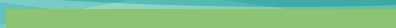




International
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Skills for Green Jobs in Bangladesh



Canada



Skills for Green Jobs in **Bangladesh**

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Skills for Green Jobs in Bangladesh

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Abbreviations and Acronyms

ADB	Asian Development Bank
ALGAS	Asia Least Cost Gas Abatement Strategy
AQI	Air Quality Index
AQMP	Air Quality Management Project
BAB	Bangladesh Accreditation Board
BADC	Bangladesh Agriculture Development Corporation
BBMOA	Bangladesh Brick Manufacturers Owners' Association
BBS	Bangladesh Bureau of Statistics
BCAS	Bangladesh Centre for Advanced Studies
BCCRF	Bangladesh Climate Change Resilience Fund
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BCLT	Bangladesh College of Leather Technology
BCSIR	Bangladesh Council of Scientific and Industrial Research
BDT	Bangladesh Taka
BERC	Bangladesh Energy Regulatory Commission
BGBA	Bangladesh Green Building Academy
BGEF	Bright Green Energy Foundation
BGMEA	Bangladesh Garment Manufacturers and Exporters Association
BKMEA	Bangladesh Knitwear Manufacturers & Exporters Association
BMET	Bureau of Manpower, Employment and Training
BOD	Biochemical Oxygen Demand
BPDB	Bangladesh Power Development Board
BRTA	Bangladesh Road Transport Authority
BSES	Bangladesh Solar Energy Society
BTA	Bangladesh Tanners Association
BTCL	Bangladesh Telecommunication Company Limited
BTEB	Bangladesh Technical Education Board
BUET	Bangladesh University of Engineering and Technology
BWDB	Bangladesh Water Development Board
CBOs	Community Based Organizations
CCCP	Community Climate Change Project
CDM	Clean Development Mechanism
CER	Carbon Emission Reduction
CERs	Certified Emission Reductions
CES	Centre for Energy Studies
CETP	Central Effluent Treatment Plant
CFL	Compact Fluorescent

CNG	Compressed Natural Gas
CO₂	Carbon dioxide
CPP	Coordination, Communication and Cooperation
CSP	Concentrating Thermal Power
CSWC	Community Seed Wealth Centre
CVT	Continuing Vocational Education
DCC	Dhaka City Corporation
DG	Director General
DMC	Disaster Management Committee
DNA	Designated National Authority
DNCC	Dhaka North City Corporation
DO	Dissolved Oxygen
DOE	Department of Environment
DOF	Department of Forest
DM	Disaster Management
DRR	Disaster Risk Reduction
DSCC	Dhaka South City Corporation
DTE	Department of Technical Education
DWCP	Decent Work Country Programme
EAP	Ecological Agriculture Program
ECA	Environmental Conservation Act
ECAMA	Ecologically Critical Area Management Act
ECAs	Ecologically Critical Areas
ECR	Environmental Conservation Rules
ECNEC	Executive Committee of the National Economic Council
EMS	Environmental Management System
EPZs	Export Processing Zones
ERPA	Emissions Reduction Purchase Agreements
ETP	Effluent Treatment Plant
FCKs	Fixed Chimney Kilns
GDP	Gross Domestic Product
GEF	Global Environment Facility
Gg	Gigagrams
GGEI	Global Green Economy Index
GHG	Greenhouse Gas
GIS	Geographic Information System
GNI	Gross National Income
GOs	Governmental Organizations
GOB	Government of Bangladesh
GP	Graminphone

GS	Grameen Shakti
GTCs	Grameen Technology Centers
GTZ	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
IDCOL	Infrastructure Development Company Limited
IDMCC	Inter-Ministerial Disaster Management Coordination Committee
IFOAM	International Federation of Organic Agriculture Movements-Organics International
IIDFC	Industrial and Infrastructure Development Finance Company Limited
IPS	Instant Power Services
IUCN	International Union for Conservation of Nature and Natural Resources
LFS	Labour Force Survey
LGED	Local Government Engineering Department
LMI	Labour market information
LPG	Liquefied petroleum gas
mcm	Micrograms per cubic meter
MDGs	Millennium Development Goals
MDMR	Ministry of Disaster Management and Relief
MEF	Ministry of Environment and Forests
MEMR	Ministry of Energy and Mineral Resources
MLE	Ministry of Labour and Employment
MTOE	Million ton oil equivalent
NAPA	National Adaptation Programme of Action
NCSA	National Capacity Self-Assessment for Global Management
NEP	National Environment Policy
NEMAP	National Environmental Management Action Plan
NGOs	Nongovernmental organizations
NGV	Natural Gas Vehicle
NIP	National Industrial Policy
NPDM	National Plan for Disaster Management
NSDC	National Skills Development Council
OE	Oil equivalent
PJ	Pico-Joule
PM	Particulate Matter
PMO	Prime Minister's Office
PPM	Part per Million

PPP	Public-Private Partnership
PV	Photovoltaic
R&D	Research and Development
RE	Renewable energy
REB	Rural Electrification Board
RERC	Renewable Energy Research Centre
REREDP	Rural Electrification and Renewable Energy Development Project
RET	Renewable Energy Technology
RMG	Readymade garments
RPGCL	Rupantarita Prakritik Gas Company Limited
RREL	Rahimafrooz Renewable Energy Limited
SDGs	Sustainable Development Goals
7thFYP	Seventh Five Year Plan
SHS	Solar home system
SIS	Solar Irrigation System
SFU	Sustainable Financial Units
SFYP	Sixth Five Year Plan
SMEs	Small and medium enterprises
SRE	Sustainable Rural Energy Project of LGED
SREDA	Sustainable and Renewable Energy Development Authority
TOT	Training of Trainers
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
WASA	Water and Sewerage Authority
WRI	World Risk Index

Abstract

The main greening shifts in the economy and the labour market of Bangladesh have taken place predominantly in renewable energy – most prominently in solar photovoltaic energy followed by biogas, but only rather weakly in materials management, telecommunication, transport, and manufacture of bricks and ready-made garments (RMG). The shifts in the sectors other than renewable energy remain weak, owing primarily to inadequate policy and institutional support. Available evidence shows that green jobs in solar energy steadily increased by 18.5% annually from 60,000 in 2011 to 140,000 in 2016, compared to 1.9% nationally. Bangladesh has embarked on a large number of legal acts, policies and programmes for adaptation to climate change and mitigation of its adverse impact, but it has no national policy for the formation and development of skills for greening the economy. In all the sectors including renewable energy, skills response remains informal, essentially provided by NGOs. National skills development objectives and targets do not match national environmental objectives and targets; and existing national skills development policies, programmes and strategies have no correspondence with national climate change policies, programmes or strategies. They are mutually exclusive. This works to the detriment of a smooth transition of the economy to a greener growth path.

A coherent national 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 implementation of the skills needs for green jobs in various sectors with priority to renewable energy, RMG, waste management and brick manufacture as identified by the present study; 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 promote strategic interventions for overcoming the skills gaps. The existing TVET system needs to be made environment-friendly. Further research and regular data collection on green jobs, especially by the Bangladesh Bureau of Statistics (BBS) in its periodic Labour Force Survey (LFS), should be undertaken with a view to updating knowledge and progress in greening the economy.

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Executive summary

The major challenge of the labour market in Bangladesh is that the economy needs to grow progressively in line with the 7th Five-Year Plan (FYP) target of raising the average annual growth rate to 7.4 per cent from its current 6 per cent in order to absorb all the additional labour force, including many of the underemployed, in about 15 years (by 2030). According to the 7th FYP, this growth will be inclusive, pro-poor, and environmentally sustainable. The economy needs to attain job-rich growth, with high employment growth being achieved along with high output growth. This is a great challenge because of the recent experiences of (i) manufacturing, in which employment growth has exceeded output growth, and (ii) construction, in which employment growth has been negative despite positive output growth. This requires a genuine structural transformation of the economy through much more diversified growth in general, and manufacturing in particular. A major challenge is to raise labour productivity and wages in manufacturing. Separate strategies are needed for both the employed and the self-employed.

This updated research report attempts to identify strategic skills development responses for Bangladesh in the light of environmental degradation, climate change and the global call for greening economies. It confirms 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 threat from environmental degradation. But the policy priorities for greening the economy remain limited. General environmental strategy and, for that matter, skills development strategies for greening the economy, are inadequate.

The main greening shifts in the economy and the labour market of Bangladesh have taken place strongly in renewable energy – most prominently in solar photovoltaic energy followed by biogas energy, but rather weakly in materials management, telecommunications, transport and manufacturing (brick-making and RMG). Available evidence shows that green jobs in solar energy have steadily increased by 18.5 per cent annually from 60,000 in 2011 to 140,000 in 2016, compared

to 1.9 per cent for the overall economy. Greening shifts in other sectors remain weak primarily due to inadequate policy and institutional support. With the right policies, institutional framework, commitment, and immediate reinvestment in place, it is possible to bring about the change needed for greening the economy.

There is a pressing need to ensure that the growth of the RMG sector does not come about at the expense of environmental degradation and inefficient use of resources. In the RMG sector priority should be given to energy efficiency, waste water treatment and green renewable technologies. Experience shows that investing in green technology is good not only in terms of reducing costs, but also in terms of acquiring more international customers. There is growing pressure from the international fashion brands and buying houses on greening the RMG industry; some of the brands already have a strategy to move towards greater sustainability, such as H&M who have just launched their strategy for 100 per cent circularity. This includes favouring factories that invest in energy efficiency, reduction and recycling of water, renewable energy and other green technologies. An energy audit finds that potential savings in the utility area of the RMG industry are of the order of 67,000-110,000 GWh/yearly.

The structural transformation taking place in Bangladesh is derived not merely from economic growth but also from autonomous green investment. However, current and future employment shifts and trends are likely to take place as a result of existing and anticipated green structural change, notably in renewable energy, telecommunications and manufacturing (brick-making and RMG). A green employment shift to renewable energy with huge potential for growth is gaining momentum. Change is anticipated through green structural change, especially in energy efficiency, manufacturing, waste management, construction, transport, telecommunications 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 for overcoming existing skills gaps in different occupations remains 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 a number of 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. The objectives and targets of the 2011 National Skills Development Policy do not reflect national environmental objectives and targets.

The skills response to meet the challenge of green economic restructuring remains limited. There are no active labour market policy measures and planning for initial and continuing training. On the whole, across sectors and occupations more attention has been given to greening higher-skilled than lower-skilled education.

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 the weak delivery mechanisms of these institutions. Skills shortage is prominent among agricultural workers, sustainable agriculture specialists and precision soil conservation technicians in agriculture; among graders, scalemen, de-heading workers and machine operators in shrimp cultivation; among hazardous waste management specialists, solid waste (energy) specialists and sustainable design specialists in waste management; among carbon credit traders, carbon trading analysts and investment underwriters in carbon trading; among solar energy installation managers, solar PV installers and technicians in solar energy; among CNG engineers and technicians in fuel-efficient transport; among masons in green construction; among supervisors and machine operators in tanning; and among brick-making technologists and supply chain managers in brick manufacture.

A coherent national policy for the formation and development of skills for green jobs should be formulated and put in place within the overall framework for human resource development

(HRD). For greening the economy, labour market information (LMI) and analysis is essential for identifying skills needs and gaps, but systematic LMI on green jobs is not available in Bangladesh. National policy should target the establishment of a LMI database and implementation of programmes for meeting existing skills needs for green jobs in various sectors. For the present, the proposed National Skills Development Policy for Green Jobs can target 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 skills gaps for green jobs.

Existing education and training policies have inadequate provision 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. The existing TVET system has virtually no environment-friendly curricula or courses targeted on establishing and improving the skills base for green jobs. Curricula for greening the economy should be incorporated in the existing education and training programmes from primary level onwards.

The National Skills Development Council (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. Newly-established SREDA as a focal point for development and promotion of sustainable and renewable energy was put in place in 2014 to steer the country towards a cleaner environment.

Bangladesh should develop LMI and a technological knowledge base for green jobs. In order to improve on the ongoing policies and programmes relating to greening of HRD, further research and regular data collection on green jobs, especially by BBS in its periodic Labour Force Survey, should be undertaken with a view to updating knowledge and progress in greening the economy.

1. Introduction

The objective of the present exercise is to update the Bangladesh country background study on the developments that occurred after 2009/10 and on any planned in the near future. The tasks of the assignment are as follows:

- identify major challenges and priorities related to climate change (as defined in Nationally Determined Contributions – NDCs) and the subsequent greening policies and strategies;
- identify major sectors with a greening potential in the country and those particularly affected by green stimulus packages and programmes;
- analyse whether and how skills response strategies are incorporated into wider 'greening' policies and programmes;
- analyse skills needs for new occupations, new skills for greening existing occupations and retraining needs in sectors undergoing structural changes as a result of policy implementation and introduction of greening technologies and practices;
- identify which methods and tools, systems and institutional frameworks for skills anticipation and assessment are in use to ensure that skills provision corresponds to current and future labour market demand for workers in transition to a greener economy, both quantitatively and qualitatively and at different levels, i.e. national, sectoral, regional, company, training provider;
- analyse how the skills response is organised to meet the challenge of greening the economy effectively, paying specific attention to planning initial and continuing training, institutional frameworks, systemic provisions, delivery channels, *ad hoc versus* anticipated skills responses, and skills response by different actors and providers; *and*
- draw conclusions and policy recommendations for skills policies and strategies, skills provision at national, sectoral, local or enterprise level and further research needs to meet the demand for greening the economy in the country.

The updated Bangladesh study is essentially based on secondary information and interviews. It combines qualitative and quantitative research depending on data availability. Wherever secondary information was not available, interviews and inputs from key informants in the respective sectors as well as from experts were sought to fill the information gap. However it did not attempt collection of primary data. Quantitative analysis is based on and limited to the available national and international statistics on current and expected employment trends in greening economic activities.

A quantified estimate of green sectors, green occupations and of trends in demand for green jobs and skills are analyzed in conjunction with information on the supply of available skills and the system's capacity to meet the demand in the wider 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 helped generate information on the current and expected demand for skills, areas of workforce shortages and skill gaps, and strategies and implementation channels for meeting the demand. Personal interviews included relevant and representative trade unions and employers' associations, policy-makers at different levels, human resource development (HRD) 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 implementation of the greening policy agenda of Bangladesh. The selection of interviewees and other resource persons primarily targeted economic sectors with the most extensive greening potential for the economy. Information gaps that remain are clearly indicated and examined to draw

conclusions and recommendations for further research and data collection.

The analytical framework of the present study consists of 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 skills set: those skills which are generic and therefore tend to apply across a range of different occupational groups; and those which are technical or vocational in that they are specific to the work within an occupation. Generic skills encompass leadership, communication, team-work, problem-solving and associated skills. Vocational skills tend to encompass work in a given occupation or job-specific skills. In addition, many employers look for particular individual characteristics in recruits such as motivation, judgment, leadership skills and so on. Leadership skills are important generic skills, especially in the context of green jobs because they are instrumental in green jobs initiatives. Many of the latter are considered to be innate skills. The key issue is to examine the extent to which this translates into fulfilling future skills 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 systems 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 across sectors in the context of greening the overall economy. A sample of 42 key informants and experts from all the broad economic sectors (representing the key ILO constituents, particularly the Ministry of Labour and Employment (MLE), the 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 purposely selected for interview with a predesigned checklist to represent a mix of

experts from different sectors. The checklist followed new and emerging green occupations as classified by economic sector in Dierdorff et al. (2009). These economic sectors include, but are not limited to, energy, manufacturing, transport, materials management, construction, agriculture and forestry. Personal interviews with the representatives of the employers, workers and the MLE were conducted with on-site research for the case studies at enterprise level.

The analysis of strategic skills needs and skills development responses includes eight in-depth case studies in line with the baseline study (Mondal et al, 2010). The added value of the case studies was manifested in new findings which helped in the drawing of 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 skills 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 new changes occurring in the labour market, the following eight case studies were undertaken (Table 1).

Table 1. Case studies

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 – some jobs are eliminated.	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 – new jobs are created.	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) – some jobs are substituted.	6: Architects, Civil Engineers, Designers and Masons in Greening Buildings
	7: Supervisors and Machine Operators in Tannery
	8: Brickfield Managers in Brick Manufacturing

2. Policy context

2.1 Key challenges and priorities for the green economy

Bangladesh is one of the most vulnerable countries in the world to the impacts of climate change despite its insignificant greenhouse gas (GHG) emission at an average of 0.4 metric tons *per capita* against the sustainable average emission of 2 (BB, 2014). 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 threat from environmental degradation taking place in the forms of soil erosion, deforestation, increased water salinity and water body pollution. Bangladesh aims to develop from a low-income economy to the first stages of a middle-income economy by 2021. However 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 as an effective response to these challenges.

Bangladesh emitted 190 million metric tons of carbon (MtCO₂e) in 2012, with agriculture and industry contributing nearly 40 per cent to overall emissions. Bangladesh's emissions increased 59 per cent from 1990 to 2012, with an annual average increase of two per cent. The Bangladesh Climate Change Strategy and Action Plan (BCCSAP), modified in 2014, identified the transportation sector, especially road transport, as a priority sector for improvement since its share of carbon emissions is growing faster than that of any other sector, even though agriculture is the leading emitter of greenhouse gases primarily due to rice production, enteric fermentation, manure and poultry litter management (USAID, 2016). CO₂ emissions in Bangladesh were reported at 0.44 metric tons *per capita* in 2013, according to the World Bank's collection of development indicators, compiled

from officially-recognized sources. Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.

In Bangladesh massive deforestation is occurring at an alarming pace and is changing climate and geography with a substantial contribution to global warming; the burning of forests to clear land releases tonnes 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 landslides occur.

Forest area in Bangladesh currently accounts for only 11 per cent of its total land area (2015) as against 11.5 per cent in 1990 (WB, 2016), primarily due to deforestation far exceeding afforestation. It is crucially important to arrest the deforestation trend in Bangladesh. Civil Society, NGOs and local communities should come forward and work closely with government agencies. Awareness-building education and training can play a pivotal role in this process.

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 skills development programmes in this sector.

Bangladesh is a deltaic land created and flushed by numerous rivers. It had 1,400-1,500 rivers in the 11th century, which were reduced to 700-800 due to various natural anthropogenic factors over time. At present no more than 400 rivers with numerous tributaries and distributaries exist in the country, of which 25 are already dead or moribund. Dozens of others are gradually drying up. Only around 100 rivers have adequate year-round navigable depth at present. The total

river route in the country in 1971 was 24,140 km, covering eight per cent of the country's area, now reduced to only 3,800 km during the lean flow period. There are three principal river systems in the country: (a) Barak-Meghna; (b) Brahmaputra-Jamuna; and (c) Ganga-Padma. Teesta is an important water-course for the country because it is the terminal tributary for the Brahmaputra. These systems and all other rivers carry an annual water load of about 1,074 billion cubic meters from upstream sources. Rainfall adds another 251 billion cubic meters of water volume. Around 150 billion cubic meters of water is required to be available in the riverbeds to maintain navigability (Matin, 2017).

Bangladesh is historically a country of riverine agro-economy. This small land is burdened with an increasing population. Over time agriculture is going to lose its position as the highest contributor to GDP. There has been a gradual shifting of its economy towards industrialisation and other drivers of economic prosperity. The country's population and eco-insensitive industrial development are now the major factors behind river degradation through grabbing or cordon structures as well as pollution of the rivers, viz:

- i) **Physical Degradation:** this is manifested by reduced flow, silting, erosion, and cordon structures and encroachment. Any exotic entity in river water is itself a polluter.
- ii) **Reduction of flows:** flow reduction becomes critical in 97 per cent of the rivers in the dry season (November to March). Causes of flow reduction include flow diversion and water withdrawal in the upstream region, mainly by India in all 54 rivers, and partly by China and Myanmar through damming or other obstructive or diversionary infrastructures. The Indian River Linking Project (IRLP) and Tipaimukh Dam will be last nails in the coffin. Dried-up water flows provoke more pollution interference in water content.
- iii) **Silt deposition:** prolonged silt deposition meanwhile destroyed 187 rivers (28 per cent of the total). The rivers of Bangladesh carry about 3.8 billion tonnes of silt every year and 40-45 million tonnes are deposited on the river beds. Many rivers have lost their depth and about 77 per cent of the river-mouths are silted. The silt deposit rate has increased in

574 rivers (86 per cent). Reduced water flows from upstream are a prominent causative factor in increased silting and consequent impacts such as river-bed elevation, reduced water-holding capacity and increased river-bank erosion.

- iv) **River Bank Erosion:** 41 per cent of rivers in Bangladesh suffer from erosion. During the rainy season erosion increases in some rivers owing to raised river-beds and reduced water-holding capacity that causes further erosion during the next monsoon.
- v) **Cordon Structures:** around 500 flood control, drainage and irrigation projects, undertaken over the last 60 years, have disconnected 35 million hectares of land from the rivers. Harmful structures such as regulators or sluice gates and cross dams were built on many rivers causing immense negative impacts. Cross dams and short-length bridges built in the name of development are now the main river-destroyers in the country. There is cause for worry in that the recent governmental initiative "Bangladesh Delta Plan 2100" is going to be the replica of the same problem.
- vi) **Encroachment:** 158 rivers lost their width from unauthorised encroachments and this process is quite unhindered owing to the strong socio-political links of a section of grabbers.
- vii) **Instrumental and organic dumping:** different abandoned parts of marine vehicles such as wooden boats, steamers, fishing-nets, boundaries used in dry seasons as fishing traps, plastics and other non-degradable items, household materials, rejected foods-fruits-vegetables and so forth are also causing further pollution.
- viii) **Untreated hospital wastes:** hospital waste and highly poisonous and infective materials are becoming mixed with water all over the country throughout the year, contributing to severe biological pollution of rivers and wetlands (Matin, *ibid.*). Reduced water quality, more sediment, narrowing, cordoning, diversions, dry-ups, commercialisation, so-called development projects, unplanned re-excavations, sluggish

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flows due to the reasons mentioned above, all accelerate pollution and induce the deaths of rivers.

Moreover about 11 per cent of the rivers in Bangladesh are polluted by industrial wastes (chemical contamination). Further increases are noted from agro-chemicals, marine vehicular discharges and wastes, and municipal and domestic wastes. According to government sources, rivers around Dhaka, namely the Buriganga, Shitalakshya, Turag, Balu, Bangshi and Dhaleswary, have earned notorious reputations due to very high levels of pollution from industrial wastes (60 per cent), and municipal and household drainage of toilet wastes (30 per cent). Especially during the winter season, all these rivers become absolutely filthy and poisonous; devoid of oxygen and aquatic biodiversity. The government seems quite incapable of or reluctant to make decisions requiring mandatory installation of effluent treatment plant (ETP) in industrial units.

Excreta play a significant role in polluting the rivers in Bangladesh. In spite of prolonged national drives, the country has yet to achieve a satisfactory sanitation management system. Rivers and canals are major disposal receptacles for human and animal excreta as well as dead animal bodies, especially by riverside inhabitants.

About 1.6 million tonnes of chemical fertilisers and 4-5 thousand tonnes of pesticides are used in agriculture every year. Although illegal worldwide, 9 out of 12 Persistent Organic Pollutants, also known as the dirty dozen, are also being used all over the country for agricultural and household purposes. They are smuggled-in items, harmful to human health. A huge proportion of these dangerous items is carried by rain-water and floods, contaminating rivers, wetlands, ponds, soil and finally entering the food chain, causing numerous deadly diseases including cancers. Besides, marine vehicular discharges (chemical contamination) results in obnoxious chemical pollution in river water and becomes deposited on river beds; the quantity is said to be 1.7-2.4 billion tonnes, giving rise to 35 million tonnes of silt deposits in the rivers every year (Matin, *ibid*).

In addition, all the plain land and hilly rivers are carrying huge amounts of waste from a large

stretch of India surrounding Bangladesh and part of Myanmar. The components include eroded river bank soil, peeled-off hill stones, boulders, construction materials from urban developmental projects and hydro-power plants and dam constructions, contaminated mountains and glaciers, run-off urban wastes, coal dust, gravel, suspected radioactive materials, and municipal wastes from Meghalaya, Assam, Tripura, West Bengal and areas bordering Myanmar. Bangladeshi rivers work as the gateway to enormous amounts of waste from the upstream region. This problem can only be solved through trans-boundary planning and cooperation.

Chemical pollutants of water also induce toxic impacts on all living entities, including human beings, *via* water, soil and even air. Common diseases from the polluted rivers include skin allergies and inflammations, gastroenteritis, typhoid and paratyphoid, liver diseases such as hepatitis, jaundice, and upper respiratory inflammations, and moreover any of these areas may develop into even deadlier cancers. The population around the river banks is, in a true sense, a permanently vulnerable society, with higher morbidity and mortality rates, prolonged sickness, reduced work capacity and burdened lives leading to more poverty.

In general we know that the Dhaka Water and Sewerage Authority (WASA) has a limited capacity for managing toilet discharges (around 30 per cent of the total) and the remainder goes into the rivers around Dhaka city through the WASA storm water drainage but without formal permission from the organisation. At the same time, the Dhaka City Corporation (DCC) has the capacity for disposing of 45 per cent of municipal waste. The rest remains lying in or around roadside bins, often finding their way back into households through footwear and increasing cyclical human family diseases. A notable amount flows into the rivers through roadside drains. Key informant sources reveal that 60 per cent of pollution is caused by industries, 30 per cent by WASA and DCC and the rest from elsewhere. By and large, rivers and water bodies in Bangladesh are the drainline – not the lifeline.

Extreme air pollution in some cities in the country has been creating serious health hazards.

Air becomes extremely unhealthy in some cities after the winter as the presence of pollutant particles in the air, even on a normal day, is 4-8 times as high as the safe limit. Higher amounts of harmful particles have been found in the air of Dhaka, Gazipur, Narayanganj, Chittagong and Barisal during the winter in different tests. According to Clean Air and Sustainable Environment Project (CASE, 2017), the monthly average concentration level of particulate matter (PM_{2.5} and PM₁₀) measured at different places was found to be 102-237 µg/m³ and 166-397 µg/m³ respectively during the month of January 2017. In Bangladesh, the Air Quality Index (AQI) is based on five pollutants — particulate matter (PM₁₀ and PM_{2.5}), nitrogen oxide, carbon monoxide, sulphur dioxide and ozone. The other levels in the AQI are moderate (51-100), needing caution (101-150), unhealthy (151-200), very unhealthy (201-300), and extremely unhealthy (301-500).

According to CASE data, on 18 January 2017 the air was extremely unhealthy in Dhaka (416 points in AQI), Narayanganj (821), Gazipur (440), Chittagong (312), Barisal (349) and Sylhet (237). The number of air pollution-related deaths has increased in Bangladesh, according to a report by the State of Global Air 2017 prepared by the US-based Health Effects Institute (HEI).

According to the World Health Organisation (WHO, 2017a; 2017b), environment pollution is killing some 280,000 children in Bangladesh annually. Outdoor pollution is very high in the cities because of construction work and large numbers of vehicles. Indoor pollution is also present because of use of fossil fuel for cooking. Although the role of brick kilns in environment pollution is known to all, the government has continued to allow them to operate around the city. Children are very vulnerable to different kinds of ailment because their immune system cannot cope with such pollution. The reports have outlined the damage caused to children as they are exposed to second-hand smoke when outdoors which is passed on to the children in the mother's womb as she is inhaling toxic air.

WHO ranked Bangladesh fourth among 91 countries with the worst urban air quality in its recent air pollution monitoring report. Three cities in the country, Dhaka, Gazipur and Narayanganj, were among the top 25 cities

with the highest air pollution. In the city-wise assessment, Narayanganj was rated 17th for air quality whereas Gazipur and Dhaka were ranked 21st and 23rd respectively. The report said that almost 90 per cent of people living in these cities were being exposed to dangerous levels of air pollution. Outdoor air pollution killed 3.7 million people in 2013 and the WHO said that it is now the world's largest single environmental health risk.

Environmental pollution has become a major health concern for the people of this country. The WHO report has already provided enough evidence that Bangladesh is an extremely polluted country. Air pollution in Bangladesh is caused mainly by vehicle emissions, industrial discharges and burning of fossil fuel. The ground-water resource of Bangladesh is becoming a major health hazard owing to arsenic and river water contamination due to inadequate solid waste and industrial effluent management.

As ground-water still remains the main source of drinking water for about 90 per cent of people of Bangladesh, one of the main problems facing the country is that consumption of arsenic on a daily basis reduces the productivity level of an individual. The WHO said some years ago that if contaminated water can be replaced with clean drinking water, a victim of arsenic poisoning can be brought back to good health. But the government is yet to take any fruitful action, leaving large number people at risk of dying from cancer of the liver, lung, kidney or bladder.

Dhaka city has earned the reputation of being the most unliveable city in the world. The city has all the characteristics of environmental pollution. The onslaught of sound in Dhaka has reached such epidemic proportions that it is posing a serious threat to the people living in the city. The range of noise pollution has been causing different types of public health hazard. Millions of people living in Dhaka city are being affected every year by continued exposure to the deafeningly noise leading to deafness or even heart ailments. Dhaka is now known as one of the noisiest and over-crowded cities in the world. Unplanned urbanisation, the noise of construction equipment, lack of public awareness, the increasing number of vehicles and indiscriminate use of horns are the major sources of intense sound pollution in Dhaka city.

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The environmental degradation coupled with climate change has been impacting heavily on the country's ecological system. Rivers are drying up, the frequency of floods and cyclones is increasing and major changes are evident in the country's overall temperature. Recently the country has passed through a hot spell of summer days and it has already experienced hot temperatures during the winter season. All these symptoms clearly point to the need for taking immediate measures to control environmental pollution.

Bangladesh's *per capita* energy consumption is very low at 222 kg in 2014 although it is steadily increasing over time. In contrast, combustible renewable and waste as a percentage of total energy steadily declined from 41.7 per cent in 2000 to 26.1 per cent in 2014. Table 2 provides some information on how the country's green economy is developing. Both energy production and energy use are growing at the same rate of 4.1 per cent annually. Carbon emission grows alarmingly at the rate of 6.6 per cent annually.

According to MDMR (2017), the main environmental hazards in Bangladesh are the following:

Flood: flood is an annual phenomenon generally affecting 30 per cent of the country, but up to 70 per cent in extreme years. Flood-related fatalities are decreasing, but economic losses have been increasing over the years. The government has been developing and implementing various measures to better equip the country to handle floods. Important initiatives include the flood action plan, flood hydrology study, flood management model study, national water management plan, national water policy, flood early warning study and construction of flood embankments and flood shelters. Flood damage potential is increasing owing to climate change, urbanization, growth of settlements in flood-prone areas and overreliance on flood control works such as levees and reservoirs.

Cyclone and surge, tornado: severe cyclones with storm surges sometimes in excess of ten metres frequently impact on Bangladesh's low-lying coast. The Government of Bangladesh (GOB) has a well-coordinated cyclone forecasting, early warning and evacuation system and the cyclone mortality rate has been reduced greatly

for any given category of cyclone. However, a growing and higher concentration of assets has resulted in increasing economic losses. Tornadoes are seasonal and occur in the pre-monsoon season. The frequency of tornadoes in Bangladesh is among the highest in the world.

Earthquake: Bangladesh is located in a tectonically-active region and some of the major cities including Dhaka, Chittagong and Sylhet are at risk of massive destruction by earthquakes from nearby seismic faults. To address this hazard the Bangladesh National Building Code (BNBC) was updated in 2015. Other initiatives include Urban Community Volunteers trained in search-and-rescue and first aid, training in safe construction for masons and construction workers, and school safety and evacuation drills. The Urban Development Directorate (UDD) is promoting risk-integrated land-use planning and updating of the existing policy for planned urbanization. Earthquakes pose one of the highest risks in Bangladesh, and the National Plan for Disaster Management (NPDMP) 2016-2020 has prioritized earthquake risk reduction as a key action plan.

Riverbank erosion: riverbank erosion is a common problem in Bangladesh due to the deltaic topography and it has been forcing people to migrate or resettle. Riverbank erosion renders millions homeless; the majority of slum dwellers in large urban and metropolitan towns and cities are victims of erosion. The major rivers such as the Jamuna, Ganges, Padma, Lower Meghna, Arial Khan and Teesta are highly erosion-prone. Structural interventions are costly and need to be complemented by non-structural measures, for example erosion prediction and warning.

Landslide: landslides have emerged as a major hazard, usually triggered by heavy rainfall in hilly areas (18 per cent of the total area of the country). Human settlements and activities on the slopes make landslides lethal. An online landslide early warning system has been developed for Chittagong city under the BUET-JIDPUS project. Community-based early warning has been piloted in the Cox's Bazar and Teknaf districts under GoB's Comprehensive Disaster Management Programme (CDMP).

Salinity intrusion: salinity intrusion is an increasing hazard in the coastal areas of

Table 2. Development of green economy in Bangladesh

INDICATORS	2000	2001	2002	2003	2006	2010	2014
Energy Production (kt of oil equivalent)	15,156	16,217	16,760	17,572	21,070	26,080	29,457
Energy use (kt of oil equivalent)	18,262	19,976	20,454	21,553	24,422	30,513	35,423
Energy use (kg of oil equivalent per capita)	138.8	148.9	149.7	155.03	168	200.6	222.22
Electric power consumption per capita (kwh)	101.5	111.7	119.3	125.46	190.9	239.8	310.39
Combustible renewable and waste (% of total energy)	41.7	38.85	38.64	37.31	34.41	28.83	26.1
Population (million)	131.58	134.11	136.6	139.02	145.37	152.15	162.9 (2016)
GDP (constant 2010 US billion \$)	67.01	70.42	73.12	76.58	91.59	115.28	167.8 (2016)
Waste Generation Rate(kg/cap/day)					0.5		
Particulate emission damage (% of GNI)	1.85	1.81	1.76	1.72	1.47	1.33	1.19 (2015)
CO2 emissions (kt)	27,869	32,457	33,707	35,673	43,542	59,992	68,951 (2013)
CO2 emissions (kg per 2010 US\$ of GDP)	0.42	0.46	0.46	0.47	0.48	0.52	0.50 (2013)
CO2 emissions (kg per 2011 PPP \$ of GDP)	0.13	0.14	0.14	0.14	0.15	0.16	0.15 (2013)
CO2 emissions (metric tons per capita)	0.21	0.24	0.25	0.26	0.3	0.39	0.44 (2013)
CO2 emissions growth (%)				5	8		6.6
CO2damage (% of GNI)	0.73	0.89	0.95	0.96	1.15	1.16	1.17 (2015)
Rate of deforestation (average annual%)	0.18						0.18 (2015)
Internal freshwater resources per capita (cu. M)			771		716		660 (2014)
Access to improved water source (% of total population)	76	77	78	78	81	84	86.9 (2015)
Energy depletion (% of GNI)					2.9		1.2 (2014)
Mineral depletion (% of GNI)					0		0.0 (2014)
Net forest depletion (% of GNI)					0.7		1.3 (2014)
PM10, country level (micrograms per cubic meter)	162	162	158	150	135	115	
GEF benefit index for biodiversity (0 for no biodiversity potentiality and 100 for maximum)				1.6	1.4		
Organic water pollutant (BOD) emissions (kg per day)				250976	303264		

Sources:

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

IEA: <http://www.iea.org/countries/non-membercountries/bangladesh/>

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

World Development Indicator, July 1, 2017

<http://wdi.worldbank.org/table/3.4>

http://data.un.org/Data.aspx?q=vietnam&d=WDI&f=Indicator_Code%3AER.H2O.INTR.PC%3BCountry_Code%3AVNM

http://www.econstats.com/wdi/wdiv_389.htm

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Bangladesh, posing a threat to ecosystems, livelihoods and public health and diminishing access to freshwater for household and commercial use. About 20 million people in the coastal areas of Bangladesh are affected by salinity in their drinking water. Bangladesh Water Development Board (BWDB) undertook studies on groundwater availability and found in some coastal districts that there was no freshwater layer for as deep as 300 meters; in many cases saline water was found in aquifers at 200 meters.

Drought: drought is seasonal – northwestern parts of Bangladesh experience drought in the crop season. During the last 50 years Bangladesh has suffered around 20 severe droughts. As much as 20 per cent of the main crop – wet season paddy – may be lost in a typical year due to drought. Drought-prone areas are also affected by cold waves with impacts on human health. There is an opportunity for supporting resilience to drought through institutional initiatives. The consultations for developing NPDM 2016-2020 strongly suggested the need for addressing drought though structural and non-structural measures.

Lightning: Bangladesh is prone to thunderstorms. Deaths caused by lightning strikes often occur during the pre-monsoon season – usually between March and May and often in rural areas where people work outdoors. The open haor areas are particularly at risk.

Arsenic contamination: increasing arsenic contamination of groundwater in Bangladesh is a major disaster, especially in the southwestern and southeastern parts. Of 64 districts, 61 are seriously affected by arsenic contamination of drinking water. 75 million people are at risk and a further 24 million potentially exposed to arsenic contamination.

Human-induced hazards

Industrial hazards: industrial hazards occur regularly in Bangladesh. Many chemical factories and warehouses are located in residential areas, making densely-built urban areas highly vulnerable. Chemical explosions are another common incident in the industrial premises in Bangladesh. On average 21 people die each month in Bangladesh due to toxic chemicals.

Fire: every year major fires occur causing

massive loss of life and properties in Bangladesh. Between 2005 and 2015 there were 1,765 fire-related deaths from nearly 130,000 fire incidents. The Bangladesh Fire Service and Civil Defense is well-trained and equipped but timely response is often hindered by traffic congestion.

Building collapse: weak construction and non-compliance with building regulations cause frequent collapse of buildings in Bangladesh. Such disasters highlight the need to develop an incident command system, training for professional rescue workers and volunteers, adequate and readily accessible tools, and pre-positioned supplies and better coordination with national and international agencies.

Oil and toxic chemical spills: spills of oils and toxic chemicals from maritime vessels are on the rise in Bangladesh. The most recent incident was the oil spill in the Shela river in the Sundarbans protected forest area in 2014. 70,000 litres of oil had to be cleaned up by local residents, the Bangladesh Navy and GoB.

Health hazards: health hazards are human-induced or natural incidents which make humans vulnerable to disaster risk through exposure. In Bangladesh some human activities with hazardous substances increase the level of vulnerability. The use of formalin in preserving fish, fruits and other processes is causing growing concern in Bangladesh. GoB has adopted some regulatory measures and an awareness-building programme to protect people from harm. Water contamination with chemicals and microorganisms also makes people vulnerable and in need of appropriate preventive and regulatory initiatives to reduce risks. Biological hazards are the triggering factor for health risks from vector-borne diseases such as avian influenza, all of which need to be included in comprehensive disaster risk management strategy, programmes and plans.

According to the Global Green Economy Index (GGEI) of DCL (2016), Bangladesh receives no recognition from GGEI experts on the four dimensions of the GGEI (leadership and climate change, efficiency sectors, markets and investment, and environment). Among the eighty countries covered, in terms of perception Bangladesh ranks 43rd with 34.6 compared to top-ranking Germany with a 97.7 score.

Bangladesh's overall GGEI performance scores are low, ranking 73rd (39.1), near the bottom of the eighty countries covered, compared to top-ranking Sweden with a 77.6 score. While each dimension of the GGEI needs improvement, Bangladesh's environmental performance requires urgent focus. The country's performance in Air Quality, Water Treatment and Access and Biodiversity are all near the bottom of the GGEI performance rankings.

2.2 The response strategy

Part III of the Constitution of Bangladesh enshrines the basic rights 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 factories concerned 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.

2.2.1 General environmental strategy

The following adaptation and mitigation initiatives in response to climate change and environmental degradation in Bangladesh have been undertaken.

National Environmental Policy, 2013

The National Environmental Policy (NEP 2013) has been formulated, revising and updating the NEP 1992 with the aim of integrating environment conservation and management in the mainstream of development. NEP 2013 is based on 17 principal issues and 12 objectives. It proposes 271 Action Plans for 23 sectors.

The 17 principles of NEP 2013 focus on population growth control; environmental protection; introducing scientific processes and assessing the environmental impacts and risks in acquiring, using and preserving natural resources and the environment; valuation of natural resources and ecosystem services; considering the accessibility of local people and

equity when using natural resources and ecosystem services; decent and reasonable use of natural resources and reducing their wastage; sustainable use of renewable resources; poverty reduction and strengthening of food security through biodiversity conservation; enforcing the polluter pays principle; including the issue of preserving the environment in all national-level policy and ensuring its enforcement in the public and private sectors; prioritizing preventive rather than curative measures at national level; inclusion of adaptive and mitigative strategies in all development plans and their implementation in relation to combating the impacts of climate change; and consideration of climate change impacts and disaster management issues during the construction of any infrastructure in the country.

The twelve objectives of NEP 2013 include provision of natural balance and overall development through sustainable development and environmental conservation; reducing the adverse impacts of climate change and decreasing losses from natural disasters in the country; determining and controlling environment polluting and degrading activities; ensuring environment-friendly development in all sectors; ensuring sustainable, long-term and environment-friendly use of all national resources; emphasizing mass awareness creation for conserving nature, establishing a public-private partnership (PPP) for improving the environment; inaugurating and flourishing global and regional co-operation for improving the global environment; mainstreaming environmental policies and strategies; creating awareness among the population of the need to combat challenges related to climate change and ecological sectors; assessing environmental impacts in all the necessary sectors; discouraging intrusion of alien and invasive species and taking decisions about them based on adequate research.

The action plans of the policies are elaborated under 23 different sectors, namely (i) land; (ii) water resources; (iii) air; (iv) food and potable water; (v) agriculture; (vi) health and health-care provision; (vii) accommodation, housing and urbanization; (viii) education and mass awareness; (ix) forests; (x) biodiversity,

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ecosystem conservation and biosafety; (xi) hilly ecosystem; (xii) fisheries and animal resources; (xiii) coastal and marine ecosystem; (xiv) industry; (xv) fuel and mineral resources; (xvi) communication and transportation; (xvii) ecotourism; (xviii) population; (xix) combating the impacts of climate change; (xx) disaster management; (xxi) science, research, information and communication technologies; (xxii) other pollution control; and (xxiii) economic development.

The first section in the land plan discusses the land sector, emphasizes sustainable land management, but there is no mention of land or soil pollution. Under the water resources sector, it is mentioned that the water bodies and water resources should be kept free from pollution and illegal grabbing. This section emphasizes protection of water resources. The policy requires the necessary steps to restore and conserve the water bodies which have reached a critical level owing to continuous degradation. In necessary cases the water bodies should be declared as protected or ecologically critical areas to accelerate the restoration process. The policy proposes making provision for new industrial zoning to protect water bodies from possible industrial pollution. It also states that the water-polluting industries must have ETP. Water monitoring systems should be established for preventing pollution from different sources. Re-evaluation of all types of development planning that run counter to conservation of rivers, water bodies and the environment is proposed in this section.

Management of air, maintaining air quality and keeping pollutants within the limit is proposed. It is also proposed that law enforcement for maintaining and upgrading air quality standards is needed for improving air quality. This policy restricts the import of very old vehicles and makes it mandatory to obtain an emission testing certificate before acquiring or renewing the fitness certificate of a vehicle. It is also advised to define the quality standard of fuels to be used in industries and vehicles and to comply strictly with it. Moreover, the emission standard of specific industries and vehicles should also be set and maintained for improving the air quality. Emission taxes should be fixed and collected for

violating the defined standards.

For preserving water sources from pollution, establishing industries or dumping grounds near the sources is restricted. Production, export, distribution, purchase or sale of all types of food which are adulterated, stale, contaminated, beyond their expiry dates, polluted through radiation, mixed with artificial colour or chemicals, genetically modified, are prohibited.

Organic farming is encouraged in the context of environmental concerns related to agriculture. To reduce agricultural pollution it is encouraged to use organic fertilizer and organic pesticide. It is advised to take proper measures to reduce emission of methane from paddy fields and to stop open burning of agricultural waste. Under health-care provision it is laid down that all activities in the development and other sectors which can cause pollution, create imbalances in nature or threaten public health should be prevented. As regards education and mass awareness, it is advised that all educational institutions be encouraged to stay pollution-free and take preventive measures for reducing polluting activities. It is also suggested that an incentive be provided through honouring the best educational institution in terms of environmental protection.

During the conduct of research in the field of genetic engineering with a view to devising measures to reduce environmental pollution, instructions are given for applying and following all rules relating to biosafety. For conserving fish population and production in the Bay of Bengal instructions are given to prevent all harmful activities and to take measures to stop marine pollution. It is also proposed that national and international level steps be taken to control marine pollution. Control of industrial pollution is emphasized in this policy. As to industries, it is proposed that controlling measures be taken to stop industrial pollution. The need to conduct an environmental impact assessment (EIA) before establishing any new industry is also stressed. It is instructed that establishment of polluting industries be prohibited and that the polluting activities of already established industries be progressively terminated. Finding alternatives to discourage the use of products from polluting industries is also suggested. Introducing zero

discharge and zero emission programmes in industries and implementing clean development mechanisms (CDM) throughout the country is also suggested. Mandatory measures to establish central effluent treatment plants in industries should be taken, according to the action plan. It is also advised that all industrial units ensure internal security and a healthy environment.

The use of fuels which accelerates environmental pollution and climate change should be discouraged and the use of alternative and comparatively greener fuel should be encouraged. Harmful substances such as sulphur should be reduced to a minimum level in fuel oil used in the country. Export of coal with excessive sulphur content should be reduced. In the case of fuel extraction, the harmful impacts on the environment and local people should be considered with urgency and destructive extraction methods should be prohibited under this policy.

Reduction of environmental pollution is also emphasized. It is instructed that all environment-polluting activities in the road, rail, air and water transportation sectors be prohibited. Rail and water transportation is encouraged in this policy as these are fuel-efficient and less polluting modes of transport.

Strengthening the implementation of CDM, such as carbon trading, is encouraged to combat the impacts of climate change. It is suggested that environment pollution monitoring and control should be included in national science and technology policy. It is instructed that other forms of pollution such as those caused by sound, vibration, radiation, thermal, photo or lighting, and indoor pollution should be prevented. In NEP 2013 it is advised that the legal framework and laws should be upgraded and already established and upgraded laws and environmental courts be utilized and enforced to control the pollution and degradation of the environment, ecosystem and resources.

Bangladesh Water Act, 2013

The Bangladesh Water Act of 2013 is mainly based on the National Water Policy and it is designed for integrated development, management, extraction, distribution, usage, protection and conservation of water resources

in Bangladesh. The law provides a National Water Resources Council with the Prime Minister in the chair and 11 other ministers as members of the Council. The Council also includes representatives from relevant departments and nominated national experts to formulate relevant guidelines and policies in this regard. An executive committee under the Ministry of Water Resources will work on implementing the decisions, policies and guidelines issued by the council.

The Act declares all forms of water within the territory of Bangladesh to be the property of the government. However, the surface water in private property can be used by the owner for all required purposes. The Act requires permits or a licence for withdrawing large-scale surface or groundwater; however, the maximum amount of water that can be withdrawn is not specified in the law.

Prevention of trans-boundary water pollution is also discussed in the Act. In this regard, combined survey, study and research on the international rivers and activities to prevent chemical and biological pollutant are proposed. According to this Act, for regulating and controlling water pollution the provisions of the 1995 Bangladesh Environment Conservation Act (the 1st law of 1995) would be applicable. Non-compliance with the law would carry a maximum penalty of five years of imprisonment or a fine of BDT 10,000 or both.

This law was one of the much-needed steps for protecting the water resources. It significantly recognizes the management aspects of the natural flow of surface water and recharging of groundwater. However, one of the major drawbacks of this law is the requirement for a written complaint prior to filing a lawsuit under the provisions of the Act.

Bangladesh Climate Change Strategy and Action Plan 2009 Modified in 2014

Bangladesh was one of the first countries to develop a climate change strategy and action plan, the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) 2009, a 10-year programme (2009-2018). BCCSAP is constantly being updated and was modified in October 2014 to build up the capacity and resilience of

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the country to meet the challenge of climate change. The needs of the poor and vulnerable, including women and children, are prioritised in all activities under the BCCSAP which comprises immediate, short, medium and long-term programmes. It is being implemented under the overall guidance of the National Environment Committee, chaired by the Prime Minister. It is coordinated by the Ministry of Environment and Forests (MEF). Programmes funded under the Plan are implemented by ministries or their agencies, with the involvement, as appropriate, of civil society and the private sector. In the first five-year period (2009-13), the programme comprised six pillars: (i) food security, social protection and health; (ii) comprehensive disaster management; (iii) infrastructure; (iv) research and knowledge management; (v) mitigation and low carbon development; and (vi) capacity-building and institutional development.

BCCSAP also includes a 10-year programme to build up the capacity and resilience of the country to meet the challenge of climate change over the next 20-25 years based on the following thematic areas, with full cognizance of the link between climate change and disasters: (a) food security, social protection and health targeted on the poorest and most vulnerable in society; (b) comprehensive disaster management to further strengthen the country's already proven disaster management systems; (c) infrastructure to ensure that existing assets (e.g. coastal and river embankments) are well-maintained and fit for purpose; (d) research and knowledge management to predict the likely scale and timing of climate change impacts on different sectors; (e) development of low-carbon options; and (f) capacity-building and institutional strengthening to enhance the capacity of government ministries and agencies.

Sixth Five Year Plan

A major step forward in the GOB's plans to address the potential impact of climate change was demonstrated through Bangladesh's Sixth Five-Year Plan FY2011-FY2015 (SFYP). Unlike previous plans, a key strategic element of the 6th FYP was a firm commitment to pursue an environmentally-sustainable development process and climate change issues, and it

dedicated an entire chapter to adaptation and mitigation strategies for addressing climate change. It focused on an environmental management strategy, conservation and maintenance of natural resources, reduction of air and water pollution, and liberation of encroached rivers, water bodies, forest areas and khas land. The SFYP included provisions for both disaster risk reduction and environmental sustainability, including conservation of natural resources, efforts to reduce air and water pollution, water management and climate change, which all signals an awareness of key issues and the underlying drivers (GED, 2011).

Sustainable Development Goals and the Seventh Five Year Plan

Sustainable Development Goal: Agenda 2030 vows to leave no-one behind; the global community has adopted the new 2030 Agenda for Sustainable Development, encompassing 17 universal and transformative goals and 169 targets aimed at ending poverty and hunger, attaining gender equality, fighting inequality and tackling climate change over the next 15 years (UN, 2015).

The Seventh Five Year Plan (7th FYP) of Bangladesh coincides with the final year of the MDGs (Millennium Development Goals) and the launching of the UN's post-2015 Sustainable Development Goals (SDGs). The development approach underlying the 7th FYP is consistent with the global agenda for higher growth in developing countries with appropriate measures for protection of the environment. Eradication of extreme poverty will be a cardinal principle of the strategies laid out in the 7th FYP document. The Plan will strive for just, equitable and inclusive economic growth, gender equality and social development while protecting the environment. It targeted 7.4 per cent GDP growth per annum synchronizing with the SDGs' suggested attainment of at least seven per cent growth by the least developed countries. Finally, the 7th Plan will create the base for implementing the SDGs by 2030 (including two more Five Year Plans).

SDGs 4, 5, 6, 7, 8, 11, 12, 13, 14 and 15 target different aspects of environmental sustainability. All these targets are integrally embodied in the 7thFYP, as follows (GED, 2015):

SDG 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all: (i) Achieve 100 per cent net enrollment rate for primary and secondary education; (ii) Ensure quality education at primary, secondary and tertiary levels; (iii) percentage of cohort reaching grade 5 to be increased to 100 per cent from its current 80 per cent.

SDG 5. Achieve gender equality and empower all women and girls: (i) Gender Parity Index in tertiary education to be raised from current 0.70 to 1.0; (ii) The ratio of female-to-male literacy for age group 20-24 to be raised to 100 per cent from the current 86 per cent; and (iii) Increase the share of female officers (Grade-9 and above) in the public sector to 25 per cent by 2020. These plan targets would be helpful in greening the economy by prioritizing disadvantaged groups (particularly women and girls) in any intervention, particularly for skills development.

SDG 6. Ensure availability and sustainable management of water and sanitation for all: (i) Safe drinking water to be made available for the entire rural and urban population; (ii) Proportion of urban population with access to sanitary latrines to be increased to 100 per cent, and to 90 per cent for the rural population.

SDG 7. Ensure access to affordable, reliable, sustainable and modern energy for all: (i) Generation of electricity to be increased to 23,000MW; (ii) Electricity coverage to be increased to 96 per cent; (iii) Energy efficiency to be increased by ten per cent.

SDG 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all: (i) Attaining average real GDP growth rate of 7.4 per cent per year over the Plan period; (ii) Total revenue to be raised from 10.7 per cent of GDP to 16.1 per cent by FY20; (iii) Maintain the current fiscal deficit of five per cent of GDP; (iv) FDI to be increased substantially to \$9.6 billion by FY20 from present \$1.57 billion; (v) Substantial improvement in exports to \$54.1 billion by FY20 from \$30.3 billion of FY15; (vi) Raising trade-GDP ratio to 50 per cent by FY20; (vii) 12.9 million additional jobs to be available during 7th FYP, including some 2 million jobs abroad, for the 9.9 million workers that will join the workforce.

SDG 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation: (i) Construction of 6.15 km-long Padma Multi-purpose Bridge at Mawa-Janjira; (ii) Construction of about 26 km-long Dhaka Elevated Expressway; (iii) Focus on fast tracking a number of transformational infrastructure projects; (iv) Substantially reduce urban traffic congestion with focus on Dhaka and Chittagong Metropolitan areas; (v) Increase the contribution of the manufacturing sector to 21.5 per cent of GDP by FY20 from 17.8 per cent of FY15.

SDG 11. Make cities and human settlements inclusive, safe, resilient and sustainable: (i) Access to improved water source will be ensured for all urban dwellers; (ii) Coverage of drainage system to be expanded to 80 per cent; (iii) Ensure sustainable urban development that supports increased productivity, investment and employment.

SDG 12. Ensure sustainable consumption and production patterns.

SDG 13. Take urgent action to combat climate change and its impacts.

SDG 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development.

SDG 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss: (i) Increase productive forest coverage to 20 per cent with 70 per cent tree density; (ii) Improve air quality in Dhaka including large cities and enact Clean Air Act; (iii) Promote zero discharge of industrial effluents; (iv) 15 per cent of wetland in peak dry season to be protected as aquatic sanctuary; (v) 500 meter wide green belt to be established and protected along the coast; (vi) Eco-tourism to be promoted at least in 20 protected areas and ECAs; (vii) Land zoning for sustainable land/water use; (viii) Environmental, climate change and disaster risk reduction considerations to be integrated into project design, budgetary allocations and implementation process; (ix) Canals and natural water flows of Dhaka and other major cities to be restored.

National Plan for Disaster Management

The National Plan for Disaster Management (NPDM) 2016-2020, aims at building resilience for sustainable human development. It is designed to support the government of Bangladesh's target of becoming a middle-income country by 2021 and a developed country in 2041. The plan, which sets out priorities and core targets for the next five years in a longer-term perspective for 2030, aims to realize the country's economic and development goals by safeguarding them from the impacts of disasters through disaster management (DM) for resilience. DM to achieve resilience is highly important in Bangladesh for reducing the adverse impacts of disasters and thereby safeguarding the socio-economic progress of the country and contributing to sustainable development. The plan has three core goals: (i) saving lives, (ii) protecting investments, and (iii) effective recovery and rebuilding. This requires that the attainment of 34 key targets be achieved or initiated by 2020 and that work towards them be continued until 2030. These targets include: (1) Continuation and planned expansion of earthquake programme; (2) Signatory to AMCDRR and Delhi Declaration 2017-2018; (3) At least one innovation in forecasting of at least one hazard (e.g. drought, landslide); (4) Continuation and planned expansion of earthquake programme (e.g. EPAC); (5) At least two research and development (R&D) projects initiated with balance between scientific and socio-economic aspects; (6) National Earthquake Contingency Plan reviewed and updated; (7) At least five training courses on Disaster Management Committee (DMC) conducted with at least 100 DMC leaders on each course; urban DMC activation strategy paper produced; (8) Disaster Impact Assessment strategy paper produced; (9) Inter-Ministerial Disaster Management Coordination Committee (IDMCC) to make provision for periodic review of NPDM 2016-2020; (10) At least two "all-hazards" risk reduction pilot projects initiated in prioritized multi-hazard regions (e.g. coastal, haor); (11) National DM capacity-building plan produced; (12) Construction of fire stations initiated in all district headquarters; (13) At least one demonstrated improvement of flood and cyclone management in each district; (14) Preparedness and emergency response

guidelines produced for at least one prioritized sector; (15) Concept paper produced for recovery and rehabilitation strategy; (16) At least one demonstrated improvement in forecasting or early warning; (17) Capacity-raising programme for CPP (Coordination, Communication and Cooperation) begun in 2019-2020; (18) At least two R&D projects (scientific and socio-economic) completed with directions for future research; (19) Studies on resilience-building for at least two human-induced hazards; (20) At least one demonstrated innovation in forecasting of at least one hazard (e.g. drought, landslide) and another initiated; (21) Social protection for disaster resilience agency established; (22) Guidelines for risk-informed private sector investments produced; (23) Drought and cold wave unit in the Ministry of Disaster Management and Relief (MDMR) established; (24) IDMCC to make provision for periodic review of NPDM 2016-2020; (25) Urban DMCs activated; (26) Concept paper on DM financial options produced; (27) At least one R&D institution initiated; (28) Pilot implementation of a national DM capacity-building plan; (29) Construction of at least five fire stations completed in district headquarters and construction of further stations initiated; (30) Concept paper on finance for disaster recovery produced; (31) Emergency preparedness and response plan produced – for at least one human-induced and one slow-onset (e.g. drought) hazard; (32) Preparedness and emergency response guidelines produced for at least one other prioritized sector; (33) Pilot recovery and rehabilitation strategy programme initiated; and (34) Capacity-raising programme for CPP demonstrated (MDMR, 2017).

Disaster Management Act, 2012

The Disaster Management Act 2012 seeks to promote safer and more resilient communities. It was enacted with a view to creating the legislative tool under which disaster and emergency management will be undertaken in Bangladesh, and the legal basis on which activities and actions will be managed. It creates mandatory obligations and responsibilities on ministries, committees and appointments. Its objectives are to: (a) reduce the overall impact of a disaster by bringing its harmful impact to a tolerable level through disaster

risk reduction programmes; (b) manage post-disaster recovery and rehabilitation with greater efficiency; (c) provide emergency human assistance to disaster-distressed people; and (d) build disaster management infrastructure by integrating, target-orienting and empowering the programmes of government and non-governmental organizations in coping with disasters. It is a Government-wide framework for the effective integration of disaster management planning and programming, focusing on a risk reduction and resilience approach across agencies and sectors. Various GOB ministries and other relevant agencies are expected to use this framework as guidance for producing their detailed Departmental-specific or Agency-specific Annual Work Plans (MDMR, 2012).

The Disaster Management Policy, 2015

The Disaster Management (DM) Policy was approved by the GOB in 2015, with a strong emphasis on Disaster Risk Reduction (DRR). It defines “the national perspective on disaster risk reduction and emergency management, and to describe the strategic framework, and national principles of disaster management in Bangladesh”. It is strategic and describes the broad national objectives and strategies in disaster management including Disaster Management Plans, Standing Orders on Disasters and Guidelines for Government at all Levels from national to local levels (best practice models). The policy places importance on the DM Fund, Relief Godown and so forth as a dedicated financial resource and relief for DM activities at all levels – national and local. It is expected that the policy will be an effective instrument for advancing DM in Bangladesh (MDMR, 2015).

Ecologically Critical Area Management Act, 2016

The Ecologically Critical Area Management Act (ECAMA) 2016 consists of a 19-member National Committee chaired by the Secretary of the MEF. It also consists of a District Committee, Upazila Committee and Union Coordination Committee with the aim of detecting ecologically-critical areas (ECAs) within their respective jurisdictions. According to the ECAMA, the lower committee will submit detailed reports to the next higher

committee on the current status of the ECAs, the underlying causes, consequences and the remedial measures needed to restore the ECAs to their previous condition and protect them. The committees will take into account all aspects of species diversity, genetic diversity and ecosystem diversity of the natural environment (MEF, 2016).

Sustainable and Renewable Energy Development Authority Act, 2012

This Act, predicated on the aim of increasing energy security, created an independent authority, the Sustainable and Renewable Energy Development Authority (SREDA), to promote the development and use of renewable energy. The Act specifies 23 responsibilities of the authority, including: (i) encouraging the use of power and energy-efficient equipment and taking the necessary steps for standardisation and labelling of power and energy-using equipment and appliances; (ii) assisting the government in making and implementing an energy-efficient building code; (iii) providing technical and financial assistance in research, development, demonstration and training on renewable energy; and (iv) encouraging commercialisation of renewable energy and energy-efficiency activities in the private sector through implementation of a pilot project.

The Act establishes SREDA with a view to ensuring energy security and mitigating risks associated with natural calamities stemming from global warming. SREDA came into being in 2014, is now fully functional as a government agency, and aims to promote renewable energy (RE) and energy-efficiency by:

- i) coordinating renewable energy and energy-efficiency efforts of the government;
- ii) standardizing and labelling the renewable energy and energy-efficiency products;
- iii) piloting new technologies, and taking initiatives for their expansion;
- iv) creating a conducive environment for the investors;
- v) conducting research and development;
- vi) developing capacity;
- vii) creating awareness of renewable energy and

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energy-efficiency; and

- viii) establishing linkages with regional and international organizations.

Activities of SREDA on Renewable Energy Promotion

The activities of SREDA include (a) developing a legal, regulatory and policy framework; (b) fund-raising and channelling for RE project development; (c) giving logistical and technical support to interested groups for private sector investment; (d) supporting demonstration of new technologies and new business models for RE technologies; (e) collecting data and assessing the RE resource base, especially in the context of a Rural Energy Master Plan; and (f) dissemination of RE technology, awareness-building through organizing workshops, seminars and so forth.

Energy Efficiency Action Plan

Targets set up include: 10 per cent of Primary and Secondary Energy Saving by 2015, 15 per cent by 2021, and 20 per cent by 2030 through (i) 39 interventions – Industrial, Commercial and Residential; and (ii) Energy Efficiency and Conservation Master Plan up to 2030.

Future programme of SREDA (see Table 3)

National Industrial Policy-2016

Unlike all Bangladesh's previous industrial policies including those of 2005 and 2010, the National Industrial Policy (NIP)-2016 was adopted as a response to the challenges of

industrial pollution in tandem with launching of SDGs in Bangladesh. According to NIP-2016, an indispensable precondition of sustainable development is environment-friendly industrialization (p.1). It places emphasis on taking appropriate measures for environment-friendly industrial expansion including environment-friendly high-tech industries. To this end it argues for reforms of the existing laws and regulations and formulation of appropriate strategies and guidelines in consultation with the stakeholders and subject-matter experts, and ensuring their implementation. For establishing environment-friendly industrial units for green industrialization, it provides special incentives and assistance to those industrial units making use of renewable energy (4.19). On a case-to-case basis large-scale industrial units with high investment and employment potential and use of environment-friendly innovative technology will be provided with the same special incentives and assistance as in the industrial units in the Export Processing Zones (EPZs) (4.21). For small and medium enterprises (SMEs) special incentives will be provided to those industrial units importing environment-friendly technology and productive machinery and equipment, and producing environment-friendly goods (5.3). The National Productivity Organization (NPO) will undertake programmes for increasing labour productivity along with total productivity by according priority to "green productivity" (8.2). To this end training will be provided for increasing the skills and abilities of the workforce (8.3), and the Bangladesh Accreditation Board (BAB)

Table 3. Renewable energy target (MW) of Bangladesh

TECHNOLOGY	2015	2016	2017	2018	2019	2020	2021	TOTAL SOLAR
Solar	222	253	421.75	237	195	203	208	1,739.8
Wind	0	20	250	350	350	200	200	1,370
Biomass	1	16	6	6	6	6	6	47
Biogas (Biogas to electricity)	1	1	1	1	1	1	1	7
Hydro (mini/micro)		2	2					4
Total	224	292	680.75	594	552	410	415	3,167.8

Source: SREDA

will be upgraded to international standards (8.5). Industries involved in producing green-technology- innovated, value-added and diversified jute goods and mixed jute products will be considered as export-oriented or import-substituting industries (11.4 h). To make the export price internationally competitive, necessary measures will be taken for the use of environment-friendly modern technology and improved product quality in the production process (11.8). Foreign direct investment (FDI) will be encouraged and a special financial incentive package will be provided for those industries which are green, high-tech and innovative and have the potential for transferable industrial skills and technology (12.1). Priority will be given to foreign investment for establishing all kinds of renewable-energy-based electricity generation centres including solar-energy-based electricity production, wind-energy-based electricity production, electricity production centres based on biomass, domestic waste and industrial waste, and so forth (12.15). In the case of PPP, domestic and foreign joint-venture investment, priority will be given to environment-friendly technology innovation and transfer (12.17). Competitive effective measures will be taken for increasing the skills of industrial establishments in Bangladesh through the use of cost-saving environment-friendly technology (13.1). Provision will be made for awarding prizes to the innovators of environment-friendly, sustainable and new technology for the purpose of greater development of industrial goods through coordination of new technology in the industrial arena (13.6).

For environment-friendly industrial management, NIP-2016 lays down the following strategies:

- i) In the case of allocation of land and water for industrial projects, decisions will be taken on the basis of EIA. Moreover public awareness will be created regarding the harmful effects of smoke and industrial plant waste on air, land and water (14.1).
- ii) Establishment of ETP and a Central Effluent Treatment Plant (CETP) for controlling environmental pollution in industrial units will be encouraged. In this respect government will ensure the enforcement

of Environment Conservation Law 1995, Bangladesh Water Law 2013 and other relevant laws (14.2).

- iii) Government will provide necessary assistance for bringing under CDM the industrial units undertaking measures for controlling greenhouse gas (GHG) emissions in combating the negative impact of climate change (14.3).
- iv) Industrial location will be given priority by taking into account disaster risk reduction and the surrounding environment. If necessary incentives will be provided for the establishment of environment pollution controlling and climate change resistant industrial units (14.4).
- v) In establishing effluent treatment industries, domestic and foreign entrepreneurs will be encouraged and government will provide all possible assistance including financial incentives (14.5).
- vi) Business organizations, nongovernmental organizations (NGOs) and other social organizations will be encouraged to participate actively in waste management by industrial units and in the environment conservation programme (14.6).
- vii) Green industry and establishment of industries capable of climate change mitigation will be encouraged (14.7).
- viii) For establishing industrial units, use of intensive cultivable and high-yielding agricultural land will be discouraged (14.8).
- ix) Investors will be encouraged to undertake environment-friendly large projects on PPP (14.9).
- x) Industrial entrepreneurs will be encouraged to follow the 3Rs (Reduce, Reuse and Recycle) in industry establishment and management (14.10).

Draft Renewable Energy Policy, 2014

As an energy policy response, the Draft Renewable Energy Policy 2014, has a target of achieving five per cent (about 800 MW) by 2015 and 10 per cent (2,000 MW) from renewable energy by 2020. Under the government's adopted action plan for energy-efficiency, energy

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conservation targets of 10 per cent, 15 per cent and 20 per cent have been set for 2015, 2020 and 2030 respectively. Moreover by 2030 all cooking stoves will be converted into clean cooking stoves. A Draft Renewable Energy Policy (2014) is in the process of final approval which would possibly address many relevant issues faced by stakeholders. (Rechsteiner et al, 2015).

Brick Manufacturing and Kilns Establishment (Control) Act, 2013

According to the Brick Manufacturing and Kilns Establishment (Control) Act 2013, (i) no brick manufacturer is allowed to use agricultural land or hills or hilltops for collecting earth as raw materials for brick manufacturing; (ii) without permission from the relevant authority, no-one is allowed to dig in derelict ponds, canals, rivers, sandy zones or fallow land for collecting soil for brick manufacture; (iii) to reduce the use of soil as raw material for bricks at least 50 per cent hollow brick will have to be produced in modern technology kilns; (iv) no-one is allowed to use heavy vehicles for carrying soil or bricks on Upazila, Union or rural roads constructed by the Local Government Engineering Department; (v) no-one is allowed to use fuel wood as fuel for brick baking, drying or calcining in brick kilns, no matter what law is in force at the time; (vi) for brick manufacture no-one is allowed to use coal combined with sulphur, ash, mercury or similar elements in excess of predetermined standard limits, whatever law is in force at the time; (vii) no matter what law is in force at the time, or no matter whether or not there is a clearance certificate, under this law no-one is allowed to establish a brick kiln in (a) residential, protected or commercial area (within 1 km); (b) a city corporation, municipality or Upazila headquarters (within 1 km); (c) public forest (within 2 km) or privately-owned forest, jungle, garden or waterbody; (d) agricultural land; (e) an ecologically critical area; and (f) degraded air shed (BG, 2013).

Progress of Bangladesh with climate adaptation

Bangladesh is often considered a climate-change adaptation champion. The government is committed to the cause. Bangladesh is one of the nations that emits very little carbon,

but it is likely to be among those that suffer most because of global warming. However, the country has taken several initiatives to facilitate climate-resilient development. The Government has set up a multi-donor trust fund – the Bangladesh Climate Change Resilience Fund (BCCRF) – a ‘one-stop’ mechanism for large-scale climate change financing in Bangladesh. The BCCRF is supported by Australia, Denmark, the European Union, Sweden, Switzerland, the United Kingdom, and the United States. BCCRF started its work in January 2011 with a gazette notification circulated to nominate members of the governing council and management committee of BCCRF. Aside from investment projects, the World Bank has now started to focus its efforts on the fourth pillar of BCCSAP, namely research and knowledge management. A wealth of information research has already been undertaken in the field of climate change in Bangladesh, and the team has identified knowledge gaps (WB, 2017).

BCCRF has also recognized the long-indispensable roles of local empowerment and numerous NGOs in community-based programmes and services, often in partnership with government and international development partners. BCCRF allocated \$13 million of its climate-resilience funding to NGOs through its Community Climate Change Project (CCCP). The CCCP in turn provides competitive grants to NGOs to implement community-driven adaptation to climate change. The BCCRF Governing Council designated the Palli Karma-Sahayak Foundation as the responsible agency for this project. The CCCP focuses on communities hit hardest by current weather extremes: populations who live in coastal areas affected by saltwater intrusion, in flood-prone chars (silt islands in rivers) and river basins, or in areas afflicted by recurring droughts (WB, *ibid.*).

So far the achievements of the CCCP are the following: (a) nearly 500 project concept notes were received; (b) 41 NGOs were awarded sub-grants addressing three climatic risk zones, salinity-, flood- and drought-prone areas of Bangladesh; (c) 40,000 people benefit from community-led schemes in flood-, drought- and salinity-prone vulnerable Upazilas; (d) 400 vulnerable households obtain fresh drinking

water from a pilot desalinization plant in Shyamnagar; (e) women's income levels have been raised through earning an additional BDT 1,500 a month from saline-tolerant mud-crab culture in high-saline areas; and (f) all NGOs completed their activities.

At ground level Bangladesh has achieved tremendous success in the area of disaster management. The country has a very effective cyclone warning system which is supported by nearly 50,000 cyclone preparedness volunteers. It is also relevant that the industrial sector has been growing, creating new livelihoods and boosting income opportunities (Rahman, 2017).

According to the World Bank (2016), Bangladesh - being located at the tail-end of the fragile delta formed by the Ganges, Brahmaputra, and Meghna rivers - is more exposed to tropical cyclones than any other country. It also experiences about two-fifths of the world's storm surges every year. According to the 2015 Climate Change Vulnerability Index, Bangladesh's economy is more at risk from climate change than any other country. With a *per capita* gross domestic product, or GDP, of about \$1,220, the economic losses in Bangladesh over the past 40 years were an estimated \$12 billion, depressing GDP annually by 0.5 per cent-1 per cent.

Owing to the effects of climate change, an increase in the frequency and severity of cyclones and other natural disasters is likely, making it essential for Bangladesh to adapt to increased uncertainty and be prepared to ride out even the worst storms. The Multipurpose Disaster Shelter Project (MDSP) will benefit nearly 14 million coastal people who are more vulnerable to natural disasters. Two-thirds of the country is less than five meters above sea level, and floods increasingly inundate homes, destroy farm production, close businesses, and shut down public infrastructure. Erosion leads to an annual loss of about 10,000 hectares of land and weakens natural coastal defenses and aquatic ecosystems.

The Emergency Cyclone Recovery and Restoration Project (ECRRP) supports GOB efforts to facilitate recovery from the damage to livelihoods and infrastructure caused by Cyclone Sidr and to build long-term preparedness through strengthened disaster risk reduction and management.

Addressing climate change is a national priority. Bangladesh is recognized internationally for its cutting-edge achievements in addressing climate change. Bangladesh has invested more than \$10 billion in climate change actions – enhancing the capacity of communities to increase their resilience, increasing the capacity of government agencies to respond to emergencies, strengthening river embankments and coastal polders (low-lying tracts of lands vulnerable to flooding), building emergency cyclone shelters and resilient homes, adapting rural households' farming systems, reducing saline water intrusion, especially in areas dependent on agriculture, and implementing early warning and emergency management systems. The Coastal Embankment Improvement Project - Phase I (CEIP-I) aims to upgrade Bangladesh's embankment system by increasing the area protected by polders from tidal flooding and frequent storm surges.

Despite the considerable progress that the GOB and the Bangladeshi people have made, they face continuous challenges associated with climate change. The World Bank Group's Climate Change Action Plan reconfirms its commitment to further increasing the climate-related share of its portfolio. Already in Fiscal Years 2011- 2015, the share of activities with climate co-benefits was 31 per cent of total IDA financing. And addressing climate change is one of the three primary focus areas in the Country Partnership Framework for Fiscal Years 2016- 2020. World Bank funding has supported projects in some of the poorest regions to build desalinization plants and solar-powered irrigation and solar home systems (SHS), raise the plinths of homes to protect them from future flooding, and help identify livelihoods largely insulated from frequent natural disasters. World Bank financing has also facilitated research on the impact of climate-sensitive diseases and the dynamics of urban flooding in the Dhaka area. The World Bank, International Finance Corporation and the 2030 Water Resources Group have also collaborated on an investment strategy for the Bangladesh Delta Plan 2100, a long-term investment programme to spur adaptive management of the Bangladesh Delta.

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For mitigating and adapting to climate change, World-Bank-supported initiatives have resulted in a range of outcomes, such as: (i) building 320 solar irrigation pumps benefiting 8,000 farmers; (ii) protecting 17,500-hectare block plantations and 2,000-kilometer strip plantations from flooding and saline intrusion; (iii) providing basic adaptive services for 40,000 families; (iv) offering training on alternative livelihoods for 6,000 poor households in 200 communities; (v) constructing 224 new cyclone shelters and repairing 387 kilometers of embankment; (vi) publishing research analyzing the impact of climate change in urban areas; (vii) providing 3.95 million remote households and rural shops with solar home systems, which has increased access to electricity; (viii) installing seven mini-grids to provide continuous electricity to 2,000 rural businesses and shops; (ix) distributing clean, energy-efficient cooking-stoves to 750,000 rural women; and (x) improving the availability of energy through electricity transfers in the Haripur, Siddhirganj and Narayanganj regions.

For the future, given the level of climate uncertainty, the Bank will continue to emphasize measures that simultaneously deliver climate resilience and development benefits.

CDM Projects in Bangladesh

Greenhouse gases (GHGs) generated by burning of fossil fuels are sure to cause global warming and bring about climate change. Scientists have detected various clear indications of this change in several areas. With the emissions and atmospheric concentrations of greenhouse gases, there are signs of rapidly-increasing average surface temperatures and scientists have also detected a changing rain pattern. However climate change, on the one hand, is one of the greatest challenges that the world is facing today, and on the other hand it has also created opportunities for meeting the challenges. In such a situation some market-based trading mechanisms such as the Clean Development Mechanism (CDM) have been developed, since the inception of the Kyoto protocol in 1997, to trade GHG emissions from the less-polluting countries to polluting countries. In CDM, developing countries such as Bangladesh can, under the Kyoto Protocol, invest and develop various energy-efficient technologies, which are

not common practices in the country. In return they can earn Certified Emission Reductions (CER), with the approval of the CDM Executive Board of the United Nations Framework Convention on Climate Change (UNFCCC), for sale in the market where the developed countries are ready to purchase CERs to pay off their domestic activities to enable them to meet their legally-binding GHG emission reduction obligation under the Kyoto Protocol. This can help Bangladesh adopt the latest energy-efficient and environment-friendly technologies, which otherwise are neither financially lucrative nor feasible for investment or “business as usual”.

Despite having enough potential, as of 2012 Bangladesh had only been able to obtain registration of five projects while several other projects were at a validation stage. The titles of the registered projects are as follows (Alam, 2012): (1) Landfill Gas Extraction and Utilization at the Matuail landfill site, Dhaka, Bangladesh; (2) Composting of Organic Waste in Dhaka; (3) Improving Kiln Efficiency in the Brick Making Industry in Bangladesh (Bundle-1); (4) Efficient Lighting Initiative of Bangladesh (ELIB); and (5) Improved Cooking Stoves in Bangladesh. However, according to DOE (2016), as of June 2016 13 CDM projects in Bangladesh obtained registration from the CDM Executive Board of the United Nations out of 21 CDM projects approved by the Designated National Authority (DNA).

Failure to overcome various hurdles in CDM projects is one of the major impediments to registering such projects successfully while lack of, and unwillingness to participate in, knowledge-sharing is contributing no less to the lamentable state of CDM projects in Bangladesh. In contrast with the poor status of Bangladesh, Asian countries such as China and India have been dominating the CDM market. China's dominance is so discernible that people at times refer to the CDM as the China Development Mechanism. In January 2011 the total number of registered Chinese CDM projects was 1,353 while that for India was fairly good with some 650. The Chinese and Indian successes do not necessarily mean that CDM is a straightforward process. Indeed the changes in rules and methodologies over the years have made CDM rather complex (Alam, *ibid.*).

To implement CDM projects easily the GOB some years ago formed a two-tier Designated National Authority (DNA). The lower tier belongs to the MEF, while the upper tier, known as the National CDM Board, is headed by the Principal Secretary to the Prime Minister. DNA, after being assured that the project is voluntary and would lead to sustainable development, gives Host Country Approval (HCA) to the project. The Department of Environment (DOE) has of late published a CDM handbook, at least to help those searching for a way out. Apart from that, DOE arranges a workshop on CDM every year, given that its concept and scope are not well understood by business communities and policy planners. This is why some projects, such as the introduction in Dhaka of emission-saving CNG-run auto-rickshaws in place of polluting two-stroke taxis, have lost carbon trading opportunities for good.

In 2014-15 DOE undertook a Programmatic CDM Project using Municipal Organic Waste from 64 Districts of Bangladesh to overcome the harmful effects of climate change. The project is expected to ensure environment-friendly collection and management of solid waste from all the municipalities of Bangladesh through the Aerobic Composting method (DOE, 2015). Interviews with key informants reveal that in Bangladesh many sectors have high potential to implement CDM projects. Nevertheless, owing to the lack of a reliable baseline study, the actual potential for energy savings cannot be properly assessed. To assess CDM potential properly, energy audits are needed in specific sectors. Again, for example, sugar cogeneration is a major opportunity for emission reduction but the sugar mills are not only public-sector entities in the country but they are also losing concerns. Under such circumstances it is not surprising that the number of registered CDM projects in the country is so few.

2.2.2 Major changes in the economy and employment shifts in the green transition since 2009/10

In Bangladesh no national estimate is available of the number of green jobs that will be created as a consequence of the green policy measures. The Bangladesh Bureau of Statistics (BBS), the only official statistical authority, conducts periodic Labour Force Surveys (LFS). But in its LFS the BBS does not break down employment into green and non-green. Hence there is no hard evidence on the employment shifts in the green transition in the Bangladesh economy. If the existing indicators could be further split into green and non-green jobs by occupations across sectors, this could in future facilitate estimates of sectoral shifts of green jobs. However, in the section on case studies we present some fragmentary evidence on the growth of green jobs.

Although the climate change response policies and strategies of the GOB do not include any skills development component, they have far-reaching skills implications for developing new green-collar occupations in response to increasing demand for them in new green sectors (e.g. renewable energy) and also for greening existing occupations prevailing in the non-green sectors.

2.3 The skills development strategy in response to greening

Existing climate change response policies and strategies of the GOB have skills development implications for a wide range of occupations covering all sectors of the economy. Unfortunately, existing national skills development policies, programmes and strategies have no correspondence with national climate change policies and strategies. They are mutually exclusive. This works to the detriment of smooth transition of the economy to a greener growth path.

Most of the higher-level skills (e.g. of environmental scientists, economists, engineers, industrial ecologists etc) acquired through foreign education and training already exist in Bangladesh, but they are inadequate in

Table 4. Employment by economic sectors in Bangladesh during 2010-16

SECTOR	LFS 2010		LFS 2013		QLFS 2015-16	
	Number (‘000’)	%	Number (‘000’)	%	Number (‘000’)	%
Agriculture, forestry & fishery	25,405	46.97	26,190	45.1	25,398	42.7
Agriculture Sub-Total	25,405	46.97	26,190	45.1	25,398	42.7
Mining & quarrying	109	0.20	231	0.4	91	0.2
Manufacturing	6,731	12.44	9,500	16.4	8,598	14.4
Electricity, gas, steam & air condition	96	0.18	119	0.2	111	0.2
Water supply, sewerage & waste management	27	0.05	80	0.1	54	0.1
Construction	2,617	4.84	2,144	3.7	3,327	5.6
Industry Sub-Total	9,580	17.71	12,073	20.8	12,180	20.5
Wholesale & retail trade, repair of motor vehicles	7,540	13.94	7,522	13.0	7,949	13.4
Transportation & storage	3,983	7.36	3,745	6.4	4,571	7.7
Accommodation & food service	831	1.54	871	1.5	1,030	1.7
Information & communication	55	0.10	144	0.2	178	0.3
Financial & insurance activities	364	0.67	448	0.8	426	0.7
Real estate activities	35	0.07	74	0.1	101	0.2
Professional, scientific & technical activities	115	0.21	345	0.6	241	0.4
Administrative & support service	487	0.90	423	0.7	284	0.6
Public administration & defence	539	1.00	764	1.3	1,083	1.7
Education	1,285	2.38	1,876	3.2	2,157	3.6
Human health & social work	430	0.80	751	1.3	508	0.9
Arts, entertainment & recreation	67	0.12	53	0.1	80	0.1
Other services	2,358	4.36	1,599	2.8	2,267	3.8
Activities of households as employers	1,006	1.86	1,167	2.0	1,069	1.8
Activities of extraterritorial organizations	4	0.01	27	0.0	7	0.0
Service Sub-Total	19,099	35.31	19,809	34.1	21,952	36.9
All Sector Total	54,084	100.0	58,073	100.0	59,530	100.0

Sources: BBS: 2017, 2015 & 2011.

supply, requiring further skills development programmes. As reported by the DOE, there are critical skills shortages and opportunities for Brownfield Redevelopment Specialists and Site Managers to participate in planning and directing cleanup and redevelopment of contaminated properties for reuse; and for 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. The inadequacy and unavailability of these skills point to the need for specialized skills development programmes in these areas.

In skills training for green jobs NGOs are predominant. Although there is a system for coordinating technical cooperation projects at the level of MEF, the training programme is targeted only on its staff development in environmental administration and management. The ongoing solar energy programmes of various institutions including Infrastructure Development Company Limited (IDCOL), Grameen Shakti, Bright Green Energy Foundation (BGEF) and other agencies have important skills implications for transition to a greener economy. But the training provided for such skills development is taking place very informally, mainly on the job with very little or no coordination nationally. There is no separate institution or systematic process in skills training for green jobs. There is a massive need to upgrade current competence standards (curricula, training programmes etc.) for well-established green occupations. There are virtually no underlying mechanisms for systematic training. New green occupations (e.g. R&D computer, electrical, environmental, mechanical, material engineers, industrial engineers and technicians, system designers, etc) and the design of related competence standards, curricula and training are very important in their own right. No criteria for designing new competence “green” standards have been developed as yet, owing to a lack of a national green skills development policy.

According to BMET sources, in 2012 ILO piloted a formal training programme on solar energy

in collaboration with BMET and GS through a technical assistance programme. GS participated in the programme as an employer. This training programme continued for two months during November-December 2012 in ten District TTCs of Sylhet, Rangpur, Dinajpur, Bogra, Lakshipur, Faridpur, Khulna, Mymensingh, Barisal and Rangamati. Currently this programme is supported by the World Bank STEP project and is continuing in four District TTCs of Rangpur, Dinajpur, Jessore and Rangamati. According to ILO B-SEP sources, during 2010-15 ILO piloted five projects for capacity-building of stakeholders in green jobs: (i) engagement of tripartite partners for awareness of and improved access to ILO's data and information sources on green jobs; (ii) initiation of community-level advocacy on alternative livelihoods promotion for disadvantaged people in ecologically critical areas; (iii) project initiatives which included installation of improved cooking stoves, reduced GHG emission and indoor air pollution; (iv) promotion of green livelihood options in ecologically fragile areas (2012-15) in collaboration with the United Nations Development Programme (UNDP) and World Food Programme (WFP); and (v) development by the TVET Reforms Project of competence standards for Solar Home Systems, piloted in two TVET institutes, linked with GS for employment. Currently ILO is piloting green enterprises and institutionalizing green skills. B-SEP Project is promoting green enterprises for self-employment (a) in organic mushroom production and marketing through eight mushroom cooperatives by 200 persons (mainly women) with disabilities; and (b) linking urban waste management with a greening supply chain of safe food production through (i) waste collection by 90 persons, (ii) organic fertilizer production and marketing by 43 persons, (iii) safe food and seeds production and marketing by 112 persons, and (iv) waste trading by 55 persons.

Further to the ILO's current programmes in Bangladesh, institutionalizing of green jobs and advocacy of the ILO includes (1) developing competence standards on urban waste management and four green occupations in partnership with BTEB; (2) dissemination of a green enterprise project model on urban waste management and safe food production

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to mayors and municipal staff; (3) providing shops on municipality premises for green products (organic fertilizer, organic food and seeds); (4) advocacy for trade licences for small entrepreneurs producing and selling organic fertilizer; and (5) exploring the possibility of setting up a Green Entrepreneurs Network for organic fertilizers and organic food producers. Expanding and deepening the Green Initiatives Skills 21 and Decent Work Country Programme (DWCP) encompasses: (i) Skills21 to further deepen green jobs interventions in skills system through: (a) identifying green occupations in demand in order to develop competence standards and training, (b) improving the technology and processes of a green shift in existing jobs, (c) improving the capacity of the skills system for promoting green jobs and employability, and (d) promoting and supporting green investments by employers; and (ii) DWCP 2017-20 to integrate a green jobs focus in its priority area into skills and employability policies and practices. Among the operational challenges of these green initiatives mention can be made of the following:

- lack of awareness, information, exposure and incentives for green jobs;
- lack of a coherent policy, policy gaps in terms of adequate incentives for greening industries (tax subsidies), greening skills system and creating green enterprise;
- lack of systems for (a) certifying and regulating green products, and (b) measuring carbon footprints to determine incentives;
- lack of market opportunities for green entrepreneurs; *and*
- socio-cultural barriers restricting women's participation in certain green occupations.

As regards GOB initiatives, the Bank of Bangladesh mandated the financial institutions under its jurisdiction to set up Sustainable Financial Units (SFU). But the challenges involved are (i) low awareness among beneficiaries and lack of clarity in operationalizing the newly set up SFUs; (ii) low or insufficient investment demand, lack of skills in assessing the financial implications of environmental risks; (iii) high risk in funding of new green technologies and other untested green ventures; and (iv) high

transaction cost of disbursing green loans to small-scale entrepreneurs with no prior credit records.

For green jobs Bangladesh has no skills development policy or 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 or coordination as such. No skills response strategies are incorporated into a wider greening policy agenda. Nor is there a coherent national strategy or policy targeting meeting of the skills needs for greening the economy. A national HRD strategy for the provision of skills for green jobs is non-existent. In fact the existing national HRD strategy is market-driven, not environmental-policy-driven. There is no green skills identification in HRD strategy development. The National Skills Development Policy adopted in 2011 does not refer to environmental issues at all – not to mention skills for green jobs. National skills development objectives and targets do not reflect national environmental objectives and targets. In general, existing national skills development policies, programmes and strategies have no correspondence with national climate change policies, programmes and strategies. They are mutually exclusive. This works to the detriment of a smooth transition of the economy to a greener growth path.

In the context of greening the economy, skills development policies and strategies are not coordinated with or linked to industrial, trade, technological, macroeconomic and environmental policies. In the existing general and technical education curricula there is no content on developing skills for green jobs. In the same vein, there is no role for the Tripartite Consultative Council or social dialogue in skills development for a greener economy. The largest institutional bottlenecks that hamper skills development for transition to a 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 Ministry of Labour and Employment; and (ii) lack of a clear policy

agenda for developing skills for greening the economy.

Although opinion is divided, compulsory-level education is considered by most experts crucial in promoting green skills among the population. However, initial TVET and continuing vocational training (CVT) are also considered instrumental in greening the economy. There is virtually no role for business management education and training in promoting sustainable entrepreneurship. Generic skills such as leadership, communication, problem-solving, and so forth, in skills provision for green jobs have proved important, especially in the case of NGOs. The existing education and training system including general schooling does not follow a strategy of “mainstreaming” sustainability and environment protection issues within the education and training system. However, although no explicit policy is in place, the government has introduced several chapters on environmental issues and on pollution mitigation in the syllabus from Grade III to Grade VIII in the general schooling system. Moreover 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 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 address (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 in the labour market.

3.1.1 Green restructuring and its impact on the labour market

Broad economic sectors and economic activities with major employment growth potential for green jobs in Bangladesh encompass energy supply, manufacturing, materials (waste) management, construction, trade, transport and telecommunications, agriculture and forestry. According to the LFSs of the BBS, total employment increased from 54.1 million in 2010 to 58.1 million in 2013 and then to 59.5 million in 2015-16 (BBS, 2017, 2015, 2011) with an annual average increase of additional jobs of 1,329,667 during 2010-13 and 485,667 during 2013-16, equivalent to 907,667 over the period 2010-16. Major employment-losing sectors are agriculture and administrative services, while major employment-gaining sectors are hospitality and food service, information and communication, real estate, public administration and defence, and education. Job creation in other sectors either remains constant or experiences ups and downs (Table 4).

The major challenge of the labour market in Bangladesh is that the economy needs to meet the 7thFYP target of raising the average annual growth rate to 7.4 per cent from the current 6 per cent by 2020 so as to absorb all the additional labour force, including most of the underemployed, in about 15 years. According to the 7thFYP, this growth will be inclusive, pro-poor,

and environmentally sustainable. The economy needs to attain job-rich growth, that is with high employment growth achieved along with high output growth. This is a great challenge because of the recent experience of manufacturing in which employment growth has exceeded output growth, and of construction where employment growth has been negative despite positive output growth (2010-13). This requires a genuine structural transformation of the economy through much more diversified growth in general, and of manufacturing in particular. A major challenge is to raise labour productivity and wages in manufacturing. Separate strategies are needed for both the wage-employed and the self-employed (GED, 2015; ADB, 2016).

Readymade garments

The readymade garments (RMG) industry is by far the largest industry in Bangladesh in terms of growth, employment and foreign exchange earnings. Several studies (Islam et al, 2016; BIDS, 2015; ED, 2015) reveal that 5,000+ RMG factories directly employ more than 4.2 million workers accounting for around 55 per cent of total manufacturing employment; the RMG industry in Bangladesh is the second largest in the world after China. It has also contributed tremendously to empowering women as almost 90 per cent of its labour force is female, the highest percentage in South East Asia. RMG also accounts for almost 14.1 per cent of GDP as well as 81 per cent of total export earnings. The study, however, identifies some challenges to its future development including such elements as unskilled workers, inappropriate infrastructure, an energy crisis, a bank loan and high rate of interest, a high tax rate, complex social compliance, a political crisis, a lack of market and product diversification, compliance pressure of accord and alliance and lack of integration. Therefore, collaborative and coordinated steps from both public and private sectors need to be initiated to overcome these challenges.

According to a study by the World Bank (2016b), Bangladesh can create millions of jobs for garment workers in the RMG sector through improving productivity and social and environmental compliance. Currently the country's garment sector employs 4.4 million workers, of whom 80 per cent are women. The study observed that China is the largest apparel supplier with a 41 per cent global market share, Bangladesh being the second largest with a 6.4 per cent share. Bangladesh is likely to benefit from the shifting of work orders from China, as China is losing its market share owing to the higher cost of production.

A 1 per cent increase in Chinese apparel prices could increase firms' demand for female labour by 0.44 per cent in Bangladesh and 1 per cent increase in output could increase firms' labour demand by about 0.3 per cent in Bangladesh, according to the study. The study also stated that a 1 per cent increase in Chinese apparel prices could increase the demand for Bangladeshi apparel items to the United States by 1.4 per cent. The findings stated that a 1 per cent increase in apparel outputs is associated with a 0.3-0.4 per cent increase in employment for both men and women in Bangladesh, Pakistan and Sri Lanka. These results suggest that the sector has a larger potential for job generation in Bangladesh in response to an increase in exports than other sectors, especially for women. The study also found that for the US market a 10 per cent increase in Chinese apparel prices would increase apparel employment for males in Bangladesh by 4.2 per cent.

Bangladesh has steadily increased its share of global apparel trade above the world average at a greater rate than China but less than that of the South East Asian countries. The study report highlights that Bangladesh needs to improve performance in non-cost factors important to global buyers.

Among the major occupations in the RMG sector are: Cutters, Sewing Machine Operator, Fusing Machine Operator, Over lock Machine Operator, Button Machine Operator, Kansai Machine Operator, Finisher (Iron), Quality Inspector, Embroidery Machine Operator, Folder, Poly Man/Woman, Packer/Packing Operative, Quality Controller and Merchandiser. A BIDS

study (2016) shows that over the years 2010-2015 the skill composition of workers has changed substantially. In 2010 about 28 per cent workers were unskilled, decreasing to 16 per cent in 2015, and that the decline has been compensated for mostly by an increase in the share of skilled workers which was 43 per cent and 56 per cent respectively in 2010 and 2015.

According to BGMEA (Bangladesh Garment Manufacturers and Exporters Association), the RMG industry is making strides in terms of environmental compliance in order to have a sustainable footing in the global apparel market. Many RMG factories are adopting green technologies and practices on their own. They are using cleaner technologies and producing garments in a caring and responsible way that preserves the environment for future generations. Already a large number of RMG factories achieved LEED certification from the US Green Building Council (USGBC) for their green practices.

There is a pressing need to ensure that the growth of the RMG sector does not come about at the expense of environmental degradation and inefficient usage of resources. Issues such as energy efficiency, waste water treatment and green renewable technologies will be of paramount importance for its long-term success and sustainability in Bangladesh. Experience shows that investing in green technology is good not only in terms of reducing costs, but also in terms of obtaining more international customers. There is a growing pressure from the international fashion brands and buying houses for greening the RMG industry; some of the brands already have a strategy to move towards greater sustainability, such as H&M who have just launched their strategy for 100 per cent circularity; this includes favouring factories that invest in energy efficiency, reduction and recycling of water, renewable energy and other green technologies. An energy audit (ED, 2015) reveals that the potential for savings in the utility area of the RMG is of the order of 67,000-110,000 GWh per year.

As regards skills training for the RMG workers, apart from on-the-job training a number of public and private technical training centres are involved. Besides, BGMEA also runs 12

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training centres and one technical institute (university). Bangladesh Knitwear Manufacturers & Exporters Association (BKMEA) also runs six training institutes for unskilled workers. Some private institutions such as UCEP and NGOs such as UDDIPAN, TMSS and Dhaka Ahsania Mission provide skills training on RMG trades. UCEP offers its TVET programme through its ten technical schools in eight districts and also through outreach centres with the government in two districts as well as in the campus of UCEP's General Education set-ups in a number of locations. UCEP has training facilities for five RMG trades including Quality Control Management, Sewing Machine Operation, Tailoring and Dress Making, Industrial Sewing Machinery and Linking Machine Operation. All trades except Tailoring and Dress Making, with a 6-month duration and 120-200 students in 10 technical schools. Table 5 presents training courses on RMG trades offered by technical training centres (TTCs). These training courses, however, do not provide skills for green jobs in the RMG sector, pointing to a massive need for retraining the RMG workers.

The greening of the RMG industry results primarily from the social and environmental concerns of foreign buyers of RMG products. It appears that environmental pressure on RMG has a role in promoting its transition to greening of economic activities. The structural transformation arises not merely from economic growth but also from spontaneous green structural change. It appears that current and future employment shifts and trends are likely to take place in RMG as a result of anticipated green structural change, notably in energy-efficiency, waste treatment and green buildings. The green employment shift to RMG seems to be gaining momentum. This structural transformation is derived not merely from economic growth but also from green structural change.

The concerns of foreign buyers usually translate into the provision of corresponding skills for green jobs in RMG. Currently there is a huge gap in the skills provision for green jobs at all levels of the RMG workforce, especially among the top management, for example Managing Directors and Production Managers; at the mid-level, Electrical, Dyeing and Textile Engineers, and Supervisors, for example; and at workers' level, all

kinds of machine operators. New types of skills and competences need to be incorporated into these existing occupational profiles (i.e. greening of existing occupations). BGMEA and BKMEA may take the initiative in engaging relevant environmental experts in the existing public and private TTCs for training the workforce in green jobs.

Natural disaster management

Bangladesh is one of the most vulnerable countries to natural disasters in the world. The World Risk Index (WRI)¹ 2016 shows that Bangladesh ranks fifth with a 19 per cent risk (among the top five countries most at risk worldwide) compared to, for example, Germany with a 3 per cent risk. This is attributable to very high vulnerability and very high exposure (32 per cent among the top ten most exposed countries worldwide) of Bangladesh to natural disasters, for example cyclones and floods. The vulnerability of Bangladesh, according to WRI, is as high as 61 per cent with 38 per cent susceptibility, 86 per cent lack of coping capacities and 57 per cent lack of adaptive capacities. According to the Global Climate Risk Index 2017 by the think-tank Germanwatch (2017), Bangladesh ranks sixth among the world's top 10 countries most affected by extreme weather events in the last 20 years (1996-2015). A total of 679 people died in 185 climatic events in Bangladesh. As a result, the country lost a total of 2,283 million US\$ PPP or 0.73 per cent of its GDP. In the FM Global Resilience Index (FM Global, 2017) Bangladesh is ranked 111th, with a score of 21, out of 130 countries and territories, because it has the largest area that is both devoted to economic activities and exposed to riverine flood, along with a high urbanization rate. In terms of economic factors its rank is even worse (120th with a score of 10); in terms of risk quality its rank is 85th with a 32 score, while in terms of supply chain its rank is 105th with a 26 score. Compared to the 2016 Resilience Index, however, Bangladesh has improved from 117th to 111th (composite index), worsened from 117th to 120th in terms of economic factors, improved in risk

¹ The WorldRiskIndex is calculated with 28 individual indicators and rates the disaster risk for 171 countries owing to five natural hazards: earthquakes, cyclones, floods, droughts, and sea-level rise (UNU-EHS, 2016).

Table 5. Training courses on RMG trades offered by TTCs

SL NO.	TRADE / COURSES	NO. OF TTCs	AVG. DURATION	AVG. STUDENT CAPACITY
Public Technical Training Centers				
1	Woven Garments Machine Operator	20	2-6 months	37
2	Knit Machine Operator	1	2 months	60
3	Dress Making and Tailoring	6	6 months	42
4	Dress making & Embroidery	7	6 months	43
5	Mid-Level Garments Supervisor	10	6 months	55
6	Quality Control Management	10	6 months	37
7	Sewing Machine Operator	24	6 months	43
8	Pattern, Marking & Design man	3	6 months	60
9	Certificate in Garments Manufacturing	4	2 months	27
10	Boutique and Block batik	2	6 months	65
11	Sweater & Linking Machine Operator	1	6 weeks	30
12	Sewing Machinery Maintenance	1	3 months	30
Total sample TTCs		40		
Private Technical Training Centers				
1	Quality Control Management	11	3-6 months	50-120
2	Dress Making and Tailoring	15	6 months	30-60
3	Dress making & Embroidery	15	6 months	25-120
4	Boutique and Block batik	6	6 months	30
6	Industrial Sewing Machinery	12	6 months	40-60
7	Linking Machine Operation	10	6 months	60-120
8	Merchandising & Apron Merchandising	3	6 months	25-60
9	Pattern Making Operation	1	6 months	30
10	Production Planning and Controller	1	6 months	30
11	Garments Design & Pattern Making (Diploma)	1	4 Years	150
12	Dying Textile Engg. (Diploma)	1	4 Years	160

Source: BIDS Study (2016).

quality from 89th to 85th and in terms of supply chain from 117th to 105th. According to the United Nations (2015), floods are the most frequently-occurring natural hazard globally – the hazard escalating to disaster when human lives are lost and livelihoods are damaged or destroyed. This is despite the fact that much of the impact from flooding is both predictable and preventable.

Advanced flood mapping provides tremendous improvements in the detection of flood exposure. Solutions for flood protection include dams and dykes, afforestation and reforestation, better early warning systems, floodplain zoning and the restoration of wetlands. At a company level, flood mitigation solutions include erection of flood barriers, sealing of walls and floors, and provision

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of flood pumps and other mitigation equipment. In recent years the nature of disastrous floods has changed, with flash floods and acute riverine and coastal flooding increasingly frequent. Severe weather contingency plans are essential when managing enterprise risk.

There are huge potential skills and job requirements in natural disaster management. This sector is likely to include increased demand for green occupations with growth in employment related to environmental protection in occupations such as environmental science and natural science management. Several occupations in this sector are likely to include green-enhanced skills occupations with changes in the actual tasks or competences required for occupational performance. For instance, occupations such as environmental engineers, hazardous materials removal workers, environmental engineering technicians, atmospheric and space scientists, and soil and water conservationists may expand to include new tasks and competences. Finally, this sector is very likely to include green occupations resulting in the creation of new or substantially unique occupations. Some examples of these potentially novel occupational roles are associated with specialization in water resources, redevelopment of “brownfields,” analysis of climate change, certification of environmental quality, and industrial ecology (Dierdorff et al, 2009). Green occupations in increased demand may include the following: Forest and Conservation Workers, Forest and Conservation Technicians, Hydrologists, and Natural Sciences Managers. Green-enhanced skills occupations may include Environmental Engineering Technicians, Atmospheric and Space Scientists, Soil and Water Conservationists, Landscape Architects, Construction Managers, Engineering Managers, Environmental Engineers, Environmental Science and Protection Technicians including Health, Environmental Engineering Technicians, Geoscientists, and Hazardous Materials Removal Workers. New and emerging green economy occupations may include Climate Change Analysts, Environmental Restoration Planners, Environmental Certification Specialists, Environmental Economists, Industrial Ecologists, Water Resource Specialists and Water or Wastewater Engineers (ibid.).

Telecommunication

Grameenphone (GP) has brought about a revolutionary change in the telecommunications sector with the introduction of ecofriendly cell phones replacing landlines to a phenomenal extent in Bangladesh. In telecommunications GP targets massive carbon cuts. GP had set a target for reducing carbon emission by 30 per cent from its entire range of operations by 2015. GP has so far managed to reduce carbon dioxide (CO₂) emissions by 15 per cent from its entire range of operations such as networks, transport 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 driving force behind GP's green initiatives lies in the fact that Grameen Telecom, which owns 34.2 per cent of the shares of Grameenphone Ltd., is a not-for-profit company. It has emerged as a centre of excellence through its core competence and resource efficiency.

Grameenphone believes that climate change is a real threat to the world and hence, with its large operation in Bangladesh, the company has a major responsibility for minimising the impact on the environment. Consequently Grameenphone's first priority was to take responsibility for the carbon emissions (CO₂) generated by its own operations. Grameenphone set a target of reducing CO₂ intensity by 30 per cent in 2017 from the business-as-usual situation, taking 2011 as the baseline. Grameenphone is dedicated to the continuous deployment of enhanced sustainable solutions for energy-efficient and environment-friendly networks, which ultimately supports the country's efforts with respect to offsetting the effects of climate change.

Grameenphone has taken a number of green initiatives to reduce its carbon footprint individually and collectively. All the initiatives ensure CO₂ reduction through energy-efficiency, increased use of solar energy over fossil fuel, limiting the use of valuable resources, reducing travel requirements for operations, and lastly creating greater environmental awareness among its employees and stakeholders.

In December 2015 Grameenphone took the initiative of certifying its Environmental

Management System (EMS) as per the ISO 14001:2004 standard. After two stages of comprehensive audits conducted by the International Certification Body “Bureau Veritas”, Grameenphone received the ISO 14001 certification, which means that it has complied with the various clauses of the ISO 14001:2004 standard. By having this ISO 14001 certification, Grameenphone can assure stakeholders that its EMS meets international industry-specific standards. It has targeted: (i) reducing CO₂ intensity by 30 per cent by 2017, and (ii) establishing a green company. In terms of management control it promotes: (a) EMS, (b) green champions, and (c) business reviews. Measures taken in this regard include: (i) internal optimisation and modernisation in networks, IT and offices; (ii) aggressive rollout of solar sites; (iii) E-waste management; and (iv) employee awareness (GP, *ibid.*)

Among the Grameenphone's green initiatives mention can be made of the following (GP, *ibid.*):

As of 2016, solar power has been deployed in 1,113 sites (a 6.1 per cent increase compared to 2015) in electricity-constrained zones which are producing 6.11 GWh (27.3 per cent increase over 2015) of solar-powered electricity annually. These solar sites save approximately 1.87 million litres of fuel which is equivalent to an annual reduction of over 4,900 tonnes of CO₂. In 2016 Grameenphone converted 130 Generator+Solar sites to Commercial Power+Solar Hybrid Sites. The newly introduced hybrid sites will provide additional savings of 511,000 litres of fuel, equivalent to a reduction of around 701 tonnes of CO₂ per year.

Grameenphone is continuously committed to minimising the environmental impact of its operations. Its ISO 14001:2004-certified EMS policy provides the framework for setting and reviewing its environmental objectives and targets, setting the platform from which to progress.

E-waste Recycling: as of 31 December 2016 more than 383 tons of e-waste (GSM and microwave antennas and other electronic accessories) have been recycled through recycling partners. The recycling is undertaken in Bangladesh and overseas in accordance with ISO 14000, OSHAS 18000, and R2 standards.

Battery Reuse & Recycling: Recycling and

100 per cent reuse of used lead acid batteries have been set as an internal KPI. So far 18,369 old batteries have been recycled and 8,500 refurbished batteries were reused in 2016.

However, after all the structural changes taking place, greening of telecommunications has considerable implications for both current and future employment in this thriving sector. Skills for green jobs in telecommunications, especially for network engineers and technicians, are still in their formative stage initiated by GP. In the case of skills for green jobs at the lower end of the skills range, such as recycling and re-use of materials, on-the-job training is considered sufficient. This state of affairs points to the need for (re)training of the engineering and technical workforce currently employed in telecommunications. To this end the Bangladesh Telecommunication Company Limited (BTCL) and GP may join hands in retraining the existing BTCL workforce on a regular basis.

Organic waste recycling through composting

According to DCC an estimated 4,600-5,110 tonnes of waste is generated daily in the metropolis, with high organic content and high moisture content (about 80 per cent and 50-70 per cent by weight, respectively). The city has experienced a number of adverse impacts from improperly-managed waste, including a prevalence of diseases, contaminated ground water and poor air quality.² In Bangladesh most organic waste remains unutilized. There is inadequate legislation in the country to address the growing problem of organic waste. Waste management, along with organic waste management, is entrusted to the urban local government bodies. The responsibility for 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 of disposal of municipal waste. But most of the

2 According to FAO, CO₂ emissions in agricultural sector from 1992-2012 is OM an average 66,343 Gigagrams and it is 6,308 Gigagrams from synthetic fertilizer. By composting organic waste, the peak rate of greenhouse gas methane generation would be low and the residue could be a good organic fertilizer for organic crop cultivation.

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time it is not implemented correctly. However in the meantime two compost plants have been built for waste recycling through composting in Narayanganj City Corporation and Mymensingh Pourashava (Municipality) and two more are under construction in Rangpur City Corporation and Cox's Bazar Pourashava (Municipality) by DOE (2016).

The Waste Concern and WWR Bio Fertilizer Bangladesh Ltd. plant, an organic waste recycling project near Dhaka, are actively involved in the waste greening initiative. Under this project vegetable waste from Dhaka's market is being collected using the project's own transport networks, and taken to composting plants. 800 new jobs had been created through this plant during 2008-09. In addition about 120,000 people are employed in recycling in Dhaka city and this is also being replicated in other cities. 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 around 450 new jobs for collecting organic waste from municipal markets and 800 new jobs for aerobic composting have been created. Through utilizing organic waste in composting plants such as Waste Concern, Bangladesh can reduce gas emissions and obtain extra money from carbon trading. Major occupations in this sector include garbage cleaners, garbage collectors, supervisors, machine men, truck drivers, Conservancy Inspectors and so forth. The sector has huge potential for greening of the environment and creating new green-collar jobs in waste recycling, at the same time replacing some old jobs in waste collection through retraining.

Organic farming: Naya Krishi (New Farming)

According to IFOAM, organic agriculture is based on four principles: (i) health – healthy soil, plants, animals, humans for a healthy planet; (ii) ecology – emulating and sustaining natural systems; (iii) fairness – equity, respect and justice for all living things; and (iv) care – for the generations to come. This awareness is still not firmly rooted in the farming practices of Bangladesh which is characterized mostly by the use of modern inputs such as chemical fertilizers, pesticides

and irrigation methods which are harmful to the environment. The country's deep-tubewell-dependent irrigation cultivation destroys crop diversity. Withdrawal of underground water for such irrigation is causing a serious water crisis in the rural areas and the water level is falling every year. There are so many varieties and species which are tolerant of different climatic conditions, soils and topography. For example, many varieties of rice (Aus) and millets grow well in dry weather conditions but some are water-demanding and prefer wet conditions. Some crops are shade-loving, some are partially so but others requires long sunshine hours. The farmers need to know which crops grow in which conditions and also about their crops' interrelationships among themselves and with other species. Therefore the farmers should know about the usage practices and ideal conditions for growing crops and need to bring more species under a cropping culture to save biodiversity and maximize the use and productivity of land.

Nowadays organic farming is conducive not only to health but also to meeting the greening demand for land fertility. In organic agricultural practice farmers do not depend on modern inputs but use organic and bio-inputs for cultivation. The farmers utilize their communal agricultural knowledge and obtain relevant support through various NGOs (e.g. UBINIG) for setting up, promoting, preserving and updating traditional skills in Bangladesh and for implementing organic farming training programmes so as to improve working possibilities for women and help them become independent. The farmers' training is based on promotion of organic farming and seed preservation. It is provided mainly by NGOs' own staff. NGOs thus contribute greatly to retraining the farmers to achieve the green restructuring from current practice to organic practice.

Depletion of soil organic matter is the main cause of low productivity, which is considered as one of the most serious threats to the sustainability of agriculture. Plants in organic systems are cultivated without artificial pesticides or readily-available fertilizers but in Bangladesh most soils contain less than 17g of organic matter per kilogramme. Farmers are facing difficulties with soil fertility related to organic matter depletion.

Moreover, owing to an increase in the cost of production compared to the stagnation of rice yields, rice farming is currently a non-profitable enterprise for farmers (Mohiuddin, 2016).

PROSHIKA (NGO) is the pioneer of organic farming in the country. Since 1978 PROSHIKA has begun to spread ecological practices among its group members by growing varieties of seasonal vegetables. PROSHIKA's Ecological Agriculture Programme had involved around 0.8 million farmers in organic cultivation across 0.22 million acres of land, of whom 0.22 million have started to practice ecological agriculture on 0.08 million acres of land over the last five years. PROSHIKA has also introduced an organic vegetable marketing project to promote consumption of organic vegetables. Currently one marketing channel of PROSHIKA is selling organic products to the public in the Mirpur area of Dhaka city. Furthermore mobile vans are being used to sell organic vegetables in some areas, including apartment complexes, very large shops and departmental stores.

According to key informants, a small number of non-NGO and conventional farmers have started to cultivate organic crops. Among the few private companies that have started to invest in organic farming, Kazi and Kazi Ltd. is a leader. They have established an organic tea garden at Tetulia, in the Panchagarh district. This tea is certified by the SGS organic production standard in accordance with EU Regulation 2092/91, and is marketed as Meena Tea. This company also produces fresh organic vegetables and herbs for sale in their supermarket, Meena Bazar, in Dhaka city. The Barind Multipurpose Development Authority, a Bangladesh government organisation, has had some success in organic farming and in agricultural and aquacultural techniques.

This sector has very high potential for greening stemming from both environmental and economic considerations. In terms of economic aspects, this agricultural practice creates new employment opportunities, especially for women (since they are mainly involved in preserving organic manure and seed) and save much foreign exchange through not utilizing chemical fertilizers and pesticides which are mostly imported. Those mainly involved in this

activity include agricultural workers, agricultural advisors, chemists, traders and farmers. This sector has huge potential for creating new green-collar jobs through retraining traditional agricultural workers and farmers in organic farming. There exist huge green skills gaps among the farmers and agricultural workers all over the country.

Shrimp cultivation

According to World Aquaculture (2013), in recent years the farmed shrimp sector has become increasingly important for Bangladesh, with 97 per cent of production exported. Shrimp represents the country's second largest export after garments, contributing about 4 per cent to GDP and employing approximately 1.2 million people in production, processing and marketing. Including family members, about 4.8 million Bangladeshi people are directly dependent on this sector for their livelihoods. According to BFFEA (Bangladesh Frozen Foods Exporters Association), women accounts for over 60 per cent of total employment in shrimp processing factories and around 30 per cent of total employment in shrimp fry catching.

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. People are moving from agriculture to shrimp cultivation because of surplus labour in agriculture and high profits from 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 waterlogging 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 shrimps. 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

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by shrimp cultivation, making it imperative to introduce new technology in shrimp cultivation so that 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 storekeepers, fry depot managers, fry commission agents, Gher makers, shrimp collectors, shrimp cleaners, de-heading workers, shrimp packers, sluice gates operators, shrimp plant managers, grading workers, production workers, laboratory assistants, refrigeration assistants, processing operators, supervisors and so forth. Thus there is an urgent need for retraining of the workers involved in shrimp production, processing and export in order to protect the environment and make the sector environment-friendly and sustainable. Retraining is needed here owing to the restructuring in agriculture and fisheries. The occupations in this sector which need retraining include: Senior Grader, De-heading Operative, Checker, Scaleman, Panner, Production Supervisor, Packers, Cold Storage Worker, Senior Operator, and Operator.

3.1.2 Identification of (re)training needs

The retraining needs were identified by the researcher in consultation with the organizations and enterprises initiating or addressing the greening of the economy. No labour market information (LMI) service is yet in place in Bangladesh to collect information on the retraining needs for green jobs.

3.1.3 Skills response

The skills response (retraining, TVET) to meet the challenge of the green economic restructuring remains limited in Bangladesh. There are no active labour market policy measures or 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,

BGEF, GP, NAVANA CNG and Waste Concern, and funded by the NGOs with donor assistance.

3.1.4 Case studies

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

- i) refuse/waste collectors and dumpers; and
- ii) agricultural workers and inspectors in organic farming.

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

Case study on refuse/waste collectors and dumpers

There are mainly three types of occupation category involved in the process of waste management. They are (a) waste collectors, (b) waste dumpers, and (c) drivers of waste carriers, which are traditional jobs. The jobs of the people involved in these three categories are becoming obsolete owing to changes in the traditional manner of collecting waste and dumping. In the traditional way, waste is collected from different houses and different points in the cities and is then dumped in fixed open spaces, which creates a negative impact on the environment such as the spread of vermin (responsible for more than 40 diseases), methane gas (bad odour and GHG), leachate (polluting grass and surface water) and so forth. In 1995 Waste Concern, a private company, was established to create a common vision of contributing 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 known as community-based waste management by mobilizing local people. Coping with the new

way of collecting waste requires (re)training of existing employees actively involved in the process of waste collection and dumping. Waste Concern professionals are conducting training programmes or workshops on solid waste management, recycling, composting, clinical waste management, urban environmental management, municipal infrastructure planning and environmental impact assessment, but this is insufficient for the large number of households (Mondal et al, 2010).

In order to promote the idea and practice of converting waste into resources, Waste Concern established a Recycling Training Centre at Kanchpur, Dhaka and CDM-Based Compost Plant at Bulta, Roopganj, Greater Dhaka. During the period 2015-2017 Waste Concern worked on the following assignments (Waste Concern Website):

(1) 3R (Reduce, Reuse and Recycle) Pilot Initiative to reduce the impact of GHG in Dhaka and Chittagong cities (Phase 1) (Client: DOE); under this project Waste Concern will provide the following technical support: (i) preparation of a detailed technical architectural and structural design drawing for the construction of two compost plants, one under Dhaka North City Corporation (DNCC) and one under Dhaka South City Corporation (DSCC); (ii) preparation of a detailed technical architectural and structural design drawing for the construction of four Transfer Stations for municipal solid waste, two in DNCC area and two in the DSCC area; (iii) assistance to DOE for carrying out capacity-building training and income-generating activities; developing awareness-generating materials to enable DOE to carry out awareness-generation programmes on waste recycling, composting and segregation of waste for citizens, local NGOs, CBOs and the private sector; and (iv) support for DOE in linking the project to the Government's existing 64 District CDM projects.

(2) Disposal of Empty Pesticide Containers (Client: USAID Agro-Inputs Project (AIP)/ CNFA): under this assignment Waste Concern is responsible for laboratory testing and data collection relating to the use and disposal of empty pesticide containers. Data derived from this research will be used to identify a

viable pilot project on used pesticide container management.

(3) Sanitation and Solid Waste Management under the DDS Consultant, Coastal Towns Environmental Infrastructure Project (CTEIP. Client: ADB/LGED): under this project Waste Concern and Borda Ltd. are responsible as sub-consultants of Eptisa Engineering for (i) finalization of sub-projects for implementation (integrated sanitation and solid waste management), (ii) preparation of detailed Engineering Design Reports, inclusive of preparation of specifications, cost estimates, drawings and bills of quantity (for the identified sub-projects, that is community sanitation, Fecal Sludge Management and SWM), and (iii) supporting the DDS Consultants on preparation of bidding documents, DDR and IEE/EIA reports for selected interventions for implementation.

(4) Improved Slaughter-House Waste Management Using Biogas Technology at Gazipur City Corporation (Client: GIZ): under this assignment, Waste Concern is providing technical support for assessing slaughter-house waste management using biogas technology at Gazipur City Corporation and providing practical solutions to improving the operational efficiency and bio-slurry management system.

(5) Solid Waste and Faecal Sludge Management, under the MDS Consultant, CRDP Project (Client: ADB/LGED): under this project Waste Concern is responsible as sub-consultant to Hifab International AB for a review of existing data on solid waste for selected cities and towns as well as identification of gaps in the service chain of solid waste management, identification of potential options for solid waste recycling, treatment, disposal, and recommendation of the best possible options for the selected cities. Moreover, under this project Waste Concern is responsible for the engineering design of controlled landfill and resource recovery facilities and for recommendation of the most suitable options for implementation of the project involving the private sector. Apart from the solid waste, Waste Concern is also responsible for review of the faecal sludge management services of selected cities as well as for estimates of demand for faecal sludge collection and treatment and design of an appropriate

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faecal sludge management system including preparation of a business plan.

Waste Concern conducts training programmes and workshops on solid waste management, recycling, composting, clinical waste management, urban environmental management, municipal infrastructure planning and environmental impact assessment. The trainees are drawn from officials and staff of municipalities, government and NGOs.

From Table 6 it is evident that the urban population is growing steadily over time and it is expected that, with the increase in the urban population, the waste generation rate will increase substantially. Various sources indicate that the rate of waste generation is highest in Dhaka city compared to other cities. Waste Concern estimated that average *per capita* urban waste generation rate is about 0.41 kg/capita/day.

As mentioned earlier, 120,000 urban poor from the informal sector are involved in Dhaka city's recycling trade chain. The number of poor people involved in this process in other cities of the country works out at 0.3-0.4 million. Most of these poor people are involved in the dumping process and do not apply any sustainable scientific method. As a result the city dwellers suffer from many diseases. To create an environment-friendly means of waste collection and waste dumping and to produce some products through recycling of waste, it is necessary to train them. Specifically,

to convert organic waste into compost using the community-based decentralized approach integrated with house-to-house waste collection and also to produce used or enriched compost in agriculture, rigorous training of such people is needed. The probable impact of this training will be that existing waste collectors will not lose their jobs, new job opportunities instead being created for these hardcore poor people. In addition it will help to improve the quality of life and the environment.

According to a conservative estimate by the author, currently there are at least 150,563 garbage collectors and related labourers in the country. They are not familiar with clean garbage collection and disposal, which points to their need for training in environment-friendly skills.

The practice of environment-friendly collection and recycling of wastes is a decade-old development initiated by Waste Concern. Those in the three traditional occupations are adapting to new methods of waste collection and recycling and are gradually shifting their jobs, albeit on a limited scale. Fresh recruits are also entering the emerging green jobs market to meet the skills needs and bridge the skills gaps especially in the respective occupations, e.g. Sustainable Design Specialists, Hazardous Waste Management Specialists and Solid Waste (Energy) Engineers and Managers. These recruits are trained on the job mostly by Waste Concern. In cases where skills gaps are critical, foreign training is also arranged with

Table 6. Trend of urban population in Bangladesh

YEAR	URBAN POPULATION	URBAN POPULATION (% OF TOTAL)	URBAN POPULATION GROWTH (ANNUAL%)
1991	22,024,916	20.26	4.59
2001	32,314,461	24.10	4.02
2011	48,058,996	31.23	3.63
2014	53,426,273	33.52	3.46
2015	55,254,828	34.28	3.37
2016	57,090,079	35.04	3.27
2025**	78,440,000	40.00	-
2050**	112,443,000	56.00	-

Source: **From World Urbanization Prospects: The 2014 Revision. All others are from World Development Indicator 2017.

the assistance of partner donors, especially UNDP and the Dutch government. Among green-enhanced occupations required for the future are Hazardous Material Removal Workers, Hazardous Waste Management Specialists, Solid Waste (Energy) Engineers and Managers, Green Building and Recyclable Materials Distributors, Recycling Collection Drivers, Recycling Coordinators, and Sustainable Design Specialists. All of these skills are increasing in number in Bangladesh with the assistance of the donor agencies, albeit 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 on community-based solid waste management and resource recovery. These training modules have been utilized by Waste Concern for training workshops in Dhaka and other Bangladesh cities. One module is targeted on municipal and other local governmental officials, the second is targeted on 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, recover, reuse and recycle 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, as 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 (Waste Concern Website).

Waste Concern asked government agencies to provide land, water and electrical connections for establishing 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 operating and maintenance costs.

The main goals of Waste Concern 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) rainwater 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 seven tons per day; a conference room; a compost enrichment facility; a rain-water harvesting system; waste-water recycling; a solar lighting system; and eco-sanitation composting facilities (ibid.).

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. It 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 on the farm. It is crop or stock farming in which only natural fertilizers, pesticides and nutritional supplements are used. Hormones and synthetic chemicals are not used at all. Organic farming is free of synthetic chemicals. It entails production in soils of enhanced biological activity, determined by the humus level, crumb structure and feeder

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root development, so that plants are fed through the soil ecosystem and not primarily through soluble fertilizers added to the soil. It is an agricultural practice which promotes biodiversity, biological cycles and biological activity within the soil, accompanied where possible by the use of agronomic, biological and mechanical methods as opposed to use of 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 aim 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 an organic lifestyle believe that food produced in this manner is of higher quality and possesses higher nutritional value compared to food produced by conventional chemical-based methods. Organic farming and organic food production have some other basic rules, which are: (i) no use of chemical fertilizers or synthetic drugs; (ii) no use of genetically-modified organisms; (iii) prevention of soil loss and erosion; and (iv) promotion of 'bio-diversity' – that is supporting 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 the Population Census 2011 (the latest available census), its population was about 153.9 million and 68.8 per cent of this population are living in rural areas. Despite the significant effort to reduce poverty being undertaken by the GOB, around half of the rural population are still poor. The agricultural sector is the main livelihood source for the vast majority of rural people in Bangladesh. It contributes around 14.1 per cent of the country's GDP (2015-16) and provides about 43 per cent of its employment (BBS, 2017). Thus to reduce rural poverty it is necessary to boost agricultural production. Over the last couple of years, owing to an increase

in the cost of production of rice compared to elsewhere, rice farming is currently an unprofitable enterprise. As a result, farmers are moving from rice production to other profitable crops such as maize and researching new varieties of crops which are likely to be profitable.

According to FiBL & IFOAM (2017), in Bangladesh organic farming was initiated by the private sector and has become popular throughout the country since the 1990s. Government involvement only began after two decades, but in 2016 the organic sector received a boost through the approval of the "National Organic Agricultural Policy". This policy was approved on 7 November 2016 in a cabinet meeting and is in the process of receiving gazette notification. Approval of this organic policy is a major step in the development of the organic sector in Bangladesh.

After observing the benefits of cultivation of organic crops by NGO farmers, a small number of progressive farmers and private entrepreneurs have come forward to cultivate organic crops for domestic and export markets. These entrepreneurs are Sobazpur Tea Company Ltd, a sister concern of Square Group; Green Bangla Organic Farm and Rahmania Organic Farm; Kazi and Kazi Tea Estate (KKTE) Ltd; and WAB Trading International Ltd, who have all come forward in this new sector. The leading company, KKTE, produced 430 metric tons of organic tea in 2015 which was exported as Meena Brand to the USA, Japan, UK and Germany. A small amount of lemongrass, tulsi, ginger, mint, chilli and others were following organic practices for the domestic market in 2016. On the other hand, about 3,000 metric tons of organic shrimp was exported by WAB Trading Int'l Asis Ltd in 2016.

It is expected that the organic sector will gain momentum now that the national organic policy has been approved, and that interested organic farmers and entrepreneurs will gain access to incentives such as low-interest loans and other financial support available to conventional farmers. Furthermore, this policy also ensures the availability of the inputs required for organic farming and market facilitation, including certification. However there is still an absence of an accredited domestic certification body and a lack of infrastructure and skilled organic experts.

With a few exceptions, organic farming in Bangladesh still takes place largely on an experimental basis. The total land area under organic cultivation in Bangladesh has been estimated at 6,860 hectares ((FiBL & IFOAM, 2017)), representing only 0.1 per cent of the country's total cultivable land. By 2017 only 9,335 of its traditional farms had shifted to organic agriculture or were just starting. Since the introduction of organic farming in Bangladesh by the NGOs, the movement is still being largely driven by them.

PROSHIKA champions organic agriculture practice in cropland and vegetable production. Currently, a total of 762,395 farmers in 19 districts have been practicing organic agriculture on 227,716 acres of land. So far, a total of Tk. 628.9 million has been disbursed to 14,322 projects. The PIAF Trust of PROSHIKA is facilitating the marketing of organic vegetables and foodgrains produced by the group's members as well as by its own agricultural farms. Organic vegetables are always available in PROSHIKA's 'Trinamul' sale centre in Dhaka. That apart, vegetables are supplied to different apartment complexes, mega-shops and department stores in Dhaka city (Proshika, 2016).

According to UBINIG, currently at least 300,000 farmers in 19 districts practice Nayakrishi. In all the farming households women are the key persons preserving seeds and have therefore taken the lead in the movement. They have formed the Nayakrishi Seed Network in a systematic structure to involve women at different levels of their expertise. Ten rules of the Nayakrishi Programme of UBINIG include: (1) absolutely no use of pesticide; (2) *in situ* and *ex situ* conservation of seed and genetic resources; (3) production of healthy soil without external inputs, particularly chemical fertilizer; (4) mixed cropping; (5) production and management of both cultivated and uncultivated spaces; (6) no extraction of groundwater, along with conservation of water and efficient surface water use and management; (7) learning to calculate output in terms both of single species and varieties and of system yield; (8) integrating livestock in the household to produce more complex household ecology to maximize the benefits and wellbeing of both humans and

other life-forms; (9) integrating water and aquatic diversity to generate more ecological products; and (10) integrating non-agricultural rural activities to ensure the prosperity of the local communities as a whole (UBINIG, 2016).

The involvement of the farmers in organic farming through training programmes provided by PROSHIKA and UBINIG is increasing and today spans 38 districts and 1,062,395 farming families (with an average of five members per family). 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 a significant role in boosting organic farming. The areas in which organic farming is expanding mainly reflect the communal agricultural knowledge of workers and some support from different NGOs such as UBINIG and PROSHIKA.

Skills needs for organic farming are identified through local-level staff of the Department of Agriculture and the NGOs who are actively engaged in spreading organic farming. Initially, the staff of the NGOs try to convince local farmers that everyone should adopt organic farming as it is highly environment-friendly and more profitable. It then requires training of those farmers who are willing to adopt organic farming as they are unfamiliar with it. The training is organized and conducted by the NGOs, notably UBINO, 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.

However proper skills development of agricultural workers and inspectors through different training events, and workshops on 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, rapid expansion of organic farming will occur and the country will potentially benefit in terms of both environmental and economic benefits. As regards the economic aspect, this agricultural practice will create new employment opportunities (green jobs) especially for women

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and save much foreign currency through not utilizing chemical fertilizers and pesticides which are all imported. Organic farming is also relevant for women because they actively participate in its major processes including seed and manure preservation, sowing and plantation. Moreover organic farming is more employment-intensive than traditional farming.

Among major green organic farming occupations in increasing demand are: Energy Crop Farmers, Agriculture Extension Specialists, Biologists - Marine and 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 those employed in these occupations are limited in supply and require extensive training.

3.2 New and changing skills needs

This section and its subsections address skills needs for newly-emerging green-collar occupations, and new and changing skills requirements for existing occupations (skills gaps) in the context of greening the economy. In the identification and analysis of skills needs 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 to develop strategies for appropriate skill responses.

3.2.1 New green-collar occupations

This subsection addresses green-collar occupations which emerge as a result of adaptation to climate change and mitigation of its negative impacts. Such occupations are new in the labour market, the actual change having 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 inclusion in the catalogue in future. These are new as well as 'hybrid'

occupations (e.g. carbon traders, solarteurs, bioenergy technicians, energy assessors, compressed natural gas (CNG) conversion technicians, and green accountants).

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

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

Carbon trading

Carbon trading, also referred to as emission reduction trading, is an economic tool which, in essence, allows several parties to meet total emission reduction requirements at lower costs by working together. Carbon trading allows surplus emission reduction to the required limits to be traded to other parties needing to meet emission limits. If one party can reduce emissions at a lower cost than a second party, then first party could maximize emission reductions and sell any surplus reductions to the second party to help meet its reduction requirements. The aim is to improve the overall flexibility and economic efficiency of obtaining emission reductions.

Through the CDM mechanism GHG emissions can be reduced in three major sectors of Bangladesh: **(i) energy**, both supply-side and demand-side; **(ii) waste**; and **(iii) forestry**. The waste sector options prevent the release of methane from bio-methanation processes. The methane collected can be flared or used to generate electricity. The waste sector options for Bangladesh can be landfill, poultry waste, human excreta and waste water treatment. The options in the forestry sector can be both afforestation and reforestation. The energy sector options for CDM are numerous. It is best to examine these projects according to the categories in which they belong. The different types of CDM projects along with some suitable examples for Bangladesh are listed below (WC, undated).

(a) Switching from carbon-intensive fuels to less carbon-intensive fuels or renewables – replacing coal by natural gas in brickfields; replacing diesel buses by CNG buses; solar home systems; (b) replacing an inefficient device by an efficient one, such as from incandescent bulbs to compact fluorescent lamps; efficient air-conditioners; efficient grinders in cement industries; and improved cooking stoves; (c) increasing the efficiency of an existing device, for example retrofitting boilers and motors, and vehicle maintenance; (d) modification of a process so that it consumes less fossil fuel, for example pulping using continuous digesters in place of batch digesters; retrofitting old ammonia-urea plants to bring them to the level of state-of-the-art plants; replacing the wet process of cement manufacture by the dry process in the Chattak Cement Factory; (e) waste heat utilization either from electricity generating turbines or high temperature processes, the first option being also known as co-generation which can be employed in sugar mills, textile mills, jute mills and tea manufacture; the second option can be employed in ceramic industries; (f) greenfield projects (using an entirely different process in a new project to accomplish the same outputs as with the baseline), for example vertical shaft brick kilns (VSBK) for brick-making, and Hoffman kilns which use natural gas, a greenfield project with fuel switching; (g) lowering energy consumption through building design and materials, solar reflective glass windows to reduce the air-conditioning load, design of buildings with windows facing south; and (h) conservation car pooling, and use of mass transit systems instead of personalized transport.

From the long list of projects it would be apparent that many CDM projects could fall into one of the eight categories listed above. The essential idea is to reduce GHG emission with respect to a predetermined, agreed and approved baseline emission. Since CDM is a project-based mechanism, the fact that Bangladesh's overall energy consumption is very low should be no barrier. It is also important to note that CDM is concerned with expected future emissions, and in that respect the prospect for CDM is bright since Bangladesh's commercial energy consumption is increasing at the rate of 6 per cent per year.

In 2009 the Industrial and Infrastructure Development Finance Company Limited (IIDFC), a leading non-banking financial institution, for the first time 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 emission reduction purchase agreements (ERPA) on 25 August 2009 with the World Bank and the Danish Government to achieve 249,000 tonnes of carbon dioxide (CO₂) reduction from brick-fields. The World Bank also agreed to sign an ERPA with IIDFC on reporting the quantity of emission reduction, certification of emission reduction, and receipt of bulk payments from the Carbon Fund for distributing to the various sub-project entities. The World Bank also negotiated with IIDFC to purchase 189,000 tonnes of carbon saved through reduced emissions. Under the agreements the IIDFC will act as the bundling agent to facilitate implementation of a project on 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, with an expected reduction of CO₂ emissions of approximately 115,000 tonnes per year, according to the project proposal.

The development objective of the Bangladesh Brick Kiln Efficiency Project (P105226) is to promote the use of cleaner brick-making technology (Hybrid Hoffman Kiln) to reduce air pollution and greenhouse gas emissions. This will be achieved by leveraging the potential carbon finance benefits from energy-efficiency improvements. This is the reason for making the alternative cleaner technology more economically viable. According to the project report on the implementation status of the project, under Bundle-1 initially eight HHKs were included. SSL Ceramics Bricks Ltd. Kiln-1 and Kiln-2, owned by the same entrepreneur, were dropped. SSL Kiln-1 was constructed and had been in operation for almost a year. But owing to cracking of dry bricks which could not be solved during a year of operation, the owner decided to shut down Kiln-1 and not to invest in Kiln-2. The problem is mainly the location selected where the clay has high plasticity. Suitable clay was not found within a 20 km radius of the kiln site. Bundle-1 was then revised to exclude these two

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kilns and now consists of 6 HHKs. At present all the 6 HHKs are in operation. Under Bundle-2, initially eight HHKs were included. Kiln-1 and Kiln-2, owned by the same entrepreneur, were never constructed within the timeline and hence were excluded from Bundle-2. The current version of PDD includes 6 HHKs, of which, as of 3 February 2015, three kilns are in operation and the remaining three have yet to be constructed. However, the total Certified Emission Reductions (CERs) contract as per the Emission Reductions Purchase Agreement (ERPA) amendment are 96,830 tonnes of CO₂. IIDFC has already delivered 12,051 CERs to the Bank and another 38,676 CERs were scheduled to be delivered to the Bank in July 2015. Owing to the delay in construction of three kilns under Bundle-2, IIDFC is not expected to deliver the total amount of CERs stipulated in the ERPA. An amendment will be made to reduce the volume of CERs delivered (WB, 2016).

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 emissions in the country, which is estimated to be of the order of 8.75 million tonnes of CO₂ annually. The success of the emission reduction project in the brick manufacturing industry will encourage other brick manufacturers to come forward and switch to environment-friendly Hybrid Hoffman Kiln (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. At least two brick-fields are now in production using HHK technology. The proposed project will support the brick-making sector of Bangladesh through purchasing CERs generated from adoption of energy-efficient HHK. According to the IIDFC estimates the project will bring about a reduction of an estimated 881,000 tonnes of CO₂ during the 2010-2020 project period.

According to the DOE, as of February 2017 as many as 4,227 traditional brick kilns out of 6,646 have been converted into modern kilns adopting cleaner brick-manufacturing technologies that require less energy. Of that total, 4,108 kilns have

been converted into zigzag or improved zigzag kilns and the rest into HHK and tunnel kilns. This means that around 636,022 workforce members in traditional brick manufacturing will benefit from new green occupations.

Creation of solar energy

Renewable energy (non-conventional energy) is defined as energy derived from resources that are regenerative or which for all practical purposes cannot be depleted. The prime source of renewable energy is solar radiation, that is, sunlight. Because of the lack of available easy alternative sources of energy and the vulnerable current energy situation in Bangladesh, a massive demand for solar energy has been created. As a new green technology solar energy has significant impact on the environment and also on the economy through creating very large employment opportunities. According to Barua (2014), the worldwide leader in installation of small SHS is Bangladesh, their number having risen from 25,000 to 2.8 million in the last decade. This has increased the number of direct jobs (mostly in installations, but also in panel assembly and in operations and maintenance) from 60,000 in 2011 to more than 100,000 in 2013. The numbers are set to increase further, with an average monthly installation rate reaching some 80,000 units. According to IRENA (2017), direct employment generated in solar energy reached a high of 140,000 jobs in 2016 from a low of 100,000 jobs in 2013 (Table 7), reflecting a huge increase in solar photovoltaic usage over three years.

Available evidence shows that direct solar PV jobs in Bangladesh steadily increased by 18.5 per cent annually, reaching a high of 140,000 in 2016 from a low of 60,000 in 2011. Currently, jobs in production of solar home systems have reached a plateau, following the slowdown in installation. In comparison, jobs in mini-grids and solar pumping are picking up as the government shifts its focus towards these applications. Jobs in the biogas sector grew by more than 17.7 per cent annually following numerous initiatives to provide rural household biogas digesters across the country.

According to expert opinion, currently around 28,000 solar engineers and technicians and more than 200 green entrepreneurs are

involved in this sector. According to Grameen Shakti (GS), there is scope for 200,000 more 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. Skills needs in SHS are usually identified by NGOs (e.g. GS, BGEF), private sector (e.g. RREL) and public sector organizations (e.g. REB, BCSIR) who perform solar panel assembly and installations, and initial operations and maintenance in accordance with the plan they have in a given year. They draw on data from their past experience. There is no system of certification of the training they provide on the job except in the case of BMET which provides short course training certificates in SHS. Nor is there a system of evaluating the skills they provide through training. Wages in various grades of this sector reportedly compare well with those in the RMG sector.

According to the Governor of the Bank of Bangladesh, every bank should state in its annual report 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 give priority to investment in environment-friendly projects. For solar energy, the banks

can lend Tk.70,000-175,000, for biogas plant Tk.36,000-300,000, and for ETP the loan may amount to Tk.10 million. Meanwhile, the Governor of the Bank of Bangladesh has already allocated Tk.5,000 million for the SMEs who wish to start or have already started business in renewable energy. 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 the government offices including the Prime Minister's Office (PMO) and the Bank of Bangladesh as part of its initiatives of promoting use of renewable energy in the country.

Rahimafrooz Renewable Energy Limited (RREL) has introduced a solar-powered irrigation system that will help save 760 megawatts (MW) of 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 in the form of solar panels, and the major part of the system is guaranteed for 20 years. The number of conventional pumps replaced by solar pumps each year will save a

Table 7. Estimated direct and indirect jobs in renewable energy in Bangladesh by technology during 2013-2016

JOBS (THOUSANDS)

Technology	2013	2014	2015	2016
Solar Photovoltaic ^a	100	115	127	140
Wind Power	0.1	0.1	0.1	0.33
Biogas	9.2	9	9	15
Hydropower (Small) ^b	4.7	5	5	5
Total	114	129	141	162

Notes: (a) Direct jobs only. (b) Although 10 MW is often used as a threshold, definition may be inconsistent for international comparison.

Source: IRENA: 2014, 2015, 2016 & 2017.

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significant amount of fossil fuel consumption as well as the government subsidy, which will not be available for the next 20 years. There is as yet, however, no direct government subsidy for solar-powered pumps.

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

The training is mainly organised and conducted by the NGOs. Initially, 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 training courses are conducted at the head office and in the field. At field level, additional training is organised for the users or customers of solar energy. In particular, women from solar energy users' families are trained in basic maintenance of SHS which is a new green-collar occupation. The cost of the training and other programmes are borne by the NGOs, mainly funded by different donor agencies such as the World Bank (WB), GTZ (German Agency for Technical Cooperation), Asian Development Bank (ADB), and others.

According to GS sources, the GS training programme focuses on developing both in-house and local capacity, viz. (i) training of users so that they can take effective care of their systems; (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 help them develop into effective technical and social engineers; (iv) training of women technicians through Grameen Technology Centres (GTCs) to decentralize GS's production, marketing,

and repair and maintenance services; and (v) diversification and scaling-up of GS activities through entrepreneurship development.

GS has set up 45 GTCs under a pilot programme to scale up its solar programme, especially production of SHS accessories through local manufacture. GS planned to set up 105 GTCs by 2010. These GTCs act as resource centres for developing renewable energy entrepreneurs at local level. These resource centres help to adapt renewable energy technologies to the Bangladeshi context and then test them on a pilot basis 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's empowerment by developing solar technicians. GS helps these technicians to sign annual contracts with its clients for after-sales maintenance and to become future entrepreneurs. More than 60,000 people each year are installing SHSs all over Bangladesh for business or household purposes. GS alone planned to install one million SHSs by 2015, and envisages a future in which there will be a massive 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 Programme for rural school children and more than 5,000 schoolchildren have participated in the programme (GS Website).

GS plans to use the GTCs to meet the projected demand for repair and maintenance services and SHS accessories at affordable prices. The GTCs will train women technicians and use them to produce the accessories. They will also strengthen and expand the back-up services at local level. GS will also use the GTCs to train women members from 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 1,000 women technicians have already been trained, many of whom are assembling SHS accessories at local GTCs, others providing after-sales service.

Among other existing training programmes are (I) a Renewable Energy Technology

(RET) Training Programme, and (II) a Short Course on Renewable (Solar) Energy and its Applications, organized by the Renewable Energy Research Centre (RERC), University of Dhaka, in collaboration with the Bangladesh Solar Energy Society (BSES) and Faculty of Engineering and Technology, University of Dhaka. These programmes cover preferably graduates in science or those with diplomas in engineering, post-graduate students, researchers, architects, policy-makers, stakeholders, engineers, economists and all other working people working in this field. Course duration is one week, with a course fee of Tk.1,000 (ibid.).

The RERC has been actively working on research, development and dissemination activities on RET since the early 1980s. The RERC is also playing a pioneering role in the promotion of solar energy in Bangladesh. It is working relentlessly on the promotion of solar thermal and solar photovoltaic applications and maintains the only solar energy dissemination park in the country, popularly known as “Energy Park”, on 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 on utilization of renewable energy in Bangladesh; to train, coordinate and establish links between students, scientists, engineers, stakeholders and policy-makers, and 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 for alleviating the energy crisis. Among the resource persons are renowned teachers and researchers from energy-related departments. Some of the courses include (RERC Website):

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

IDCOL under the Rural Electrification and Renewable Energy Development Project

(REREDP) finances a Renewable Energy programme in Bangladesh. In this connection IDCOL launched a second three-day TOT Programme on SHS. Training is imparted to experts and technicians working for different organizations. The objective of the TOT is to create a capacity for designing and deploying SHS.

In addition, the Centre for Energy Studies (CES), BUET, works at promoting education and research, organizing seminars, symposia, training workshops, short courses and outreach programmes; and publishing journals, monographs and books on energy-related interdisciplinary matters. The objective of CES is to provide the energy professionals with insight into the importance, methodologies and financial benefits of implementing energy-efficiency programmes in the existing or planned garments and textile industries, the pharmaceutical and electrical-mechanical industries, hotels, shopping malls, high-rise buildings, and so forth. The courses will illustrate how energy-efficiency in any planned or existing industrial and commercial enterprise can be achieved. The contents of the training are: (i) lighting principles and energy-saving through lighting; (ii) experience of retrofits in garment industries; (iii) energy-efficient technologies in electrical systems; (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 parboiling; (viii) HVAC (Heating, Ventilating, and Air Conditioning), refrigeration systems and cooling towers; (ix) co-generation and waste heat recovery; (x) financial analysis of energy savings in case studies; (xi) energy issues in factories; and (xii) energy auditing and energy management (BUET Website).

Furthermore, technical tours in a modern energy-efficient industry are arranged to show the latest technology to the participants. The target groups include managers, management personnel from the garment and textile industries, food and pharmaceutical industries, steel rerolling mills, cement factories, and large electrical and mechanical industries. Key resource persons for the courses comprise industry practitioners, experts and academics from BUET. Course

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duration is six days with a fee of Tk.2000 for each participant, payable in advance. The course registration fee includes refreshment breaks and course materials.

In order to build capacity in RET, training courses are designed for persons interested in learning Solar PV Technology and how to produce electricity from the sun. Participants learn the practical operation and maintenance of photovoltaic power systems for a wide variety of applications; they learn system sizing, site analysis, hardware specifications 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 concepts of PV technology; (v) site selection, design and installation of PV technology; (vi) operation and maintenance of lead-acid storage batteries; (vii) trouble-shooting, operation and maintenance of PV Systems (ibid.).

Expert-level training on Practical Manufacturing of Solar Lighting Systems, a Training Module on Solar Photovoltaic Technology and a TOT Training Programme are in place. User-level training is conducted by LGED with UNDP support. Beneficiary training on the use, operation and maintenance of 5Kwp Centralized Solar (AC) Systems is conducted in different locations. User-level training is conducted by GS and BRAC; the three-day TOT Training Programme on Solar Photovoltaic Technology is organized by the Sustainable Rural Energy (SRE) Project of LGED. Participants include 30 LGED engineers. User-level training on use, operation and maintenance of a 5Kwp Centralized Solar (AC) System is organized by SRE. Participants total 275 beneficiaries with 34 in each batch from different locations. The objectives of the training include operation and maintenance of Solar PV systems including batteries, panels, lamps and so forth for daily use of the field installations (LGED Website).

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 the automotive industry. CNG is low in pollutants, high in calorific value and heat yield, economic 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 up the challenge of popularizing the CNG as alternative fuel for vehicles in the country. In 2000 the government privatized the CNG sector and initiated notable steps such as conversion of all government vehicles into CNG, duty-free import facilities for all items of CNG and natural gas vehicle (NGV) plants and equipment, phasing-out of two-stroke three-wheelers from Dhaka City, implementation of a one-stop service for setting up CNG stations and conversion workshops, and allocation of government land to the private entrepreneurs for CNG business. These policy measures started boosting CNG activities and creating new green jobs mainly for Fuel Retrofitting and Conversion Technicians, Supervisors and Workshop Technicians, and addressed the need for CNG conversion skills (Mondal et al, 2010).

Given the present-day extent of air pollution in the major cities of Bangladesh, CNG is considered an ideal environment-friendly fuel, causing minimum pollution and GHG effects as compared to other conventional fuels. According to BRTA sources, the total number of registered motorized vehicles in Bangladesh increased from 1,498,244 in 2010 to 2,879,708 in 2016 with an annual growth rate of 11.5 per cent. Between 2010 and 2016 the growth rate of three-wheelers (11 per cent), micro-buses (5.5 per cent) and buses (6.2 per cent) was significant as they generate most of the employment in the land transport sector. According to the QLFS 2015-16, the transport and storage sector employs 4,571,000 persons with an annual growth rate of 2.8 per cent. These are traditional jobs which need to be converted into green jobs with immense implications for skills development through training. Table 8 indicates an increasing

Table 8. CNG expansion activities in Bangladesh

FISCAL YEAR	NO. OF CNG FILLING STATIONS	NO. OF CONVERSION WORKSHOPS	NO. OF CONVERTED VEHICLES	NO. OF TOTAL CNG-RUN VEHICLES
2014-2015	2	0	37,368	35,115
2013-2014	0	0	6,487	6,487
2012-2013	0	0	4,382	4,389
2011-2012	0	0	5,792	5,881
2010-2011	5	10	13,343	13,476
2009-2010	119	29	28,676	29,574
2008-2009	213	20	24,516	26,141

Source: http://www.rpgcl.org.bd/exp_act.php?ltype=exp_stat accessed on August 2, 2017

trend in jobs created through CNG conversion of vehicles since 2008-2009.

The number of CNG conversions tended to decline from 2009-10 because of heavy imports of CNG-converted motorized vehicles into the country. According to RPGCL sources, Bangladesh imported 40,383 CNG-converted motorized vehicles up to January 2016.

3.2.2 Greening existing occupations

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

Tanneries

Tanneries, with their 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 water bodies including the River Buriganga, the lifeline of Dhaka City. Between 30 and 40 types of heavy metal chemical compounds and acids are used to process raw hides. Among them the most dangerous are chromium, sulphur, manganese, copper compound and lead. The tannery chemicals and working conditions in the tanneries are very poor and hazardous to health.

Dissolved Oxygen (DO) level, an indicator of measuring river health and its aquatic life, stands

at zero milligrams (per litre) at different points of the Buriganga, Turag, and Balu rivers and Tongi Khal during the dry season. Ideally, it should remain seven to eight milligrammes (per litre) in the river water. But the DO level is dropping significantly owing to unabated dumping of wastes and toxic substances into rivers and water bodies. While the DO level is alarmingly low in the rivers of Dhaka, the load of Biochemical Oxygen Demand (BOD) – the amount of oxygen used for decomposition of organic matters – is high in the Buriganga and Shitalakhya rivers. The tolerable BOD load is three milligrammes per litre at best but it remains many times higher than the tolerable level and may rise further if pollution continues in the rivers (Mondal et al, 2010).

Interestingly, most of the tanneries (about 220) of Bangladesh are located in Hazaribagh (Dhaka city – 154 units) with very few in other areas, which should facilitate training and retraining of the tannery workforce. To reduce existing pollution in the tannery sector, changes in technology as well as in the knowledge and practice of employees can play a pivotal role. The existing traditional skills in different occupations do not contribute to sustainable tanneries. New types of skills required include improved competences of managers, supervisors and technicians which need to be incorporated into existing occupational profiles. Most encouragingly, however, the Government has decided to move the tannery hub from Hazaribagh to Savar Hemayetpur (25 km away

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from Dhaka City) with full provision of ETP. The move has already started following a complete shutdown order by Bangladesh Supreme Court. According to BTA (Bangladesh Tanners Association), so far 65 out of 154 tannery units have already been moved to Hemayetpur and the rest are in the process of moving.

Brick manufacturing

According to BBMOA sources, brick manufacturing is a significant economic activity in Bangladesh. There are more than 5,000 operating brick kilns, contributing about 1 per cent to the country's gross domestic product (GDP) and employing an estimated one million people. According to DOE, however, as of February 2017 there are 6,646 brick kilns in Bangladesh. The sector is also an important source of livelihoods for large numbers of rural poor during the dry summer months, when agriculture offers only limited job opportunities.

The brick industry is resource-intensive and polluting, having significant social and environmental consequences. The industry is characterized by the use of outdated technologies, high emissions and the dominance of a single raw material (clay) and final product (solid clay brick). Bangladesh currently produces around 17 billion bricks per year, consuming around 45 million tonnes of fertile soil – equivalent to around 2,600 hectares of agricultural land. At this rate the country is quickly moving towards severe food shortages in the foreseeable future. Apart from using soil, brick kilns burn nearly 3.5 million tons of coal and 1.9 million tons of wood annually in kilns of outmoded design, causing severe air pollution. According to BUET, almost 38 per cent of particulate matter pollution around Dhaka is attributable to brick kilns.

The GOB is trying to clamp down on the brick industry through regulations mandating the use of cleaner technologies. The most common but highly polluting Fixed Chimney Kilns (FCKs) are now gradually being converted to coal-based Zig Zag kilns and gas-based Hoffman kilns. As of February 2017 DOE has converted 4,227 traditional brick kilns into modern brick kilns. However, the adoption of cleaner, gas-based technologies is hampered by a serious

gas shortage, and the brick industry is expected to have lower priority owing to the seasonal nature of its operation. Although the available alternative technologies use relatively less energy, brick manufacturers are still faced with the problems of high local and global emissions, and the scarcity of raw material.

Brickfields are operated almost all over the country during the dry season (December to April) in Bangladesh. Traditionally, brick-making is a small-scale business located mostly 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. Until now, most bricks have still been hand-moulded. Mechanical equipment driven by motive power is 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 all year round.

Taking account of all the wood fuel and fossil fuel used, it was estimated that total emissions from all the brickfields of Bangladesh would be 54,09,480 tonnes of CO₂, 23,600 tonnes of CH₄, 206,560 tonnes of CO, 164 tonnes of N₂O, 5,880 tonnes of NO_x, and 3,840 tonnes of NO per annum while the total carbon released in the atmosphere would be 147,55,320 tonnes annually.³ In Bangladesh two billion bricks are produced every year, of which 1.375 billion 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 cubic feet, of which 52 million cubic feet are burnt in the brickfields. Wood fuel and fossil fuels (coal and crude oil) are responsible for the emissions of trace and non-trace greenhouse gases such as CO₂, CH₄, CO, N₂O, NO_x and NO. Brick industries are thus important sources of GHG as they use wood fuel, coal and fuel oil (crude oil) extensively. Brickfields in Bangladesh solely burn fossil and wood fuels to produce bricks, releasing a massive amount of GHG into the atmosphere and giving rise directly to substantial deforestation (ibid.).

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

The main occupations in brick manufacturing are labour contractors, wood suppliers, brick field managers, mud mixers, brick-makers and chimney kiln operators. With the 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 green skills.

Greening buildings

Green building is a new concept in Bangladesh which might be a promising sector given the high rate of urbanization in Bangladesh. The construction sector is growing rapidly in the country, generating considerable employment for the poor. The greening of construction depends primarily 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 correctly at the design stage. In Bangladesh there exist tremendous opportunities for introducing new materials, equipment and technologies which can help enhance the energy efficiency of buildings. But potential owners are not demanding green buildings from consultants and architects, which adversely affects the industry's greening efforts since the architects have no incentive to design green buildings (Mondal et al, 2010).

It is frequently argued that green buildings are costlier, have to be air-conditioned and take more time to construct. 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 the design stage. There is a general perception that "going green" may affect project schedules. However there is absolutely no difference in the time involved in constructing a green building *vis-à-vis* a non-green building. The experts in this sector argue for changing curricula and raising awareness and training programmes for different stakeholders, including architects, developers, consumers of ready flat and plot and policy-makers. There is now a need for skilled and knowledgeable professionals who have adequate understanding of architecture and energy systems. BUET has already introduced greening of buildings in its architecture curriculum and practical application. This, however, is likely to

have limited employment implications in the immediate future since the course is four years in length with annual enrolment not exceeding 50 students.

3.2.3 Identification of skills needs

In Bangladesh there is no system in place or institutional responsibility for identification of current and future skills needs for any kind of job – non-green or green – in the labour market. Conventionally, companies on their own identify their own skills 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 skills 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 skills response primarily include Waste Concern, Grameen Shakti, IDCOL, the Bangladesh Council of Scientific and Industrial Research (BCSIR) and recently-created SREDA. 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 systems do not respond to green skills needs. Hence limited new courses, new curricula 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 and so forth. Technical assistance in this regard can be provided by the ILO in collaboration with other donors.

There is enormous potential for future training in greening the Bangladesh economy. To meet this challenge there is a crucial need for a clear policy on skills development for greening the economy which would embody strategic interventions for improving the existing education and training capacity to meet the needs adequately. Feedback mechanisms between business and the

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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:

- i) carbon trading;
- ii) solar energy engineers/technicians; *and*
- iii) mechanical engineers and CNG conversion technicians.

(3) Case study on carbon trading

Carbon trading is emissions trading specifically for carbon dioxide (calculated in tonnes of CO₂ equivalent) and currently makes up the bulk of emissions trading. It is one of the ways in which 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 pollutant emissions (Mondal et al, 2010).

Carbon trading is trading in energy and is a new and emerging green occupation which includes the following (Mondal et al, 2010):

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

who underwrite the issue 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 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 there are skills gaps in all these occupations, not only because carbon trading is still in its infancy, but also because the emerging companies feel that their existing workforce has inadequate skills and competence levels to meet their requirements.

West Concern had embarked on a project to start carbon trading on a rather small scale. RREL was planning to start commercial carbon trading in the country from May 2010 for the first time, by achieving the CER standard with the aim of earning \$100 million a year. Carbon trading is expected to provide a monetary reward and facilitate a focus on reducing emissions in every activity in the economy and bring the country into the global carbon commerce market worth \$100 billion. Reduction in carbon emissions will also promote the country's role in addressing global warming and climate change.

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 was to be submitted to the government for approval and then the Designated Operational Entity, a UN-approved agency, would 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 the CDM Executive Board. According to the MEF, the government is encouraging 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; 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; and 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 Waste Concern is involved in carbon-saving devices). Waste Concern is a small company and is coping with its critical skills needs through foreign training. While for high green-collar jobs the required training is obtained from abroad, especially from the European Union, for low green-collar jobs the company itself is providing on-the-job training (ibid.).

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 Bangladeshi and Dutch joint venture company (Waste Concern and World Wide Recycling of the Netherlands), on 21 March 2009 and the formal release of its first high-quality organic fertilizer produced from fruit and vegetable waste from the markets of Dhaka City. It has launched the bio-fertilizer on the market and has supplied the first compost to local dealers and farmers. The newly-born bio-fertilizer (*Jaiba Sar*) is being produced in the organic waste composting plant at Bhulta (Narayanganj) with a 700 tonnes per day capacity, equivalent to a compost production capacity of 50,000 tonnes per year, reducing CO₂ emissions by 560,000 tons over the next six years and benefiting more than 3.6 million people each year. Waste Concern has five composting plants in Dhaka: one of 10-12 tonnes per day capacity, two of 3 tonnes per day capacity, and two of 1 tonne per day capacity. Annual financial saving amounts to US\$7,218 for a 3 tonnes per 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 of robust growth in employment in the future.

The plant is the first of its kind in the country, with a very large capacity. The project aimed at

setting up two more plants by 2010 to produce a total handling capacity of 700 tonnes of waste per day from the Dhaka City Corporation (DCC) markets. 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 the community and private sector and with municipal government, reflecting a public-private-community partnership. It has established a Regional Recycling Training Center located in Dhaka, where it offers training programmes, instructing local officials in the process of enabling them to undertake full operational activities.

Several other companies are also planning carbon credit trading. Rahimafrooz was set to start commercial carbon trading from May 2010 after achieving the CER standard with the aim of earning \$100 million a year. Carbon trading will provide a monetary reward and facilitate a focus on reducing emissions in every activity in the economy and bringing the country into the global carbon commerce market worth \$100 billion. Bangladesh Carbon, a CDM-based carbon trading service of Rahimafrooz Renewable Energy, and Carbon Planet, an Australian company, signed an agreement in this regard on 19 May 2009.

Future Carbon has identified the growing need for carbon reduction in developing countries and has used its strong links in Bangladesh as a platform for the implementation of carbon-offset and energy-efficiency projects while developing carbon incentives for Bangladesh's key stakeholders. Its projects include (from Future Carbon Website):

- i) Micro-scale Gold Standard Solar PV Programme of Activities (PoA): Project Participant in the first-ever Voluntary Carbon Offset project in Bangladesh. The project aims to generate 30,000 carbon credits (VERs) each year from an output of 11 MW of Solar PV installation over a seven-year period.
- ii) Energy Efficiency Improvement CDM project (PoA) in the brick manufacturing industry: developing a country-wide Gold Standard

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- CDM project (PoA) as the Coordinating Managing Entity (CME). The project aims to generate 400,000 CERs each year and is funded by the UNFCCC CDM Loan Scheme.
- iii) Consultancy services for the development of a waste recycling CDM project for Waste Concern: working jointly with South Pole Carbon to assist the W2RF (Waste to Resource Fund - jointly created by UNESCAP and the Bill & Melinda Gates Foundation) in the development of a programmatic CDM project using multiple technologies.
 - iv) GHG emission modelling and Carbon Footprint Measurement for the Bank of Bangladesh: working with the Green Banking and CSR Department of the Bank to provide a model for the financial sector for measuring the carbon footprint and implementing a monitoring plan to reduce GHG emissions.
 - v) Removing constraints of regulatory framework in the renewable energy sector and introducing a national Feed-in-Tariff: member of 'Project Evaluation Group' in which other members are BERC and IRE, University of Dhaka, to engage in policy reform advocacy.
 - vi) IFC - Bangladesh Partnership for Cleaner Textile (PaCT) Project: member of the finance working group on policy development for the PaCT project implemented by IFC.
 - vii) USAID - Catalyzing Clean Energy in Bangladesh (CCEB): partner with CCEB in promoting and disseminating an improved cooking stove and introducing carbon financing in this sector.

The companies feel that new entrants to the labour market are trained and qualified for carbon credit trading, but still lack a variety of the related skills needed. These skills needs were identified by the emerging companies through their own assessment and market information flows. There is no green skills policy response to the situation, possibly because training needs are rather specific. A policy and legal framework and a level of decision-making are also non-existent. The skills provision in response to the identified need remains incidental to the emerging companies. This process looks effective since it works.

Case study on Solar Energy Engineers/Technicians

There are mainly four types of occupation category involved in the process of implementing SHS: they are as follows: (a) Branch Manager, (b) Service Engineer, (c) Financial Assistant, and (d) Solar Energy Technician. Of 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 because there are no training or schooling facilities. As noted earlier, training in solar energy is at present taking place only on a small scale and mostly through NGOs. The appropriate skills of solar energy technicians on the solar systems are a crucial factor in the rapid expansion of SHSs in the future.

Skills for green jobs have been growing robustly in the renewable energy sector of Bangladesh as compared to other sectors of the economy in which green initiatives are still in their infancy. Available evidence shows that green jobs in solar energy have increased by 18.5 per cent annually from 60,000 in 2011 to 140,000 in 2016, compared to 1.9 per cent for the overall economy. This trend is likely to continue as investment in new green energy is expected to double over the next five years.

According to SREDA, currently there are 4.5 million Solar Home Systems (SHS) with a production capacity of 216.75 MW. Government has targeted an eight-fold increase in solar energy from 222 MW in 2015 to 1,739.8 MW in 2021. Solar energy technicians account for the largest share of solar energy jobs. Few obtain access to institutional training, as no independent training centre on solar energy exists in the country. However, the qualifications and competence of this workforce are reportedly adequate. To achieve the solar energy target, there will be a massive demand for solar energy technicians to gear up the expansion of SHSs. This workforce in Bangladesh is growing rapidly, so much so that GS is even exporting this workforce to the Middle East and Africa, according to GS sources. There is no evidence of skills gaps measured in terms of a qualitative mismatch between the availability of Solar Energy Technicians and the 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.

New green-collar occupations in solar energy most in demand in the country in terms of greening the economy include the following (Mondal et al, 2010):

- 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 assessments and schematics, including measuring, cutting, assembling, and bolting of 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, propose 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; and design solar domestic hot water and space heating systems for new and existing structures, applying their knowledge of structural energy requirements, local climates, solar technology, and thermodynamics;
- vi) (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 it is mostly the NGOs (GS, BGEF etc.) that provide training. Among other training organizations, REB, BCSIR and RREL are important. The training for rural areas is organized by the NGOs and REB, while for the urban areas it is organized primarily by RREL. Initially the staff of the companies and subsequently the users of solar energy are provided with training on the submission of their applications for solar energy installation. The sponsors cover all training costs.

Future demand for green-enhanced skills occupations in solar energy primarily include the following: PV Power Systems Engineers, PV Solar Cell Designers, Solar Designers/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, Solar Thermoelectric Plant/CSP Plant Operators, Solar Hot Water Heater Manufacturing Technicians, and Solar Lab Technicians (ibid.).

Given the current employment trend, the ever-growing renewable energy industry is expected to provide jobs for an estimated 1.1 million persons by 2021. Although there is no provision of formal skills development for this workforce in the existing education and training system, there is massive 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. Institutional policy response (e.g. the creation of SREDA) to the situation in terms of the policy and legal framework and the level of decision-making is robust, and looks more than adequate. The process of existing skills provision in response to the identified need appears effective, but there is a pressing need for the putting in place of formal training programmes.

Several GO-NGO training programmes for this workforce are in hand. According to GS sources, during 2011-14 GS trained more than 1,500 women technicians through 25 GTCs to install and maintain SHS and assemble crucial components

of the SHSs, with technical support from USAID. This programme has trained 19,000 students, 5,400 women users of SHS, and 320 engineers or 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 110 women technicians in eleven batches. The GTC also imparted day-long training to 350 users and 730 students as part of awareness-building.

Case study on Mechanical Engineer and CNG Conversion Technician

According to RPGCL sources, up to June 2015 a total of 180 legal and authorized CNG conversion workshops were set up and are working in several districts where a natural gas link is available. In addition, about 250 unauthorized CNG conversion workshops are running in several areas of Bangladesh. Until January 2016 the number of CNG-run vehicles stood at 288,389, including 40,383 imported vehicles. 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 technicians play a vital role along with other technical persons under the supervision of a mechanical engineer. The occupational categories in a 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 engineering institution. The field officer is an automobile diploma engineer, the supervisor is a certificate holder of higher secondary education, and the technician is of a minimum Grade VIII standard. On average a large CNG conversion centre has 20 technicians and only one mechanical engineer. But mechanical engineers are still in short supply in this sector and instead automobile diploma engineers are performing their roles. The new skills needed in relation to CNG technologies include gas cylinder engineers and toolkit makers (Mondal et al, 2010).

Two grades of technician work in CNG conversion workshops, namely senior technician and junior technician. In a CNG conversion workshop, when

a vehicle comes for CNG conversion the senior technician checks the first-hand particulars of the vehicle, such as the model of the vehicle, the type of work needed for converting it and the size of gas cylinder needed.

The mechanical engineers graduate from engineering institutions and are knowledgeable of 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 or manufacturers, especially in the case of improved technology for adaptation. Recently some CNG companies (e.g. Navana CNG, Intraco CNG) have introduced job-specific training programmes for the engineers, but limited only to their own employees. After receiving training from different technical and vocational training institutions, the engineer provides job-specific training courses and briefings for the subordinate staff in the workplace. The technicians learn their jobs in the workshop. Very few obtain hands-on training on CNG conversion tasks from senior technicians in the workshops. In addition, for trouble-shooting they obtain support and technical assistance from the supervisor or the engineers. The CNG technicians are responsible for adapting petrol- or diesel-run engines to gas-run engines. Normally the junior technicians assist the senior technicians by doing the manual part of the work and the senior technician performs the sensitive tasks such as electrical and mechanical functions. If any new model vehicle comes into the workshop, the supervisor handles it. In the event of failure, it is the field officer and then the workshop manager who is responsible for performing the job (ibid.).

Currently the CNG sector employs an estimated 10,000 persons with 3,500 CNG technicians and 440 mechanical engineers working in various CNG conversion centres located in 17 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 the period 1983-2000 only one conversion centre was in operation and only 1,379 vehicles were run by CNG. Available statistics indicate very high prospects for the CNG conversion workshop as well as for the employment of CNG technicians

and other staff. According to the CNG technicians and engineers the 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 (i) Navana CNG for CNG conversion, refuelling, cylinder re-testing and others; (ii) RREL for CNG conversion, refuelling and others; (iii) Intraco CNG for CNG conversion, refuelling, cylinder re-testing and others; (iv) Shohag Motors for CNG conversion, refuelling and others; (v) Southern Automobiles for CNG conversion and cylinder retesting; (vi) Anudip CNG for CNG conversion and refuelling; (vii) Comet CNG for CNG conversion and other tasks; (viii) Shanji Automobiles for CNG conversion and direct sale; (ix) Rahimafrooz CNG Limited; (x) SAVRON CNG Conversion & Refuelling; and (xi) Epsilon Eximco CNG.

Services provided by these companies include: (a) conversion of petrol- or octane-driven vehicles to CNG; (b) conversion of diesel-driven vehicles to CNG; (c) conversion of diesel generators into a diesel gas system; (d) conversion of 4-stroke/3-wheeler vehicles into CNG; (e) selling gas through CNG refuelling stations; (f) selling CNG refuelling stations on a turnkey basis; (g) selling CNG conversion kits, cylinders, valves, refuelling nozzles, receptacles and other CNG conversion spare parts; (h) offering package maintenance programmes for CNG refuelling stations; (i) CNG cylinder re-testing facilities; and (j) providing company training for the internal staff on CNG conversion and refuelling stations.

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 assistants. According to the Secretary General of Bangladesh CNG Filling Station and Conversion Workshop Owners Association, the CNG sector currently employs 10,000 people with an investment of Tk.20,000 million. In the near future, employment in the CNG sector is likely to increase to 20,000 since another Tk.12,000 million investment has already been made. The existing occupations of mechanical engineers, supervisors, managers, accountants and workshop technicians are tending to become

greener.

According to CNG companies, future demand for green-enhanced skills occupations primarily include Fuel Retrofitting or 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, and Supply Chain Managers.

Training facilities for CNG conversion in Bangladesh have not yet been developed. A 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 for the engineers, and the engineers later provide training for their successors. This remains virtually the only source of skills development. RPGCL organizes very few training programmes, with very little coverage. Most of the technicians obtain training on the job. Usually, the senior employees of the CNG conversion centres come mainly from 14 public universities of engineering, science and technology and 42 technical training institutes with backgrounds in automobile, electrical and mechanical engineering. In addition, according to BANBEIS (Bangladesh Bureau of Educational Information and Statistics), there are 439 polytechnic institutes (52 public and 387 private), 172 technical schools and colleges (64 public and 108 private) and 164 Technical Training Centres (68 public and 96 private) under the Ministry of Education as of 2016. But the graduates from these technical and vocational training institutes receive very little practical knowledge on automobile as well as used CNG engines and conversion. However, skills in this sector are becoming more widely available, owing primarily to the aggressive marketing drive of foreign companies producing CNG machinery and undertaking equipment manufacturing and trading.

CNG-converted vehicles entail high risk due to accident-prone CNG fuel. Few accidents occurred in the past from using sub-standard, non-specified and old cylinders which caused loss of lives and property. To keep such losses to a minimum, the activities of the CNG sector should

be closely monitored and safety codes and standards should be ensured at every stage. This requires adequate training of 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 skills gaps which need to be incorporated into existing occupational profiles (greening existing occupations). For the selection of occupations, these illustrative case studies cover: (a) greening potential in terms of reducing GHG emissions or non-renewable resources; (b) contribution to the adaptive capacities of communities; (c) skills development records; and (d) contributions to the national economy and as a source of employment.

The selected case study occupations include:

(i) architects, civil engineers, designers and masons in greening buildings; (ii) supervisors and machine operators in tanneries; and (iii) brick-field managers in brick-making.

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

According to QLFS (2017), 3,327,000 persons are employed in the construction sector. About 920,135 people are estimated to be currently employed in architecture and the town planning profession. Every year about 500 new architects and town planners enter the job market. The construction industry in the country is growing rapidly with real estate growth rate at 24.3 per cent in 2015. Around 1,492 real estate developers currently work in Bangladesh on building construction and related projects. Most of them work in large cities such as Dhaka, Chittagong and Sylhet with massive potential for greening existing occupations in the construction sector.

The main occupations in building construction include architects, civil engineers, masons, assistants and site managers. But for greening buildings, architects have the central role to play because they are responsible for building design. New skills needed, therefore, include green architects, green town planners, green

civil engineers, green supervisors and masons. The Bangladesh Labour Law 2006 (amended in 2013) accords special importance to occupational safety and health of workers in workplace buildings. NEP-2013 recognizes the importance of the environmental impacts of building, structures and any polluting industries or any activities which require environmental clearance from them.

Energy simulation programmes are excellent tools for designing energy-efficient buildings. The tools typically used are Visual DOE, Energy Plus and Lumen Micro. At present building professionals trained in the use of green tools and techniques are scarce. Along with the competence of professional groups, some technical and logistical requirements - for example the availability of green construction materials, equipment and technologies - also need to be taken into account. The availability and affordability of materials and equipment which contribute to energy efficiency is another major challenge. Tremendous potential exists for the use of materials and equipment such as heat-resistant paints, fly ash blocks, insulation materials, high-efficiency chillers, variable frequency drives, high-efficiency cooling towers, building management systems, lighting controls, building integrated PV, and so forth. New technologies such as wind towers, geothermal systems and others are gaining increasing importance for greening existing occupations in building construction.

The Housing and Building Research Institute (HBRI) is trying to develop a green skills development strategy for workers at risk of becoming redundant as a result of green structural change on the labour market caused primarily by newly-emerging green building technology and the growing obsolescence of traditional building technology. The green skills development strategy for workers entails (i) undertaking short on-the-job training courses on green jobs for existing construction workers; (ii) undertaking awareness campaigns among real estate developers, contractors and building dwellers; and (iii) forming green job skills development committees representing workers' unions and employers' associations.

Employment effects have occurred as a result

of the green building policy, traditional building workers tending to become redundant. The main occupations in the greening process of buildings include architects, civil engineers, designers, masons, assistants and site managers. So there is enormous 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 includes the following: Architecture Technicians, Boilermakers, Carpenter Assistants, Carpenters, Cement Masons, Construction Equipment Operators, Installation Assistants, Insulation Installers, Insulation Workers, Iron and Steel Workers, Metal Fabricators and Fitters, and Welders, Cutters, Solderers and Braziers. Through the greening of 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, and Solar Installation Managers and Project Foremen. These skills are available in Bangladesh but are limited in supply, indicating a need for extensive skills development programmes for greening buildings.

Architects are selected as an example of an existing occupation which typically undergoes 'greening' in reaction to the demands of the 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 incorporation of 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 of reducing its energy requirement by 40 per cent.

US Green Building Council (USGBC) statistics show that there are currently 108 green buildings

in Bangladesh. A green building is marked by water efficiency, reduced impact on the environment and energy-efficiency. Green construction or sustainable building implies structures and the use of environmentally responsible and resource-efficient processes throughout a building's lifecycle. A green building must have a water treatment process to purify and recycle waste-water. The Bangladesh Green Building Academy (BGBA) has already completed 38 projects that have been certified by the Leadership in Energy and Environmental Design (LEED). As many as 35 BGBA projects are in the pipeline. Building owners place more emphasis on initial investment than on operating costs, most people being unaware of the facilities provided by green buildings. Rahimafrooz Renewable Energy Ltd has for the first time introduced four categories of light-emitting diodes (LED) which save up to 80 per cent of energy and are more powerful than normal electric lights. The price range of LED lights varies from Tk 30 to Tk 300. Walton also has brought about industrial lighting which saves up to 90 per cent of energy and is compatible with the environment (Ahmed, 2017).

With these new initiatives, the occupation of an architect is slowly tending to become green. 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 NGOs, mostly in Dhaka City. According to Holcim Bangladesh sources, 25 to 75 members of the architect workforce are already performing a greener version of this occupation, about one-third of them being women. They are graduate architects. This workforce is likely to evolve into a greener version in the near future.

According to Grameen Bank and Holcim Bangladesh, there is no skills gap in greening this occupation because existing architects are competent enough, possessing the required knowledge and skills in green architecture. Existing skills provision may simply prioritise the importance of green architecture in sustainable buildings. Existing education and training systems have huge potential for skills provision for greening this occupation. Green curricula and training programmes in architecture may be

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adopted.

BGBA, established in 2010 with its LEED-accredited professionals, can assist developers, building owners, and architects with designing and certifying projects to various USGBC LEED standards. Years of experience in building and working with RMG factories, plus its knowledge of the LEED certification process, may be helpful in making valuable decisions sufficiently early in the design process to offer the maximum cost-saving benefits to clients. BGBA can assist with all sustainable building needs. Currently it has 50 projects across Bangladesh including two green-certified projects.

Skills policy response to greening of buildings is positive in terms of the legal framework, but there is a pressing need for skills provision in response to identified needs. The process needs to be taken forward by the Ministry of Works and the Ministry of Education in collaboration with the existing education and training institutions. For greening buildings, the following steps are necessary:

- i) aim for green 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.);
- ii) freeze baseline costs at the outset so as to realistically evaluate the incremental cost due to greening (e.g. green design can be an easy scapegoat for incremental costs which in reality are attributable to other factors);
- iii) use the energy simulation tool at the design stage for materials and equipment selection; *and*
- iv) monitor closely and document correctly certain materials-related credits, viz. low VOC paints, adhesives, sealants, and a few construction-related credits such as 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 has become a potential sector. It is more cost-effective to construct new green buildings

than to retrofit projects at a later stage.

- 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) Focus on programmes that have immediate results and are very cost-effective, especially lighting programmes, air-conditioning, water heating, and building insulation.
- d) Provide incentives and funding opportunities for people to make these changes.

Most of these concerns have been addressed by the Bangladesh National Building Code (Final Draft, HBRI, 2015). In its Chapter 4 on Energy Efficiency and Sustainability, it focuses on changing the existing building codes to fit into green building construction, saving non-renewable energy and introducing solar and other renewable energy (3 per cent), provision of adequate ventilation in new buildings and implementation of the Green Building Policy.

Case study on Supervisors and Machine Operators in Tanneries

The leather and leather goods sector is the second largest sector of Bangladesh after garments. According to BTA sources, about 35,000 workers are employed in the tannery sector of Bangladesh. In addition, about 2,500 persons are involved in the process of collecting raw hides and skins and making them available to tannery units. Moreover, 109 organizations employing 15,000 persons import chemicals for use in the tanning industry. Although no greening process is taking place, this sector has been included in the research because since there is great potential for greening existing jobs with a substantial contribution to total manufacturing employment.

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 the only

professional training for tannery and leather specialists is provided by the Bangladesh College of Leather Technology (BCLT). On-the-site research reveals that most tannery workers are not trained in environmental aspects. Among existing occupations in tanneries are hides and skins cleaners, supervisors, machine operators, machine maintenance technicians and assistants. The existing occupations in tanneries are totally non-green with consequently massive potential for greening the existing jobs. To this end persons employed in different occupations in tanneries need to be trained in greening their jobs. At present there are no instances of greening of such tannery occupations.

Among the main existing jobs in tanneries are supervisors, machine operators, machine maintenance technicians and assistants. About 20 workers in a small tannery and 30 workers in a large tannery work during the lean season (9 months). During the peak season (3 months), employment in tanneries increases to around 70 in small units and around 100 in 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 work and maintaining communication with the head office are the prime responsibility of the supervisors, while the operators run different machines and assistants carry out manual work 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 a minimum Higher Secondary Certificate (HSC) degree while the machine operator need not be well-educated but must be experienced in machine operation. Not all machine operators become operators without learning and gaining experience through working in the factory. The assistant mainly does manual and transportation work. In the process of upgrading the job, a quick learner is given preference.

Some key machines used in tanneries are Fleshing machines, Spirit machines, Trimming machines, Setting machines, Vacuum machines, Toggle machines, Spray machines and so forth. Fleshing machines are used for separating raw

hide from flesh and fat, which cause most of the pollution. In the shaving process hides are cleaned by detergent and the thickness of the hides is maintained. The Spirit machine is used for dividing hides into two parts called *ban pit* (mainly exported) and *spirit site* (used for internal use). In tanneries 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, among others.

The Appex Tannery made some abortive attempts to introduce the greening process in this sector. They did not work, primarily due to the planned moving of all the tannery units from the Hazaribagh area of Dhaka City to Savar, mainly for environmental reasons. The removal process has already started. However, a greening process in this sector is expected to occur once the relocation of tannery units is complete.

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

However, according to the production managers of the tannery companies, skills gaps linked to green processes in tanneries feature most prominently in the occupations of Chemical Equipment Operators and Tenders, Chemical Technicians, First-Line Production Supervisors, and Safety Investigators and Cause Analysts. Companies collaborating with foreign leather buyers arrange overseas training to overcome the skills gaps. In several instances buyers post their technical staff in the companies for one or two weeks in order to ensure the quality of the products.

Machine Operator is selected as the basis for a case study to illustrate an existing occupation which has the potential to undergo a greening process in tanneries. There is no evidence of greening of this occupation in the existing companies; the process needs to be introduced. Potential greening is relevant to a large

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proportion of existing occupations. Planned introduction of ETP in each tannery unit in Savar is expected to play a vital role in the process of greening tanneries. The number of the current workforce who can potentially perform a greener version of this occupation is estimated to be in the region of 2,000. The volume of the workforce expected to transit into a greener version of this occupation in the coming years is expected to increase substantially. Currently, there exists a 100 per cent skills gap for greening this occupation.

There is potential in 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 a legal framework and the level of decision-making. A policy response is totally absent. The skills provision in response to the identified need is important in its own right.

Case study on Brickfield Managers in Brick Manufacturing

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 workers, and in a large unit up to 200 workers, are employed during the peak season. The gender composition of employment in the brickfields has been undergoing change in recent years. Prior to the year 2000, female workers were very rare in the brick industry but now their participation is very common. Almost 20 per cent of the workers in brick manufacturing are female. Of 150 workers in a brickfield, about one-third are engaged in cleaning the field, 25-30 of them in brick-making through dice, about 40 in carrying the bricks into the kiln, and about 25 in brick burning. To run a brickfield the manager plays the key role. He maintains ready links with the owner, brick buyer and labourers. In Bangladesh a brickfield manager need not be highly educated but must be experienced in managerial work. To run a brick field successfully, a manager needs to understand the pulse of the workers and assess the brick market (Mondal et al, 2010).

According to the owners of brick manufacturing companies, the Government should arrange training for brickfield managers because it is a widespread business and it is very difficult for the owners to arrange training for managers individually. Besides, owners are not interested in spending money on their training. To implement such a training programme there are three main requirements: first, the training programmes should be funded and implemented by the government; second, training should be provided during the off-season and free of cost; and third, the training programme should be conducted regularly and continue for at least five years. In the first year 10 brickfield managers and 100 workers may be trained. 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 skills gaps in brick-making occupations primarily include brick-making technologists and supply chain managers responsible for the 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 of brick-making, the manager needs to be trained in environment conservation and use of green technology, especially CDM.

The role of brickfield manager is selected as a case study illustrating an existing occupation which typically undergoes 'greening' in reaction to the demands of the economy. This age-old occupation has most recently been undergoing a greening process. With innovation and the introduction of green technology, the ongoing greening affects a large proportion of existing occupations. The share of the current workforce already performing a greener version of this occupation is around 64 per cent (based on DOE conversion of 4,227 traditional brick kilns out of 6,646 into modern brick kilns by February 2017). 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 speedily into a greener

version of this occupation in the coming years.

According to the owner of Diamond Auto Bricks at Aduria Saughat in Narayanganj, there are skills gaps in greening of the occupation. This was identified from existing information flows on the innovative technology. Although currently there is no skills provision, there is large potential in 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 greening brickfields is positive in terms of the legal framework. The policy response is adequate, but there is a pressing need for skills provision in response to the identified need. The existing process is partly effective and requires full participation by BBMOA.

4. Conclusions

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

Skills and labour development is a vital component of any restructuring in the transition of Bangladesh to a low-carbon economy. The main greening shifts in the economy and labour market of Bangladesh have taken place strongly in renewable energy, but weakly in materials management, telecommunications, transport and manufacturing (brick-making and RMG). But these greening shifts remain weak (except in renewable energy), primarily due to inadequate policy, institutional support, and policy implementation. The main institutional bottleneck that hampers skills development for a transition to green economy seems to be inadequate appreciation of the needs by the DTE, BTEB, BMET and, above all, MEF, Ministry of Education, Ministry of Works and MLE.

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

National concerns such as climate change and loss of biodiversity require concerted efforts by 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 renewable energy (solar, wind, hydroelectricity, geothermal energy etc.) has enormous potential for Bangladesh. If properly tapped, these alternative sources of energy can bring about revolutionary change for transition to a green economy. There is a general consensus that cleaner technology is needed but the

cost is too high to be affordable. The costs of implementing many of the available green technological solutions and alternative lifestyles are considerably higher than those of the "business as usual" practices.

4.2 Skills implications and development

4.2.1 Anticipation and identification of skills needs

Eight case studies illustrate anticipated change and provision of skills.

Two case studies, (i) refuse and 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 in the labour market and of 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 waste carriers, which are traditional jobs. The jobs of the people involved in these three categories are becoming obsolete owing to changes in the traditional way of collecting waste and dumping. To cope with the new way of collecting waste requires (re)training of existing employees who are actively involved in waste collection and dumping. Existing training programmes on solid waste management are scarce.

From the informal sector 420,000-520,000 of the urban poor are involved in the waste recycling trade chain. As of 2015 there are an estimated 150,563 garbage collectors and related labourers in the country. They are unfamiliar with clean garbage collection and disposal, pointing to the need for their retraining to develop environment-

friendly skills. This workforce is likely to grow at the rate of 1 per cent annually. Those 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 the green-enhanced skills required for the future are hazardous materials removal workers, hazardous waste management specialists, solid waste (energy) engineers and managers, green building and recyclable materials distributors, recycling collections drivers, recycling coordinators and sustainable design specialists. All of these skills are spreading in Bangladesh with the assistance of the donor agencies, but on a limited scale.

The involvement of the farmers in using organic and bio-inputs is increasing and today spans over 38 districts and around 1,062,395 farming families. The farmers have responded well and have 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, thereby influencing the growth of crops with 'zero impact' on the environment. As of 2016 the total land area under organic cultivation in Bangladesh was estimated at 6,860 hectares, representing only 0.1 per cent of the country's total cultivable land. The number of organic producers is only 9,335. Agricultural inspectors can also play a significant role in boosting organic farming. Barely 1 per cent of them practise organic farming. Therefore this workforce, including agricultural workers, badly requires retraining in organic farming. Among major green increased demand occupations in organic farming are energy crop farmers, agriculture extension specialists, biologists, fishery specialists, 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 and extensive training is required.

For new green-collar occupations, three case studies on (i) carbon trading, (ii) solar energy engineers and technicians, and (iii) mechanical engineers and CNG conversion technicians, illustrate how these occupations emerge afresh as a result of adaptation to climate change and mitigation of its negative impacts, and are new in the labour market. The same applies to 'hybrid' occupations, for example carbon traders, solarteurs, bioenergy technicians, energy assessors, CNG conversion technicians and green accountants. These new green-collar occupations are concentrated mainly in the energy and transport sectors. The workforce involved in such occupations is now quite sizable 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 pollutant emissions. It entails trading in energy and is a new and emerging green occupation which includes (i) carbon credit traders, (ii) carbon trading analysts, (iii) energy brokers, (iv) investment underwriters, and (v) securities and commodities traders. In Bangladesh there are skills gaps in all these occupations, particularly as 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, securities and commodities traders, along with staff involved in carbon capture power-plant installation, operations, engineering and management, and also in general and carbon sequestration plant installation, operations, engineering and general management, carbon capture and sequestration systems installation. Of these occupations, only carbon sequestration plant installation, operations, engineering and general management staff, and carbon capture and sequestration systems installation staff exist in Bangladesh, and then only on a limited scale (only Waste Concern is involved in carbon saving devices). Waste Concern is a small company and is coping with its critical skills needs through foreign training, while for high green-collar jobs the required training is obtained from abroad, especially from the European Union. For low

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green-collar jobs the company itself provides on-the-job training.

Rural electrification through solar technology is becoming more and more popular in Bangladesh. Currently, there are 4.5 million Solar Home Systems with a production capacity of 216.75 MW. The Government has targeted an eight-fold increase in solar energy from 222 MW in 2015 to 1,740 MW in 2021. The study finds that green jobs in solar energy have steadily increased by 18.5 per cent annually from 60,000 in 2011 to 140,000 in 2016, compared to 1.9 per cent for the overall economy. Jobs in SHS have reached a plateau with the slowdown in installation compared to the earlier period, while jobs in mini-grids and solar pumping are picking up as the government shifts its focus towards these applications. Exceptionally, jobs in the biogas sector grew by more than 60 per cent following numerous initiatives to provide rural household biogas digesters across the country.

Solar energy interventions replace fossil fuel and directly reduces GHG by a considerable amount, potentially 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 workers, and so forth. This sector is totally green and has ample scope for creating new green-collar jobs.

Because of the lack of available easy alternative sources of energy and the vulnerable current energy situation in Bangladesh, a massive demand for solar energy has been created. As a new green technology or type of activity, solar energy is having significant impact on the environment and economy through creating enormous employment opportunities. Currently around 28,000 solar engineers and technicians and more than 200 green entrepreneurs are involved in this sector. There is scope for 200,000 more 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.

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

- (a) branch manager, (b) service engineer, (c) financial assistant, and (d) solar energy technician.

Of 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 SHS on a larger scale. At present the training in solar energy is taking place only on a small scale and mostly through certain NGOs (e.g. GS and BGEF), REB, BCSIR, BMET and IDCOL. The appropriate skills of solar energy technicians in solar systems are a crucial factor for the rapid expansion of SHSs in the future.

New green-collar occupations in solar energy most in demand in the country include (i) solar energy installation managers, (ii) solar PV installers, (iii) solar power plant technicians, (iv) solar sales representatives and assessors, (v) solar energy systems engineers, (vi) solar thermal installers and technicians, and (vii) solar thermoelectric plant and concentrated thermal power (CSP) plant operators.

In all these occupations it is mostly the NGOs that provide training. REB, BCSIR and RREL are also training providers. Future demand for green-skills-enhanced occupations in solar energy primarily include PV power systems engineers, PV solar cell designers, solar designers and 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, solar thermoelectric plant and CSP plant operators, solar hot water heater manufacturing technicians, and solar laboratory technicians.

CNG technology contributes to greening the economy. It is one of the most viable alternatives to traditional fuel energy for the automotive industry. CNG is low in pollutants and high in calorific value and heat yield. The policy measures started boosting up CNG activities and creating new employment opportunities. The total number of registered

motorized vehicles in Bangladesh increased from 1,498,244 in 2010 to 2,879,708 in 2016 with an annual growth rate of 11.5 per cent. Between 2010 and 2016 the growth rates for 3-wheelers (11 per cent), buses (6.2 per cent) and micro buses (5.5 per cent) were significant as they were generating most of the employment in the land transport sector. As of June 2016 the transport and storage sector employed 4,571,000 persons with an annual growth rate of 2.8 per cent. 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 workshops 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 technician work in the CNG conversion workshop, namely senior technician and junior technician.

Currently the CNG sector employs an estimated 10,000 people with around 3,500 CNG technicians and 440 mechanical engineers working in various CNG conversion centres located in 17 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. The existing occupations of mechanical engineers, supervisors, managers, accountants and workshop technicians are tending to become greener. Future demand for green-skills-enhanced occupations primarily include fuel retrofitting and conversion technicians, workshop managers, field officers, 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, and supply chain managers. A 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 in turn later provide training for the junior staff. This remains virtually the only source of skills development in these occupations. Most of the technicians receive training on the job.

Three case studies on (i) supervisors and machine

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

Currently about 35,000 workers are employed in tanneries. In addition about 2,500 persons are involved in the process of collecting raw hides and skins and making them available to tannery units. Moreover, 109 organizations employing 15,000 persons import chemicals for use in tanneries. Most tannery workers are not trained in environmental aspects. Among existing occupations in tanneries are hides and skins cleaners, supervisors, machine operators, machine maintenance technicians and assistants. The existing occupations in tanneries are totally non-green, with consequently an enormous potential for greening the existing jobs. To this end persons employed in different occupations in tanneries need to be trained for greening their jobs. Among the main occupations in tanneries are supervisors, machine operators, and machine maintenance technicians and assistants. There is no training course for tannery workers or managers in clean production or management. The BCLT conducts training in manufacturing leather and leather products and professional training related to research, but have no curriculum or courses on tannery-related pollution. New training manuals and curricula to meet the environmental needs should therefore be developed by the BCLT. However, the skills gaps in tanneries figure most prominently among the occupations of chemical equipment operators and tenders, chemical

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technicians, first-line production supervisors, and safety investigators or cause analysts.

Currently more than 6,646 operating brick kilns in Bangladesh contribute more than 1 per cent to the country's GDP and employ more than one million people. The 6,646 kilns plus fixed chimney kilns form the largest stationary source of GHG emissions in Bangladesh which total about 9 million tonnes of CO₂ annually. Besides air pollution, brick-making industries contribute to land degradation, deforestation and depletion of water resources. The brick industry is an Orange B category industry, which is not environment-friendly. The goal of the ECA is to phase out or change all Orange B industries. As of February 2017 DOE has converted 4,227 traditional brick kilns into modern brick kilns. The main occupations in bricks manufacturing are contractors, wood suppliers, brick-field managers, mud mixers, brick-makers and chimney kiln operators. With the 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.

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, as used by VSBK and Hoffman Kiln, are available in other countries that can save energy and reduce emissions. This needs to be replicated all over the country in a sustainable manner. The skills 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 practical experience. In order to ensure greening of 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 energy and water operating costs from day one, over the entire

lifetime of the building. The energy savings could range from 25 per cent to 40 per cent depending on the extent of the green specifications. Several corporate bodies are now using Green Building Rating as a tool for enhancing marketability. Current building design in Bangladesh is more energy-consuming and hence green building initiatives should be undertaken. Currently 2,981,000 persons are employed in the construction sector. About 920,135 people are estimated to be employed in the architecture and town planning professions. Every year about 500 new architects and town planners enter the job market. The construction industry in the country is growing rapidly with real estate growth rate at 24.3 per cent annually. Around 1,492 real estate developers currently work in Bangladesh on building construction and related projects. The main occupations in building construction include architects, engineers, masons, assistants and site managers. But for greening buildings, architects have the central role to play because they are responsible for building design. New skills needed, therefore, include green architects, green town planners, green civil engineers, green supervisors and green 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 logistical requirements also need to be taken into account. The availability and affordability of materials and equipment which contribute to energy efficiency is another major challenge. New technologies such as wind towers, geothermal systems and so forth are gaining increasing importance for greening existing occupations in building construction. The process of greening buildings has been introduced in Bangladesh and can be replicated everywhere in a sustainable manner. The main occupations in this sector include architects, civil engineers, designers, masons, assistants and site managers. So there is enormous 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 assistants, carpenters, cement masons, construction equipment operators,

installation assistants, insulation installers, insulation workers, iron and steel workers, metal fabricators and fitters, and welders, cutters, solderers and braziers. 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 and project foremen. These skills are available in Bangladesh but they are limited in supply pointing to the need for extensive skills development programmes for greening buildings.

In the early stages skills happen to trigger off development in spite of their scarcity. 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 – even at the level of the Ministry of Education and of the Ministry of Labour and Employment - 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 a number of policies and programmes for adaptation to climate change and mitigation of its adverse impact, it has no national policy for the formation and development of skills for greening the economy. The objectives and targets of National Skills Development Policy 2011 do not reflect national environmental objectives and targets. In green skills formation and development, isolated and sporadic efforts are taking place in different sectors in an informal way with very little impact.

Existing education and training systems including general schooling do not embody a strategy of “mainstreaming” sustainability

and environment protection issues. 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. In addition the government is planning to widen the base of environmental education at the higher levels.

The TVET Reforms Project (ending in 2015) attempted to establish a training network between the public sector training institutions and industrial employers, but there was no content on developing skills for green jobs. The Project targeted market-driven, but not environment-driven, skills demand. In the same vein, there being no social dialogue in skills development for a greener economy.

The skills response to meet the challenge of green economic restructuring remains limited. There are no active labour market policy measures and planning of initial and continuing training. On the whole, across sectors and occupations more attention has been given to greening higher-skilled than to lower-skilled education.

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 the weak delivery mechanisms of these institutions. Skills shortages are prominent among agricultural workers, sustainable agriculture specialists and precision soil conservation technicians in agriculture; among graders, scalemen, de-heading men and machine operators in shrimp cultivation; among hazardous waste management specialists, solid waste (energy) specialists and sustainable design specialists in waste management; among carbon credit traders, carbon trading analysts and investment underwriters in carbon trading; among solar energy installation managers, solar PV installers and technicians in solar energy; among CNG engineers and technicians in fuel-efficient transport; among masons in green construction; among supervisors and machine

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operators in tanneries; and among brick-making technologists and supply chain managers in brick manufacturing. 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 are no special skills development programmes to cushion the effects. They are delivered on the job by, for example, RREL, GS, BGEF, GP, Navana CNG and Waste Concern, and funded by the NGOs with donor assistance.

5. Recommendations

5.1 Policy recommendations

Development of skills for green jobs needs to be mainstreamed with the existing national skills development policies and programmes with an adequate institutional framework for implementation. A separate National Skills Development Policy for Green Jobs should be formulated and implemented.

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 implementation of environment-friendly skills needs in various sectors. Existing education and training policies should incorporate provision for environmental education and training at all levels. At primary level it should be made mandatory.

National environmental policies and objectives should be integrated and coordinated with all other public policies and objectives in general and HRD policies and objectives in particular.

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 stakeholders should also be built up through social dialogue. This is a challenging task as the country lacks appropriate technologies to combat GHG effects. At the same time most 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 the technical capacities of Bangladesh it is crucially important to integrate climate change risks and

opportunities into HRD-based planning and programming. The need for climate change mitigation and adaptation skills for professionals necessitates developing and integrating a robust understanding of the implications of climate change into education and training for professionals involved in developing planned mitigation of, and adaptive responses to, the impacts of climate change.

There is a critical need for creating a 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 incentives for solutions to barriers to cost-effective energy-efficiency,
- d) feed-in tariff for solar PV, *and*
- e) waste levy, that is a levy on landfill waste driving development of the recycling industry. Incentives-based policy instruments include tax breaks, subsidies, and tradable permits.

Policy-makers may consider a market-based policy of imposing a 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 and regulation may encompass the following:

- i) minimum energy performance standards;
- ii) basic requirements, with all new residential buildings and major renovations reducing GHG emissions by 40 per cent leading to jobs and skills in cutting-edge building design; *and*

- iii) phasing-out of old technologies, e.g. electricity-powered 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. A green jobs development strategy could consist of the following:

- i) pursuit of a sustainable, low-carbon, low-waste economy which will contribute strongly to meeting Government targets for sustainable development and environment;
- ii) through 'i', stimulation of the growth in 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) identification of "Environmental Management" as a "core enabling sector".

The green jobs strategy provides 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 economy. The current economic environment presents a unique opportunity for all employers to change their working practices, not only promoting the environmental and energy sectors in 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 in providing high quality and consistent training, grants, loans and advice. One may propose the 'integration' of these tools as a coherent network, in addition to new initiatives to fill the gaps. It is also necessary to look closely at the ways in which government makes financial and policy decisions and to set about modifying them 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 sectors. There is also an opportunity to invest in packages to stimulate the economy to ensure that measures contain incentives and checks for greening the economy. Opportunities will arise for integrating activities designed to assist the economy with those specifically 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 demand 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 necessary 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 appropriate for the future, and identify opportunities for diversification. The opportunities will arise across all sectors, as all jobs become greener.

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

Environmental management is a core enabling factor. The role of the environmental sector is not an end in itself, but it supports and facilitates the overall greening agenda. Much of the job potential will be indirect in other sectors. Green jobs are not just in the environmental sector, but as a supply chain are also found in other sectors,

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especially manufacturing. The outcomes of the environmental sector will be downstream, and accrue first to businesses in the mainstream economy in achieving compliance, efficiency improvements, reduced carbon footprint, and so forth, and second to government in terms of meeting policy objectives on energy, waste, housing standards, sustainable regeneration, and so forth. These environmental and green jobs cannot be pursued in isolation from the rest of the economy; the need 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.

A skilled workforce is essentially part and parcel of any economic and employment growth strategy, and re-establishing the linkages between learning and working is a pre-condition for growth. It is vital to invest in human capital to accelerate the momentum of green economic growth and green employment creation. The success of the skills development strategy for green jobs critically depends on the active participation and commitment of all stakeholders. There is a crucial need to build an effective partnership in this critical venture. The proposed “National Skills Development Policy for Green Jobs” is a response to all these challenges.

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 including education reform and transformation of health and welfare services. The core strategy should be creation of an enabling environment for expanded strategic investment in skills development for green jobs along with control of massive population growth which exerts heaviest pressure on the environment and on labour market outcomes.

The existing TVET system needs to be recast in the light of environment-friendly curricula and courses and more effective PPP in the formulation and implementation of the training programmes targeted on establishing and improving the skills base for green jobs. Curricula for greening the economy should be incorporated in the education and training programmes from 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 mentioned 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. The best that skills policy can aim for is “islands of excellence” amidst skills gaps and shortages.

NSDC, in collaboration with BMET, DTE, BTEB, MLE, DOE, DOF, MEF, Ministry of Education, IDCOL, NGOs, and employers' and workers' associations should play a central role in the formation and development of skills for green jobs in Bangladesh. Newly-established SREDA, as a focal point for development and promotion of a sustainable and cleaner environment, is already in place to steer the country in that direction.

The organizations involved in skills response primarily include RREL, Waste Concern, GS, BGEF, REB, IDCOL and BCSIR. They are effective on a limited scale owing primarily to their informal training arrangements. In order to meet the challenges of greening the economy, formal training institutions and programmes need to 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. To meet this challenge there is a crucial need for a clear policy agenda on skills formation and development for greening the economy which would embody strategic interventions for improving the existing education and training capacity to meet the skills needs for green jobs adequately. At the

same time 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 an information and technological knowledge base on green jobs and conduct research on identification, assessment and creation of green skills in transitioning to a low-carbon economy.

In order to improve on the ongoing policies and programmes relating to greening HRD, further research and regular data collection on green jobs, especially by BBS in its periodic LFS, should be undertaken with a view to updating knowledge and progress in greening the economy. To this end, there is a crucial need for capacity-building in research for greening the economy and skills development for green jobs.

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