name of Project / Title:** Promotion, Development and Extension of Renewable Energy Technologies
- **Source of Funding / Donors:** IDCOL (World Bank, GEF, GTZ, KfW)
- **Year of Installation:** Started from 1996
- **Type of Installation:** SHS
- **Total System Capacity:** SHS installed 95,546 (Sep. 2007)
- **Number of Beneficiaries/ Buyers:** 600,000 beneficiaries
- **Objectives:** In order to see a poverty free world, energy security for all must be ensured. As the conventional sources of energy are limited and cannot meet the increasing need of the common people, wide dissemination of renewable energy technologies is the only way out. The experience of Grameen Shakti may be effective. If proposal come from other parts of the world, GS is ready to extend their hands of cooperation.

6. BRAC Foundation

- **Name of Project / Title:** BRAC Solar Energy Program for Sustainable Development
- **Source of Funding / Donors:** IDCOL (World Bank, GEF, GTZ, KfW)
- **Year of Installation:** Stated Dec. 1997
- **Type of Installation:** SHS, LED Lanterns, Hot Box cookers
- **Total System Capacity:** SHS installed 30,675 (Oct. 2007)
- **Number of Beneficiaries/ Buyers:** 26,600 Beneficiaries/ Buyers
- **Objectives:** To provide electricity in rural off-grid areas

7. Rural Services Foundation

- **Source of Funding / Donors:** IDCOL (World Bank, GEF, GTZ, KfW)
- **Year of Installation:** Stated from 2006
- **Type of Installation:** SHS

- **Total System Capacity:** 7269 SHS till 31 Aug. 2007
- **Objectives:** Dissemination of Renewable Energy Technology (RET)

Annex 3. Emissions of greenhouse gases from the brickfields (4,000) of Bangladesh due to the use of wood fuel and fossil fuel including coal and crude oil in 2000

Categories of fuel	Mean and total Observation	Fuel used (t)	Carbon released (t C)	CO2 (t CO2)	CH4 (t CH4)	CO (t CO)	N2O (t N2O)	NOx (t NOx)	NO (t NO)
Non fossil fuel (wood fuel)	Mean of Observation	317.42	142.84	523.75	2.29	20	0.02	0.57	0.37
	Total from 4,000 B.F.*	1,269,680	571,360	2,095,000	9,160	80,000	80	2,280	1,480
Fossil fuel (Coal)	Mean of Observation	426.67	215.76	791.11	3.45	30.21	0.02	0.86	0.56
	Total from 4,000 B.F.	1,706,680	863,040	3,164,440	13,800	120,840	80	3,440	2,240
Fossil fuel (Crude oil)	Mean of Observation	12.3	10.23	37.51	0.16	1.43	0.001	0.04	0.03
	Total from 4,000 B.F.	49,200	40,920	150,040	640	5,720	4	160	120
Grand total	Total emissions from 4,000 B.F. considering all categories of fuel		1,475,320	5,409,480	23,600	206,560	164	5,880	3,840

* B.F. = Brickfields

Source: Calculated following the estimation of Miah and Alam (2000).