



Roadmap and Action Plan for Implementing Bangladesh NDC

Transport, Power and Industry Sectors



Ministry of Environment, Forest and Climate Change
Government of the People's Republic of Bangladesh



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Roadmap and Action Plan for Implementing Bangladesh NDC: Transport, Power and Industry Sectors has been prepared by the Ministry of Environment, Forest and Climate Change through a process of participation and consultation with concerned ministries of the government, private sectors and climate change experts.

The document reflects Bangladesh's pathway towards emission reduction and green growth.

The Roadmap and Action Plan has elaborated Bangladesh NDC and could be updated in future. Most of the data used in this document are of years 2015-16. Also, the timelines mentioned under the sectoral activities in different appendices are tentative.

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ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
AF	Adaptation Fund
ASAP	As Soon As Possible
BADC	Bangladesh Agricultural Development Corporation
BARI	Bangladesh Agricultural Research Institute
BAU	Business-As-Usual
BBS	Bangladesh Bureau of Statistics
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
BCCTF	Bangladesh Climate Change Trust Fund
BINA	Bangladesh Institute of Nuclear Agriculture
BPDB	Bangladesh Power Development Board
BPST	Backpressure Steam Turbines
BR	Bangladesh Railway
BREB	Bangladesh Rural Electrification Board
BRT	Bus Rapid Transit
BRTA	Bangladesh Road Transport Authority
BRTC	Bangladesh Road Transport Corporation
BWDB	Bangladesh Water Development Board
BUET	Bangladesh University of Engineering and Technology
CCA	Climate Change Adaptation
CCHP	Combined Cooling, Heat and Power
CDMP	Comprehensive Disaster Management Programme
CEST	Condensing Extraction Steam Cycles
CHP	Combined Heat & Power
CO ₂	Carbon di Oxide
CIP	Country Investment Plan
CNG	Compressed Natural Gas
CPGCBL	Coal Power Generation Company Bangladesh Limited
CPP	Centralised Power Plants
CPEIR	Climate Public Expenditure and Institutional Review
DAE	Department of Agricultural Extension
DC	Designated Consumers
DCCI	Dhaka Chamber of Commerce & Industry
DESCO	Dhaka Electric Supply Company Limited
DNCC	Dhaka North City Corporation
DoE	Department of Environment
DPDC	Dhaka Power Distribution Company Limited
DRR	Disaster Risk Reduction
DPHE	Department of Public Health and Engineering
DTCA	Dhaka Transport Coordination Authority
ECNEC	Executive Committee of the National Economic Council

EE	Energy Efficiency
EE&C	Energy Efficiency and Conservation
EECMP	Energy Efficiency and Conservation Master Plan
ERD	Economic Relations Division
ESCO	Energy Service Company
FAR	Floor Area Ratio
FBCCI	Federation of Bangladesh Chambers of Commerce and Industry
FY	Fiscal Year
GBG	Green Building Guidelines
GCF	Green Climate Fund
GEF	Global Environment Facility
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIZ	Gesellschaft für Internationale Zusammenarbeit
GoB	Government of Bangladesh
GNI	Gross National Income
GW	Gigawatt
HDD	Heavy Duty Diesel
HVDC	High-Voltage Direct Current
ICB	International Competitive Bidding
ICT	Information and Communication Technology
IDCOL	Infrastructure Development Company Limited
INDC	Intended Nationally Determined Contributions
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
JCM	Joint Crediting Mechanism
JICA	Japan International Cooperation Agency
JPY	Japanese Yen
KEA	Korea Energy Agency
KWh	Kilowatt hour
LEAP	Long-range Energy Alternatives Planning
LCD	Low Carbon Development
LCOE	Levelized Cost of Electricity
LDC	Least Developed Country
LDCF	Least Developed Countries Funds
LED	Light Emitting Diode
LEED	Leadership in Energy and Environmental Design
LGED	Local Government and Engineering Department
LNG	Liquefied Natural Gas
MCCI	Metropolitan Chamber of Commerce & Industry
MFF	Multiannual Financial Framework
MNRE	Ministry for New & Renewable Energy
MoEFCC	Ministry of Environment, Forest and Climate Change

MoFDM	Ministry of Food and Disaster Management
MoI	Ministry of Industry
MoWR	Ministry of Water Resources
MPEMR	Ministry of Power, Energy and Mineral Resources
MRT	Mass Rapid Transit
MRV	Measurement, Reporting and Verification
MW	Mega Watt
NAP	National Adaptation Plan
NAPA	National Adaptation Programme of Action
NAMA	Nationally Appropriate Mitigation Action
NDA	National Designated Authority
NDC	Nationally Determined Contributions
NGO	Non-Governmental Organization
NWPDCL	North-West Zone Power Distribution Company Limited
PA	Paris Agreement
PKSF	Palli Karma Sahayak Foundation
PKM	Passenger Kilometer
PPA	Power Purchase Agreement
PSMP	Power Sector Master Plan
RCP	Representative Concentration Pathways
RHD	Roads and Highways Department
RPO	Renewable Portfolio Obligation
RSTP	Revised Strategic Transport Plan
RTHD	Road Transport and Highways Division
SASEC	South Asia Subregional Economic Cooperation
SDG	Sustainable Development Goal
SEZ	Special Economic Zone
SHS	Solar Home System
SIDS	Small Island Developing States
SREDA	Sustainable and Renewable Energy Development Authority
TDM	Time-division multiplexing
TIB	Transparency International Bangladesh
TKM	Tonne Kilometer
TOD	Transit Oriented Development
UISC	Union Information and Service Center
UN	United Nations
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
USC	Ultra-Super Critical
VAT	Value Added Tax
VC	Video Conferencing
WASH	Water, Sanitation and Hygiene
WZPDCL	West Zone Power Distribution Company Limited
WHB	Waste Heat Recovery Boiler
WRI	World Resources Institute
7FYP	Seventh Five Year Plan



ANISUL ISLAM MAHMUD, MP

Minister

Ministry of Environment, Forest and Climate Change
Government of the People's Republic of Bangladesh

MESSAGE

I am happy to know that the Roadmap and Sectoral Action Plans of the Nationally Determined Contributions (NDC) of Bangladesh is ready for launching. This work appears to me as a milestone towards our journey to achieve NDC targets.

Bangladesh is one of the leading developing countries to demonstrate her intension to address adverse impacts of climate change by keeping no stone untouched in this field. We have focused much on adaptation to protect our people and resources from the adverse impacts of climate change. However, the country has also expressed her intention through the NDC to address GHG emissions keeping our limitations in mind. Despite being a minimal emitter, such expression is made to align our efforts with others under the Paris Agreement for securing this globe from the predicted dreadful impacts of global warming. Our future actions to reduce GHG emission have been elaborated in this Roadmap and Action Plans. These documents have also take into accord our National Adaption Plan to address the impact of climate change. Thus, a close link between our adaptation and mitigation plans has been established through the NDC Roadmap and Sectoral Action Plans.

I express my sincere appreciation to the Ministries/Divisions, agencies and private sector stakeholders who contributed to prepare these documents. I hope such cooperation will continue in future in implementing the actions mentioned in the NDC Roadmap and Action Plans.

(Anisul Islam Mahmud, MP)



ABDULLAH AL ISLAM JAKOB, MP

Deputy Minister

Ministry of Environment, Forest and Climate Change
Government of the People's Republic of Bangladesh

MESSAGE

Bangladesh is always a frontrunner among the developing countries to combat climate change. Our efforts, particularly adapting to the adverse impacts of climate change, have been praised by global community many times. As a recognition of this our Honorable Prime Minister was awarded 'Champions of the Earth' by the United Nations. Despite being a negligible emitter of GHG, we have also taken steps to mitigate our emissions. Our Nationally Determined Contributions (NDC) has reflected our intentions in this regard. I am happy to learn that a Roadmap and Sectoral Action Plans have also been developed to explain our future pathways to achieve NDC targets.

The NDC Roadmap explains the objective, institutional setup and coordination mechanisms required for steering the actions. The Sectoral Action Plans for transport, industry and power sectors elaborate the specific plans and tasks needed for implementing the NDC. The action plans also contain information about the costs and other assistance needed for implementation. The NDC Roadmap and Action Plans have made a good connection among our adaptation and mitigation actions. I think this is a unique approach to address climate change.

Lastly, I appreciate the hard work and cooperation extended by the relevant ministries/departments/agencies and private stakeholders to formulate these documents. I hope our coordinated actions will contribute in future to make climate smart Bangladesh.

Joy Bangla, Joy Bangabandhu.

(Abdullah Al Islam Jakob, MP)



DR. AHMAD KAIKAUS
Secretary

Power Division
Ministry of Power, Energy and Mineral Resources
Government of the People's Republic of Bangladesh

FOREWORD

Bangladesh is developing fast and power sector is one of the major drivers for her development. Power generation in Bangladesh has increased by many folds over the last decade. In line with that, a number of projects are ongoing to meet future demand. The country is also taking action to develop a low carbon power generation system. Inclusion of power sector in the country's Nationally Determined Contributions (NDC) is an endeavour for this purpose.

Bangladesh's NDC entails that the power sector would reduce greenhouse gas (GHG) emission 5% below 'business as usual' by 2030 unconditionally. It also stated a conditional 18% GHG emission reduction below 'business as usual' by 2030 subject to appropriate international support. The 'NDC Sectoral Mitigation Action Plan for Power' provides a roadmap for achieving these targets. This 'Action Plan' reflects our plan to low carbon power generation as well as power generation from renewable sources. It also provides a tentative timeline of our actions.

I hope this 'NDC Sectoral Mitigation Action Plan for Power' would provide guidelines for investment in low carbon development and energy efficient power sector in Bangladesh. I appreciate the Ministry of Environment, Forest and Climate Change to take the lead to formulate the Action Plan. I wish this Action Plan be implemented in time with stakeholder's all-our cooperation.

(Dr. Ahmad Kaikus)



MD. NAZRUL ISLAM

Secretary

Road Transport and Highways Division
Ministry of Road Transport and Bridges
Government of the People's Republic of Bangladesh

FOREWORD

Bangladesh is one of the most susceptible countries in the world to the consequence of climate change, which bears a significant risk to the economic development of the country. According to the climate change Vulnerability Index of 2015, Bangladesh's economy is more at risk to climate change than any other country. To fight off the negative consequence of climate change the 'Nationally Determined Contributions' (NDC) sectoral action plan for various sectors has been prepared aiming to limit the increase of greenhouse gas (GHG) emissions in all possible ways.

In this context, The 'NDC sectoral action plan for transport' delineates the mechanisms about how Bangladesh intends to execute the GHG emissions reduction strategy in the transport sector, to support the overall emission reduction target set in the NDC. The Road Transport and Highways Division as the transport sector focal point for NDC implementation prepared this Action Plan in close alliance with concerned Government Ministries such as the Ministry of Railways and other relevant Departments/Agencies.

The NDC of Bangladesh sets targets for the transport sector of an unconditional 9% greenhouse gas (GHG), emission reduction and 24% conditional emission reduction below 'business as usual'. To accomplish the targets, this Action Plan has adopted the 'Avoid-Shift-Improve framework' which identifies possible options for reducing GHG in transport sector. To attain the impeccably efficient output, this plan delved into the opportunities and challenges for implementing the targets. This document is also prepared following the 7th Five Year plan and major transport sector master plans.

Nevertheless Bangladesh's contribution to global GHG emission is negligible; the target portrayed for transport sector in the NDC reflects our acute determination to combat climate change from a frontrunner perspective along with the developed countries. We appreciate the support provided by the Ministry of Environment, Forest and Climate Change as the focal point for UNFCCC and coordinating Ministry for climate change issue in Bangladesh. We hope proper implementation of this Action Plan would make better the overall impact of climate change and contribute to achieving SDG targets for transport sector as well.

(Md. Nazrul Islam)



MUHAMMAD ABDULLAH
Secretary
Ministry of Industries
Government of the People's Republic of Bangladesh

FOREWORD

The, Nationally Determined Contributions' (NDC) of Bangladesh has determined an unconditional 4% greenhouse gas (GHG) emission reduction below 'business as usual' in Industry sector by 2030. It has also set a 10% conditional emission reduction target that is subject to availability of appropriate international support. To reach these targets, the Ministry of Industries, as the industry sector focal point for NDC implementation, has prepared this 'NDC Sectoral Action Plan for Industry' with consultation of all relevant stakeholders.

The scope of the action plan is industrial energy efficiency. This plan has been prepared in line with other major plans such as the 7th Five Year Plan, the National Industrial Policy 2016, Energy Efficiency and Conservation Master Plan and the Bangladesh Climate Change Strategy and Action Plan. This action plan does not attempt to prescribe what industry should be doing to improve energy efficiency and reduce its GHG emissions. Instead the Government aims to set the appropriate policy and legislative framework to incentivise industry to tackle its GHG emissions in the way that best works for them.

I sincerely appreciate the lead role taken by the Ministry of Environment, Forest and Climate Change for launching of this Plan. I hope this Plan would benefit the stakeholders in industry sector to enhance respective endeavours for achieving energy efficiency and reducing GHG emission.

(Muhammad Abdullah)



ABDULLAH AL MOHSIN CHOWDHURY
Secretary

Ministry of Environment, Forest and Climate Change
Government of the People's Republic of Bangladesh

FOREWORD

Bangladesh has achieved sustained economic development during the last decade and is projected to grow even faster in the years to come. But climate change is considered to severely challenge the country's ability to sustain the growth. It is predicted that in the changing climate there will be increasing erratic rainfall resulting in frequent floods and droughts. Sea Level Rise along with cyclone, tidal surge and salinity intrusion will severely affect the life of more than 40 million coastal population of the country.

Bangladesh contributed insignificantly to the global greenhouse gas emission (GHG). However, being a progressive nation in global climate change negotiations, Bangladesh has committed to reduce global greenhouse gas emission by implementing its Nationally Determined Contributions (NDC). The NDC of Bangladesh has set a 5% voluntary emission reduction target below business as usual by 2030. It has also expressed an ambitious upto 15% emission reduction target below business as usual with the condition of getting appropriate support from developed nations.

Bangladesh's NDC Implementation Roadmap covers cross-cutting issues to ensure that implementation is taken forward in a holistic and effective manner. NDC Sectoral Action Plans have also been prepared for the power, industry and transport sectors. One unique feature is that the sectoral action plans have been prepared by the respective three focal ministries and thus the ownership by them is ensured. It also covers the adaptation issues in major vulnerable sectors of Bangladesh. The NDC Implementation Roadmap covers the period 2016-2025. It is expected that this will be a 'live' document and may be updated over time. During its future updates, new sectors may be added as required.

I sincerely appreciate the contributions made by different ministries and private entities for finalizing this document. I hope our joint action will continue in future to implement the NDC.

(Abdullah Al Mohsin Chowdhury)



DR. NURUL QUADIR
Additional Secretary

Ministry of Environment, Forest and Climate Change
Government of the People's Republic of Bangladesh

ACKNOWLEDGEMENT

After a long engagement and hard work of concerned stakeholders, the 'Roadmap and Action Plan for Implementing Bangladesh NDC-Transport, Power and Industry Sectors' is ready for publication. At this point in time, I feel happy to share it.

The NDC Roadmap and Action Plan is a milestone towards our journey to green growth and sustainable development. The document elaborates our mitigation actions in transport, power and industry sectors to reach NDC targets as well as refer to our adaptation preferences. The uniqueness of this document is that the sectoral action plans contained in this document have been prepared and owned by all three sectoral ministries/divisions.

The Journey to prepare this Roadmap was not smooth. We encountered quite a number of challenges to reach to this point. Bringing in all stakeholders together time and again was a challenge. Availability and sourcing of appropriate data was also a challenge.

The preparation of this document started in late 2016 under the leadership of the Ministry of Environment and Forest. A variety of stakeholders such as government ministries, agencies, private entrepreneurs, universities, climate change experts were consulted throughout the process. An Advisory Committee and a Technical Committee were formed comprising representatives from different sectors. Both the committees met a number of occasions to discuss the issues, monitored progress of the preparation of the document and provided useful guidance. A number of meetings also took place at sectoral focal ministries (Road Transport and Highways Division, Power Division and Ministry of Industries) where public and private stakeholders of specific sectors participated.

I am thankful to the concerned Government Ministries/Divisions/Agencies for their continuous support throughout the process. My humble appreciation goes to the sectoral focal ministries for coordinating sectoral issues and preparing the sectoral action plans. In this regard, I would like to specially mention the contributions made by Ms. Zahida Khanam, Additional Secretary, Road Transport and Highways Division. Ms. Yasmin Sultana, Joint Secretary, Ministry of Industries, Mr. Mohammad Alauddin, Joint Secretary, Power Division and Mr. Siddique Zobair, Member, SREDA.

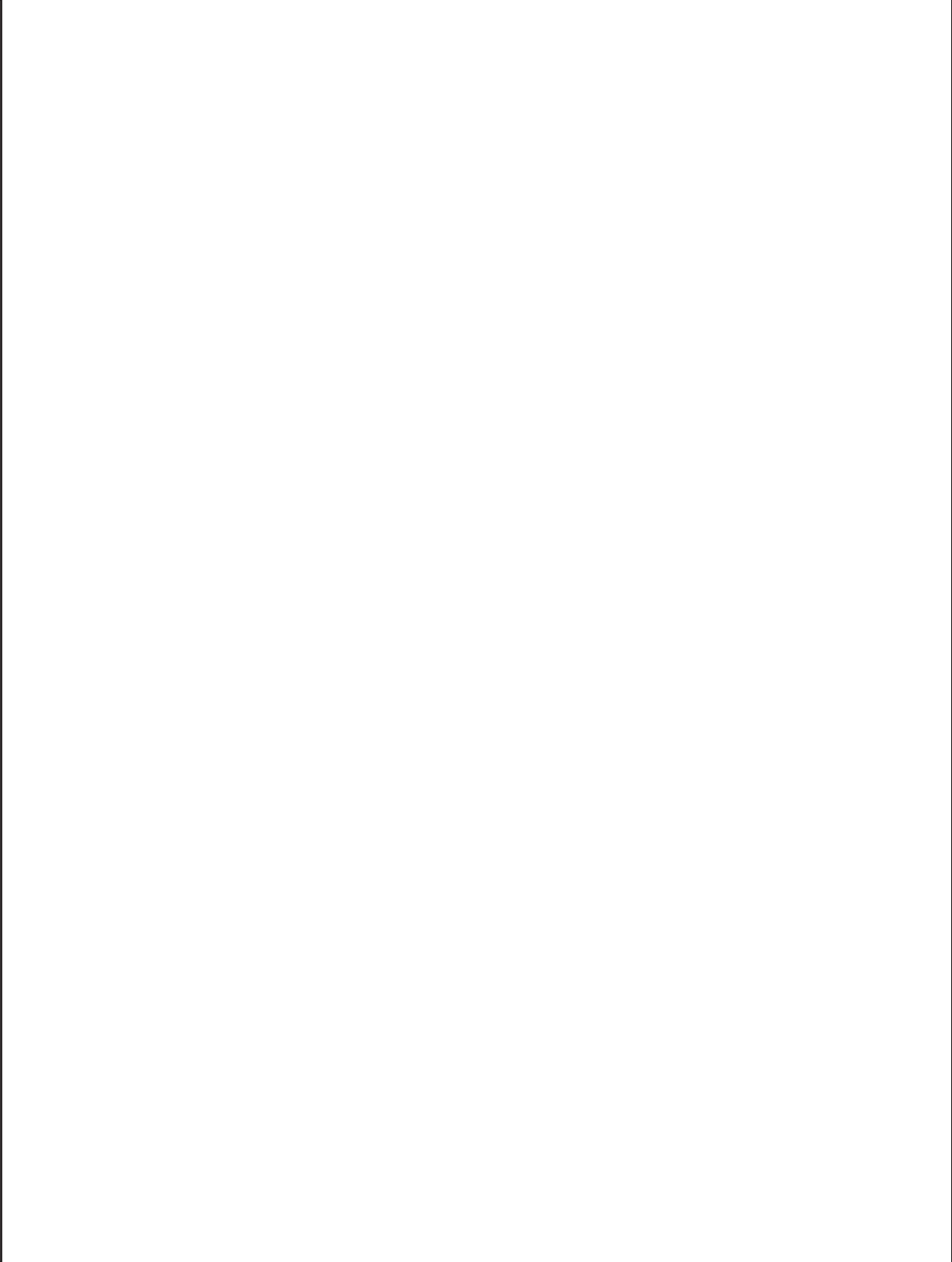
I acknowledge with thanks the contribution of my colleagues in the Ministry of Environment, Forest and Climate Change and Department of Environment (DoE) for their hard work and patience in preparing and reviewing the document. Special thanks are for Dr. S. M. Munjurul Hannan Knan, Additional Secretary, MoEFCC, Md Mozahed Hossain, Additional Secretary, MoEFCC, Dr. Mohammad Azizul Haque, Deputy Secretary, MoEFCC, Mr. Mirza Shawkat Ali and Mr. Ziaul Haq, Director from DoE.

I would like to thank CDKN for providing support to prepare this document and also acknowledges Ricardo Energy and Environment and NACOM support in the process.

I express my sincere gratitude to the honorable Minister, Deputy Minister and Secretary of the Ministry of Environment, Forest and Climate Change for their continuous support and guidance at different stages of the preparation of this document which undoubtedly helped to reach us here.

I hope the support and enthusiasm in preparing the NDC Roadmap and Action Plan will continue in future for actual implementation of the actions to achieve green growth and sustainable development in Bangladesh.

(Dr. Nurul Quadir)



EXECUTIVE SUMMARY

Bangladesh is one of the most vulnerable countries in the world to the effect of climate change, which poses a significant risk to the sustainable development of the country. Bangladesh is therefore adopting a two-fold strategy to tackling climate change: the main focus of Bangladesh's activities is on increasing resilience to the impact of climate change; at the same time, the country is also working to achieve lower greenhouse gas (GHG) emissions. This balanced approach is reflected in its Nationally Determined Contributions (NDC) submitted to the UNFCCC in September 2015 which committed to reduce GHG emissions in the power, industry and transport sectors by 5% below 'business-as-usual' GHG emissions by 2030 unilaterally, and up to 15% below 'business-as-usual' GHG emissions by 2030 if sufficient and appropriate support is received from developed countries.

The focus under the Paris Agreement now shifts to implementations. The Bangladesh's NDC implementation Roadmap includes cross-cutting NDC implementation issues to ensure that NDC implementation is taken forward in a holistic and effective manner as well as NDC Sectoral Action Plans for the Power, Industry and Transport sectors. Reflecting the balanced approach, these sectoral action plans describe the actions that need to be taken to deliver the GHG reduction targets set out in Bangladesh's NDC alongside the actions which can be taken by these sectors to strengthen their climate resilience.

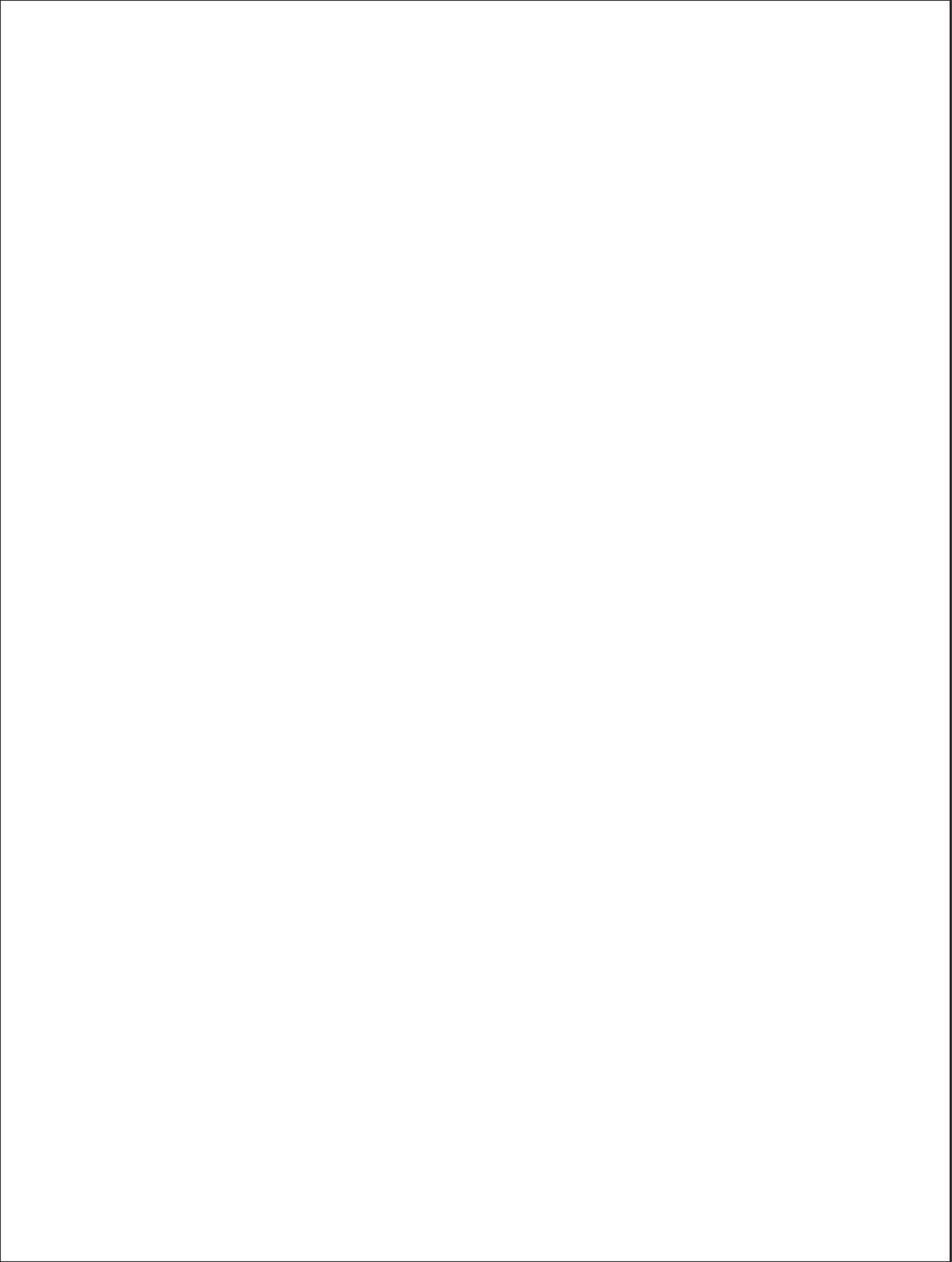
The implementation of Bangladesh's NDC builds on and supports existing action that the Government of Bangladesh is taking on climate change, as well as on other key non-climate related strategies and plans, and links closely with the Sustainable Development Goals (section 1.2). Key to successful NDC implementation is good governance and coordination among all stakeholders - including government sectors, private sector and civil society. Bespoke governance arrangements have been developed for NDC-NAP implementation and will be driven by the actions of Sectoral Working Groups (section 1.3).

While the Sectoral Working Groups will drive forward implementation of specific mitigation actions, it will be necessary in parallel to build greater capacity to prepare for updating the NDC in 2020 in three key areas relating to mitigation: analysis, policy design, and policy implementation (section 1.4). Bangladesh has now initiated the development of its National Adaptation Plan (NAP) which will be overseen by a common governance system through the NDC-NAP Implementation Coordination Committee and the NAP will provide the adaptation component of the NDC in due course (section 1.5).

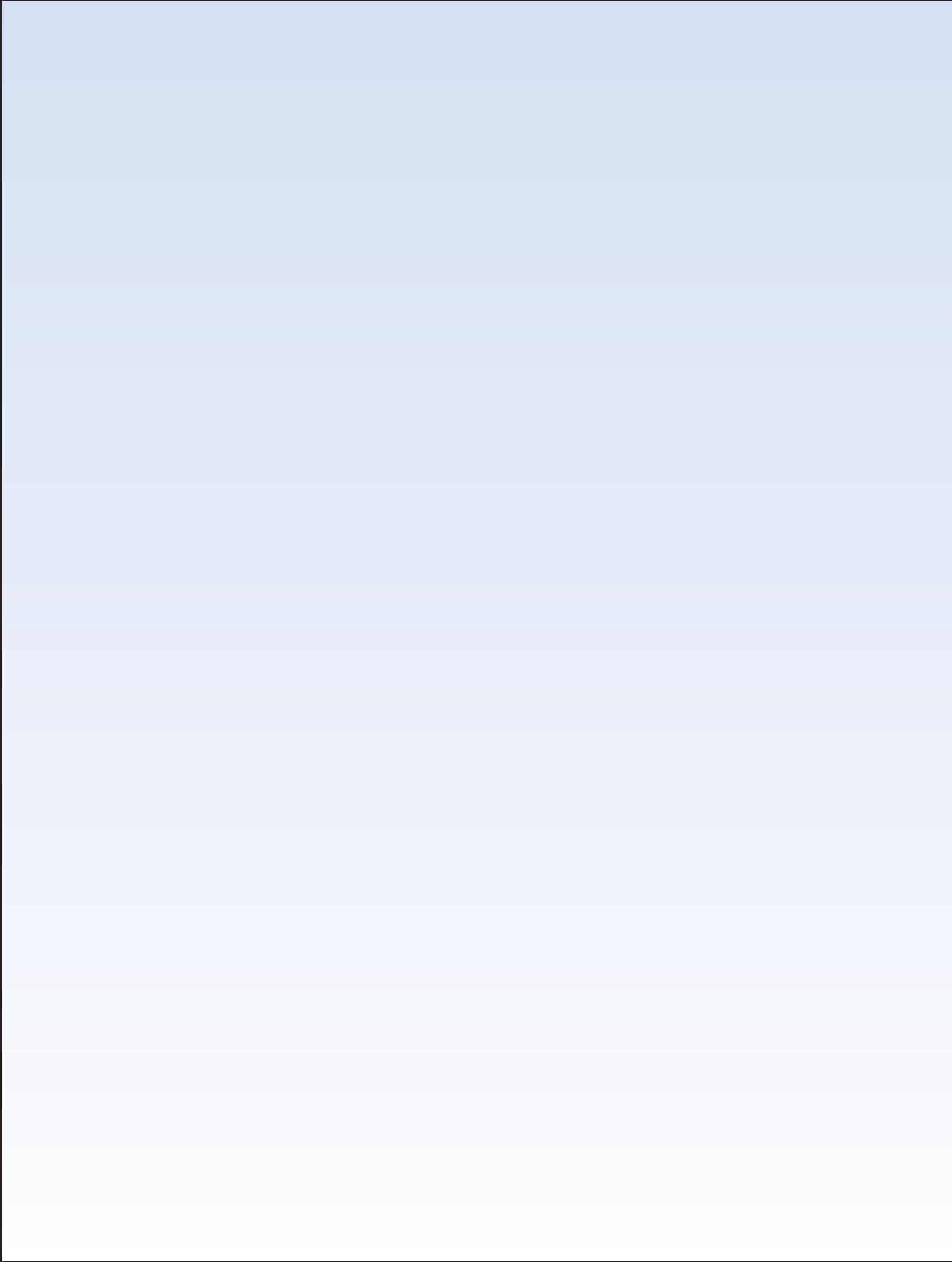
Implementation of the NDC will require considerable resources in the form of climate finance: while the NDC Sectoral Action Plans provide information on the resourcing needs for each sector, the Roadmap sets out the overarching approach for mobilizing the finance needed to implement the plan as a whole, including plans for quantifying overall costs of implementation and assessing how best to access public and private sources of finance (section 1.6). Finally, the Roadmap sets out a vision for tracking NDC implementation through its national arrangements for monitoring, reporting and verification (MRV). These will include the GHG inventory, GHG projects and the measurement and evaluation of individual measures. Bangladesh will work towards integrating these into a comprehensive MRV system which will track progress to its 2030 targets and provide the means for complying with the transparency requirements of the Paris Agreement (section 1.7).

The NDC implementation roadmap covers the period 2016-2025, with a focus on the period up to 2020, and is a live document which will be updated over time, with the addition of new sectors as required. This initial Roadmap identifies 28 specific cross-cutting actions along with detailed actions in each of the sectors. These actions together with anticipated timelines and indicative costs/needs are set out in appendices 1, 3, 4, and 5 of the report.

Finally, the detailed sectoral actions plans set out in the roadmap, each describe the vision and scope of the plan, the key mitigation measures, proposed indicators to measure progress, adaptation priorities and governance arrangements, as well as identifying detailed actions to deliver the plan.



NDC IMPLEMENTATION ROADMAP



1. NDC IMPLEMENTATION ROADMAP

1.1 INTRODUCTION

Bangladesh is one of the most vulnerable countries in the world to the effects of climate change, which poses a significant risk to the economic development of the country. According to the Climate Change Vulnerability Index of 2017 of German Watch, Bangladesh is the 6th most vulnerable country of the world due to climate change impact. With a per capita Gross National Income (GNI) US\$1,610 in FY 2016-17 (BBS, 2017), the economic losses due to climate change in Bangladesh over the past 40 years were at an estimated \$12 billion which is depressing the GDP annually by 0.5 to 1 percent.

Bangladesh is adopting a two-fold strategy against climate change impacts. The main focus of Bangladesh's activities is on increasing resilience to the impacts of climate change. At the same time, the country is also working to achieve lower greenhouse gas (GHG) emissions as well as more resilient development. The Government of Bangladesh prepared the Bangladesh Climate Change Strategy and Action Plan¹ (BCCSAP) for adaptation and Low Carbon Development (LCD), which is an overarching document on climate change and is now being updated. The Seventh Five Year Plan² has included three themes; climate change adaptation, implementation strategy on climate change resilience and climate change mitigation under "Addressing climate change under the Seventh Plan." The seventh plan has also considered green growth strategy and also development resource allocation for Environment and Climate Change.

With this in mind, Bangladesh has prepared this Implementation Roadmap for the Nationally Determined Contributions (NDC) to manage growing emissions without compromising the required development and to allow Bangladesh to play its role in global efforts to limit temperature rise to two degrees or preferably 1.5 degrees above pre-industrial levels.

Countries' Nationally Determined Contributions (NDCs) are central to the Paris Agreement that was reached in December 2015. They set out each country's approach to becoming a low carbon and climate resilient economy, as well as how this will be coordinated, managed, tracked and financed. Countries submitted their intended NDCs (known as INDCs) in advance of the Paris Climate Conference. Bangladesh submitted its INDC to the United Nations Framework Convention on Climate Change (UNFCCC) in September 2015. Countries are now encouraged to ratify the Paris Agreement and to implement their NDCs. Bangladesh ratified the Paris Agreement on 21 September 2016 and its NDC can now be found on the UNFCCC's NDC Registry³.

As a country that has an NDC with a timeframe to 2030, Bangladesh is requested under the Paris Agreement to submit an updated NDC by 2020. There then follows a regular process of updating NDCs every five years after that, with regular global 'stocktakes' to assess globally the extent to which progress is being made to the overall aims of the Paris Agreement.

Bangladesh's NDC describes its plans for tackling greenhouse gas (GHG) emissions and adapting to unavoidable climate change. This recognises two important factors:

- On the one hand, as a climate vulnerable country, adaptation remains the priority for Bangladesh. Bangladesh's NDC therefore has an adaptation component that describes what Bangladesh has already done on adaptation and what the priorities for the future.

1. <https://moef.gov.bd/site/page/97b0ae61-b74e-421b-9cae-f119f3913b5b/BCCSAP-2009>

2. http://www.plancomm.gov.bd/wp-content/uploads/2015/10/7th_FYP_18_02_2016.pdf

3. <http://www4.unfccc.int/ndcregistry/Pages/Home.aspx>

- On the other hand, Bangladesh is committed to taking a progressive approach to developing its economy on a low carbon pathway. In the submitted NDC, Bangladesh has committed to reduce GHG emissions in the power, industry and transport sectors by 5% below 'business-as-usual' GHG emissions by 2030 using only domestic resources under unconditional contribution, and by 15% below 'business-as-usual' GHG emissions by 2030 if sufficient and appropriate support is received from developed countries under conditional contribution.

The focus under the Paris Agreement now shifts to implementation. It is important to note that the Paris Agreement states that the 'least developed countries may prepare and communicate strategies, plans and actions for low greenhouse gas emissions development reflecting their special circumstances'. As a progressive member of the UNFCCC, Bangladesh was one of the first countries following the Paris Agreement to put in place a process for developing plans for NDC implementation. Bangladesh reserves the right to change its position on implementation of its NDC in future.

Implementation of Bangladesh's NDC will involve multiple stakeholders and will be taken forward through a number of different workstreams and programmes. The whole process will be set within the strategic framework of the Bangladesh Climate Change Strategy and Action Plan, which, as mentioned above, is currently under review for the future update. This document Bangladesh's NDC Implementation Roadmap describes and guides the overarching NDC implementation process and covers cross-cutting NDC implementation issues to ensure that NDC implementation is taken forward in a holistic and effective manner.

Beneath this, NDC implementation will be driven by many different documents and processes. In the future, the primary vehicle for taking forward adaptation policy and implementation is expected to be the National Adaptation Plan (NAP) process, which will implement the adaptation elements of the NDC. However, it depends upon the decision of subsequent COPs on adaptation issues.

As part of the NDC Implementation Roadmap, NDC Sectoral Action Plans have also been produced for the power, industry and transport sectors. These action plans describe the actions that will be taken in each of these three sectors to deliver the GHG emissions reductions required to meet the overall GHG reduction targets as set out under Bangladesh NDC. They also consider how the power, industry and transport sectors will be most impacted by climate change and what actions can be taken by these sectors to strengthen their climate resilience. For this NDC, Transport sectors include Roads & Railway Subsectors.

The NDC implementation roadmap covers the period 2016-2025, with a focus on the period up to 2020. The reason for this focus on the near-term time horizon is that the roadmap, and the accompanying sectoral action plans, set out the detailed actions required to implement the NDC and as such it is logical to focus most on the next few years. These detailed actions are summarised at the end of each section, as well as being listed in full in Appendix 1. Detailed actions on mitigation and adaptation can be found in the appendix 3, 4 and 5.

It is expected that this will be a 'live' document and may be updated over time. During its future updates, new sectors may be added as required.

1.1.1 Integration of NDC implementation and NAP implementation

The UNFCCC established the National Adaptation Plan (NAP) process as a way to facilitate adaptation planning in Least Developed Countries (LDCs) and other developing countries⁴. As the NAP process in Bangladesh has yet to start in full, Bangladesh is keen to integrate these two separate processes (NDC and NAP) to attain

4. http://unfccc.int/resource/docs/publications/publication_ldc_napp_2013.pdf

synergies in the actual implementation phase. Based on future updating of the NDC, the NDC implementation road-map could potentially be extended to cover other sectors that are relevant to adaptation as well. Once the NAP process is fully underway, there will be an integrated arrangement for the implementation of both the NDC and the NAP.

1.2 NDC IMPLEMENTATION IN BANGLADESH

The implementation of Bangladesh's NDC builds on and supports existing action that the Government of Bangladesh is taking on climate change, as well as on other key non-climate related strategies and plans. Before considering NDC implementation in more depth, it is helpful to first consider how NDC implementation fits with wider government policy. NDC implementation is considered as a vital component of delivering sustainable and low carbon growth in Bangladesh and meeting a wider raft of objectives and priorities, including energy access, economic growth, productivity, poverty reduction and improved quality of life. In this sense they link closely to the UN's Sustainable Development Goals⁵.

1.2.1 The climate change policy landscape in Bangladesh

The main strategic direction on climate change policy in Bangladesh is set by the Bangladesh Climate Change Strategy and Action Plan (BCCSAP), 2009, which is built on the following six pillars:

- Food security, social protection and health
- Comprehensive disaster management
- Infrastructure
- Research and knowledge management
- Mitigation and low carbon development
- Capacity building and institutional strengthening

The BCCSAP is very much Bangladesh's overarching strategy on climate change and sets the strategic direction for climate policy. The BCCSAP is currently being reviewed and updated, and the new version is due to be published in 2018.

The NDC can be seen as a communication to the international community of Bangladesh's overall approach to climate change action, on both mitigation and adaptation. The NDC is, in turn, being implemented on the ground through this NDC Implementation Roadmap and the Sectoral Action Plans that is part of this study, and for adaptation through the National Adaptation Plan (NAP) process (refer to Section 1.5 for further details).

1.2.2 The wider policy landscape in Bangladesh

It is important to note that the NDC is not just a climate change document. It charts a course to sustainable, low carbon and climate resilient growth and as such should play a key role in Bangladesh's development. As outlined in each of the NDC sectoral action plans, there are many ways in which actions to implement the NDC can support Bangladesh's development agenda.

- Expansion of renewable energy can reduce the burden of costs of importing energy, as well as being a cost effective, pragmatic solution for providing electricity to off-grid areas.
- Improving industrial energy efficiency can help increase productivity and allow domestic industry to grow to meet increasing domestic and international demand.
- Modernising transport infrastructure is vital for economic growth, whilst tackling congestion removes a key barrier to growth.

5. <https://sustainabledevelopment.un.org/?menu=1300>

This NDC Implementation Roadmap and the Sectoral Action Plans will play a key role in driving forward action in the key sectors of the NDC. But ultimately, the aim is to mainstream climate change so that it underpins everything that the Government and other stakeholders do in Bangladesh. Achieving outcomes such as those outlined above will be easier if climate change is deeply embedded in the Five-Year Planning process that is central to development in Bangladesh. The NDC therefore aligns closely with the Seventh Five Year Plan (7FYP), which proposes a number of key activities to facilitate climate change mitigation and adaptation, including enhancing understanding on low carbon development, promoting a whole-government approach to climate readiness, improving capacity, improving coordination and communication amongst key institutions and encouraging innovation and research. These will aid and support NDC implementation. As part of the implementation of the 7FYP, the Government is developing sectoral action plans for the thirteen sectors set out in the 7FYP⁶. The Ministry of Environment, Forest and Climate Change, who will coordinate action on NDC implementation (see section 1.3 on Governance and coordination), will work closely with the Planning Commission, who coordinate action on the 7FYP to ensure that climate considerations are integrated throughout the relevant 7FYP action plans, such as transport and communication, agriculture, power and energy and industrial and economic services. Furthermore, the 7FYP action plan for the Environment and Climate Change sector will be aligned closely with the BCCSAP and the NDC, as well as highlighting the strong links between climate change and other environmental parameters.

Table 1: Links between the 7FYP and Climate Policy

7 FYP sector	Link with NDC implementation	Nature of link
Industrial and Economic Service	NDC Industry Sector Action Plan	Ensuring the expanding manufacturing sector is low carbon and energy efficient.
Agriculture	NAP	Encouraging low carbon practices in the sector and strengthening the sectors resilience to climate change
Power and Energy	NDC Power Sector Action Plan	Renewable energy and state of the art coal generation technology that minimizes the impact on the environment
Transport and Communication	NDC Transport Power Sector Action Plan	Modernising the transport system, reducing congestion and encouraging lower carbon transport modes
Local Government and Rural Development	NDC Implementation Roadmap	Building the capacity of local governments can help support climate action at the local level
Environment and Climate Change	BCCSAP	The need to take into account environment, climate change adaptation and mitigation in a broader development context
Housing and Community Amenities	BCCSAP	Encouraging energy efficiency of residential sector
Health	NAP	Climate change affects the social and environment determinants of health - clean air, safe drinking water, sufficient food and secure shelter*
Education and Technology	BCCSAP	Raising awareness of climate change and building capacity, technology capability etc.
Social Protection	NAP	Disaster management and food security

* <http://www.who.int/mediacentre/factsheets/fs266/en/>

6. In total there are 14 sectors in the Seventh Five Year Plan but an action plan is not being developed for Defense.

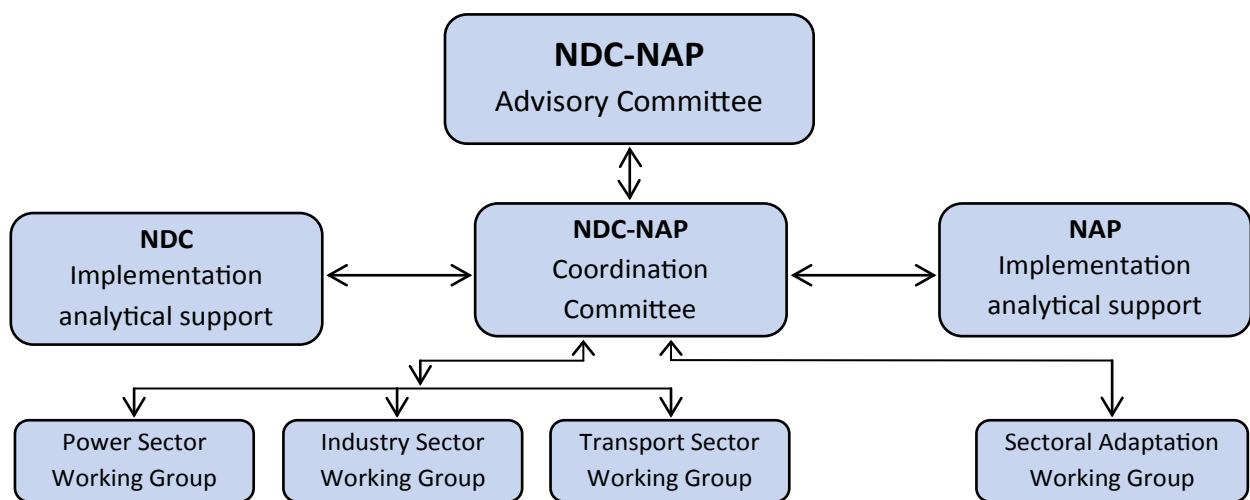
1.3 GOVERNANCE AND COORDINATION

1.3.1 Institutional arrangements for NDC implementation

Key to successful NDC implementation is good governance and coordination among sectors, different stakeholders and government and civil society, so that activities at the local level are appropriately aligned with the NDC, the BCCSAP and the Five-Year Plans.

This section explains the proposed governance arrangements for overall coordination of NDC implementation, as outlined in figure 1. Arrangements for governance and coordination at the sectoral level can be found in each of the NDC Sectoral Action Plans. NAP Integration is also shown in the diagram for better synergy and attaining adaptation-mitigation co-benefits.

Figure 1: Governance arrangements for NDC-NAP implementation framework



The arrangements proposed above are specifically proposed for the implementation of the NDC with an aim to include and integrate NAP implementation side by side under one single framework. Depending on the outcome of the review of the BCCSAP, such arrangements might be expanded to also cover the updated BCCSAP, as doing so will be more efficient than setting up parallel arrangements for the management and implementation of the BCCSAP. If this was done, then it might be expected that further sectoral working groups for both mitigation and adaptation would be set up to manage policy development and tracking of progress in those sectors. See the section below on 'NDC Sectoral Working Groups' for more details.

Furthermore, the arrangements above envisage number of adaptation working groups (more to be included from the NAP) that would feed in to the discussions and work of the NDC sectoral working groups as needed on specific adaptation-related issues. The proposed Adaptation Working Groups are put forward without prejudice to any institutional arrangements that would be set up to develop and implement the forthcoming NAP.

Both the processes (NDC and NAP) can have a single Advisory Committee headed by the MoEFCC Secretary, and a single Coordination Committee headed by the Additional Secretary from MoEFCC, backed by separate implementation analytical support for the smooth functioning of these committees. A separate secretariat also needs to be established to look after the day to day functions of the NDC and NAP implementation activities. The detail on the proposed adaptation working groups may have to be separately assessed in the NAP and then integrated into the single proposed framework.

Not all of the arrangements set out in Figure 1 would be entirely new, but this new institutional structure would formalise the arrangements and clarify roles and responsibilities. An NDC Advisory Committee was set up temporarily for the duration of the INDC and NDC implementation projects and this committee can be continued as the proposed permanent NDC-NAP Advisory Committee. An NDC Technical Committee was also set up for the duration of these projects and this could form the basis for the proposed NDC-NAP Coordination Committee.

1.3.1.1 NDC-NAP Advisory Committee

The NDC-NAP Advisory Committee will be chaired by the Secretary, MoEFCC, and will be the most senior decision-making body on NDC and NAP Implementation. Senior representatives from the organisations listed below will be the members of the Committee and will give final sign-off for proposed policies to be introduced, progress reports and other NDC and NAP Implementation reports, before they are published and/or sent to their respective domestic or international audiences. The Committee will give strategic advice on cross-cutting issues regarding NDC implementation and will also regularly review progress on overall NDC implementation. The Advisory Committee may include new members as and when necessary.

The Committee will consist of senior representatives from:

- Ministry of Environment, Forest and Climate Change (MoEFCC) - Chair
- Sectoral focal point ministries
 - Power Division
 - Ministry of Industry
 - Road Transport and Highway Division (RTHD)
- Other relevant sectoral ministries/agencies
 - Prime Minister's Office
 - Ministry of Railways
 - Ministry of Shipping
 - Ministry of Civil Aviation and Tourism
 - Ministry of Agriculture
 - Ministry of Water Resources
 - Ministry of Disaster Management and Relief
 - Planning Commission (General Economics Division)
 - Economic Relations Division
 - Ministry of Finance
 - Ministry of Women and Children Affairs
 - Ministry of Foreign Affairs
 - Ministry of Land
 - Ministry of Fisheries & Livestock
 - Ministry of Health and Family Welfare
 - Ministry of Local Government, Rural Development and Co-Operatives
 - Department of Environment

- Forest Department
- Bangladesh Water Development Board
- Department of Agricultural Extension
- Sustainable and Renewable Energy Development Authority (SREDA)
- Directorate General of Health Services
- The Committee's functions are as follows:
 - Overall responsibility for NDC and the NAP implementation
 - Advise and provide overall guidance to the NDC-NAP Coordination Committee and approve the decisions of the Coordination Committee
 - Regularly review the progress and provide necessary directions for attaining the targets
 - Provide strategic advice on cross-cutting issues regarding NDC-NAP implementation

1.3.1.2 NDC-NAP Coordination Committee

The NDC-NAP Coordination Committee will be the main focal point for the UNFCCC and will also act as the secretariat to the NDC Advisory Committee. It will be based within the Ministry of Environment, Forest and Climate Change (MoEFCC), as part of its lead role in the Government of Bangladesh on climate change and liaising with the UNFCCC.

They will prepare materials for the Advisory Committee, and seek sign off and approval from the Advisory Committee as necessary, for example for an NDC monitoring report. The Committee may include new members as and when necessary.

A full list of its functions are as follows:

- Responsibility for implementation of the Paris Agreement (PA) decisions within Bangladesh, reviewing the PA for key milestones and requirements, and ensuring that action is taken within the Government.
- Coordinating the regular update of NDCs, contribution to the Global Stocktake.
- Reporting to the UNFCCC on NDC and NAP issues through the Advisory Committee.
- Liaison with NDC Sectoral Working Groups.
- Managing of analytical support on NDC and NAP implementation (e.g. constituting the appropriate group(s), developing terms of reference for the analytical work and considering the need for external analytical work (e.g. consultancy projects) where limited capacity exists within government).
- Commissioning technical assistance projects on NDC and NAP implementation as required.
- Coordination of overall stakeholder engagement on NDC and NAP implementation. Convening stakeholder forums on NDC implementation on a regular basis, to review progress and seek stakeholder inputs on future decisions. Note that NDC Implementation Sectoral Focal Points will be responsible for stakeholder engagement on sector issues (e.g. Ministry of Industry would be responsible for convening a stakeholder workshop on NDC implementation in the industry sector).
- Making recommendations to the Advisory Committee on cross-cutting issues.

- Making recommendations to the Advisory Committee on new policies.
- Discussions on cross-sectoral issues, e.g. capacity building needs, MRV, before they go to the Advisory Committee for sign-off.
- Review of progress reports before sign-off by Advisory Committee.

The Ministries and its line agencies representing in the Advisory Committee will be represented on the Coordination Committee but at a more working level.

1.3.1.3 NDC and NAP implementation analytical support

It will be important to have access to robust analysis, both for decisions to be taken on NDC and NAP implementation and for good quality and effective MRV (refer to section 1.7). Rather than being a formal committee, it is suggested that a pool of analytical resource is drawn up across many Ministries. This pool could provide regular and ad-hoc support for analysis and data, both to the NDC-NAP Coordination Committee and to Sectoral Working Groups. It is suggested that this pool of analysts is managed by the Department of Environment (DoE), which is the technical arm of the MoEFCC. In this role, the DoE will liaise with different ministries to request analytical support and to agree terms of reference (e.g. their role, the regularity of input needed, the type of analytical support required etc.).

An indicative list of tasks for the NDC and NAP analytical support team could be as follows:

- Agreement on consistent methodologies for analysing mitigation potential (e.g. common discount rates, common assumptions on technological uptake rates etc.).
- Agreement on common parameters for MRV, e.g. population data, GDP data etc.
- Ex-ante and ex-post reports on GHG savings from policies and measures.
- Peer review of analysis carried out by others in the analytical pool.
- Collection of data, both domestic data and international benchmarks that could be used in the absence of robust domestic data.
- Review of international reports that might provide relevant information.
- Feedback to NDC-NAP Coordination Committee on areas for improvement in the evidence base (e.g. suggestions for technical assistance projects that could help improve the robustness of data in each area).

As explained above, the DoE will manage the analytical support and put requests for analysis to the appropriate analysts. They will also coordinate strategic priorities on data, liaising with the NDC-NAP Coordination Committee in MoEFCC and the analysts as mentioned will identify which areas need further development and ensuring that appropriate resources and capacity building is being targeted at these areas.

1.3.1.4 NDC sectoral working groups

Three NDC sectoral working groups are proposed, covering power, transport and industry, the three sectors with quantified GHG reduction commitments in the NDC. More information on these groups, their membership and functions, can be found in the NDC Sectoral Action Plans for the respective sectors. These working groups will liaise closely with any institutional structures or processes already set up in relation to that sector, for example any such groups or committees for the 7FYP.

1.3.2 Stakeholder engagement

Stakeholder engagement will be important throughout the NDC implementation process. It is necessary to get broad buy-in for NDC implementation and the actions that it will entail, but also to help shape the process, by taking advantage of the creativity and technical expertise on offer from a range of stakeholders.

Stakeholder engagement on NDC implementation will be coordinated by the NDC Coordination Committee, with Sectoral Focal Points coordinating specific sector-focused stakeholder engagement. Stakeholder engagement can take on many forms with different objectives, as seen below.

Table 2: Key objectives of stakeholder engagement for the implementation of NDC

Stakeholder engagement	Objective
Sharing information on the Paris Agreement and on NDC implementation	To broaden buy-in and public support for climate action and for NDC implementation, and to build knowledge capital in key institutions.
Consultations on specific interventions and policies	To seek technical expertise to help shape and improve draft policies.
Sharing of experience and lessons learned with international partners	To increase awareness and appreciation of action carried out in Bangladesh and to transfer knowledge and best practice (in both directions others learning from Bangladesh and Bangladesh learning from others).
Sharing of NDC implementation progress reports	Improve understanding of progress made and or areas where further work is needed, increase buy-in for action in new areas or increasing efforts in existing areas.

1.3.3 Building institutional capacity

A range of capacities and skills will be needed to ensure effective governance and coordination of the NDC implementation process. A good deal of capacity already exists in the central NDC Coordination Team in MoEFCC and DoE, and they will play a key role in identifying capacity needs in other Ministries and supporting them to build the capacity (e.g. through discrete technical assistance projects). There may also be a need for specific capacity building within MoEFCC and DoE to help it fulfil its coordination function on NDC implementation as effectively and efficiently as possible. This could include:

- Expertise in bankable project development and management especially for the Green Climate Fund (GCF), LDC Fund, Adaptation Fund, the Global Environment Facility (GEF) and other bi-lateral and multilateral agencies.
- Capacity building on Monitoring, Reporting and Verification (MRV), including capacity development in GHG emissions assessment in different sectors including data generation system and management.
- Capacity enhancement in climate change negotiations to strengthen the Government positions within the international negotiations.
- Expertise in using appropriate tools for project management, for example Gant charts, critical path tools and risk registers.

Expertise in and understanding of good governance structures and processes, for example well- managed committees and working groups. For example, useful lessons can be learned from other countries that have previously set up such institutional structures.

- Understanding of wider government policy, for example economic and development plans, and sectoral master plans.

More widely across the Government, other capacities that may need further development include:

- Experience and expertise in reporting policy implementation to senior officials.
- Capacity-building on gender mainstreaming for implementing ministries, departments and agencies.
- Basic knowledge of climate policy across key ministries, in particular an understanding of how their core work areas link with the climate agenda and the UN's Sustainable Development Goals.

1.4 MITIGATION

1.4.1 Overview of mitigation policy

As described in the introduction, in its INDC Bangladesh committed to reduce GHG emissions in the power, industry and transport sectors by 5% below 'business-as-usual' GHG emissions by 2030 using only domestic resources, or by 15% below 'business-as-usual' GHG emissions by 2030 if sufficient and appropriate support is received from developed countries. The NDC Sectoral Action Plans set out how the required GHG emissions reductions will be delivered in the power, transport and industry sectors. NDC implementation for these sectors will be driven forward by the Sectoral Working Groups outlined in Section 1.3.1, and their designated focal points, with this activity being coordinated by the NDC Implementation Coordination Committee.

Of course mitigation action is also taking place in other sectors, in addition to the three sectors covered by the quantified GHG target in the NDC. The BCCSAP includes actions to improve energy efficiency in the domestic and commercial sectors, reduce emissions in the agriculture sector (through energy efficiency and water and fertiliser management), capture methane emissions from landfill sites, scale up afforestation and reforestation and reduce emissions from transport through increased public transport and improved fuel efficiency of vehicles.

1.4.2 NDC updating

A key question over the coming years is how the NDC should be updated. The document should be updated in line with the time frame of Paris Agreement. The Paris Agreement expects each updated NDC to represent a 'progression' from the previous one. For mitigation, Bangladesh will consider two main options:

- Strengthening of existing GHG targets in the NDC to make them more ambitious

The strengthening of existing GHG targets in the NDC could entail adopting a more ambitious target (e.g. a higher reduction from business-as-usual than currently), or could equally entail a de facto strengthening through collection of more robust and accurate data for example, data could

potentially be collected that shows that the targets already committed to are tougher than previously thought.

Bangladesh will carry out analysis throughout 2018 and 2019 to both strengthen the evidence base on the existing mitigation targets and measures and on potential additional measures to assess whether the case for including such measures in the mitigation action plans has become more solid.

- Expansion of the scope of the quantified GHG reduction target to include more sectors

A key barrier to including more sectors in the current NDC was availability of robust data.

1.4.3 Delivery of GHG reductions

Mitigation Actions will be a key mechanism for delivering GHG reductions in Bangladesh as set out in different national policies, strategies, master plans and action plans. The foundation of submitted INDC was Bangladesh's existing strategies and plans, particularly the Bangladesh Climate Change Strategy and Action Plan (BCCSAP), the Renewable Energy Policy, the Energy Efficiency and Conservation Master Plan, the Roadmap for Clean Cookstove, the National Sustainable Development Strategy, the Perspective Plan (Vision 2021) and the Seventh Five Year Plan (2016-2020), etc. Bangladesh prepared several full-scale NAMA proposals on innovative energy optimisation in the steel sector, and railway sector.

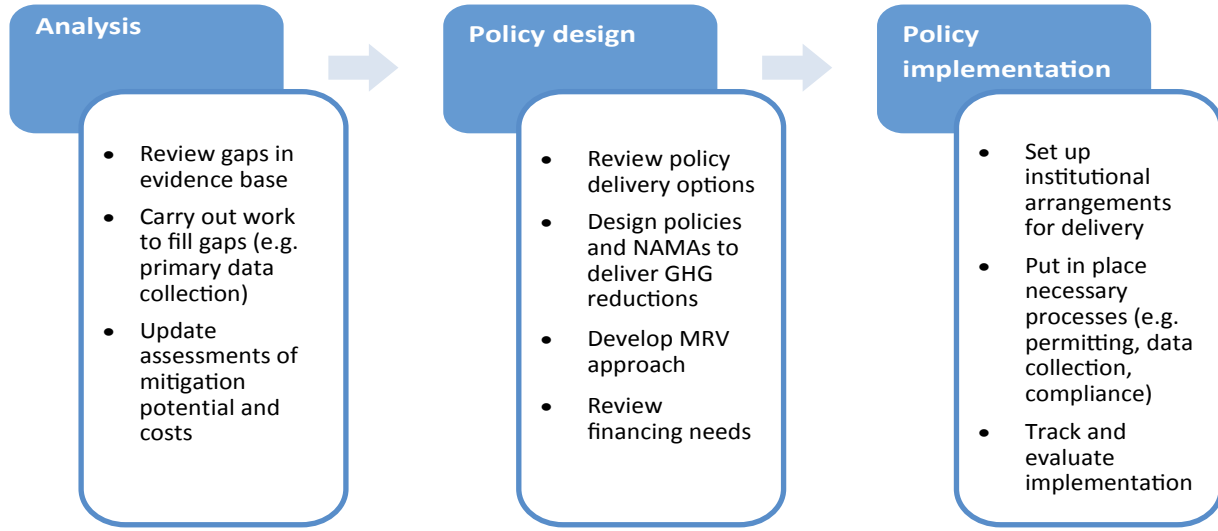
The Government is also currently working on five NAMA concepts: Solar Renewable Energy, Waste Heat Recovery, Efficient Lighting, Waste Management to lower GHG emission and Fertilizer. Initial analysis has been carried out on all five, looking at the rationale for the interventions, risks and barriers, timeframe for implementation, metrics of success, the estimated emissions reductions, other expected (co-)benefits and costs.

Bangladesh and Japan have signed a bilateral agreement for introducing the Joint Crediting Mechanism (JCM) to encourage Japanese and Bangladeshi private sector joint investment in developing low carbon green projects in Bangladesh with incentives from the Japanese Government. As of December 2017, five JCM projects are being implemented.

1.4.4 Next steps on mitigation

There are number of broad steps needed on mitigation. The sectoral action plans accompanying this NDC implementation roadmap set out what measures are expected to deliver the required GHG reductions in the sectors. Broadly, further work on mitigation can be divided into three areas, as set in Figure 2.

Figure 2: Next steps on mitigation



1.4.5 Capacity building for mitigation

To carry out the above, capacity will need to be enhanced in number of areas, as follows:

1.4.5.1 Analytical capacity

Whilst there is considerable scope for improving the climate change analytical and evidence base in Bangladesh, this should not be an impediment to acting now to tackle GHG emissions. However, the Government will look to implement a parallel programme of improvements to the underpinning analysis on climate action in Bangladesh. This will take many forms, varying from sector to sector and measure to measure.

Table 3: Capacity challenges for mitigation

Issue	Challenge	Solution
Data archiving	Lack of consistent archiving of data on mitigation, e.g. from NDC, National Communications, other reports etc.	MoEFCC and DoE will initiate a system of electronic data archiving to keep all mitigation-related data in one place. This could form the basis for the eventual MRV system (see Section 1.7 for more details)
Data sets	Lack of data, data not statistically robust, reliance on extrapolation and interpolation	MoEFCC will seek international support for a comprehensive data review across all sectors, to identify the gaps and weaknesses and to help develop more robust data (e.g. through primary data collection surveys).
Modelling capacity	Lack of capacity on key modelling approaches, such as Marginal Abatement Cost Curves, the LEAP model etc.	MoEFCC will seek international support for a capacity building project to build understanding of key mitigation modelling techniques and methodologies the officials of key sectoral Ministries and Agencies.

1.4.5.2 Policy capacity

An important next step will be for the Government to start designing specific policies to deliver the mitigation potential outlined by the analysis mentioned above. This will require knowledge of policy approaches such as feed-in tariffs, efficiency standards and green procurement etc. Considerable expertise in such policy options already exists, both within Government and also outside, for example in academia. But the Government will look for further opportunities to increase understanding on such policy options, through technical cooperation with other countries to share best practice and experiences.

A specific area for further capacity development in this respect is around the development of impact assessments. Bangladesh will consider options for introducing an impact assessment process whereby any new policies are required to produce standard information on expected impacts, including GHG reductions, before being signed off by Ministers. This will ensure that a clear understanding is reached in advance of what the policy is expected to deliver and will aid future decisions about whether to amend the policy in future to make it more effective. It will also help screen non-climate policies to better understand what their likely GHG impacts will be, before taking decisions.

1.4.5.3 Technical capacity

It will greatly benefit Bangladesh economically if it is able to capture the benefits and opportunities to encouraging economic growth from NDC implementation. However, there is limited local manufacturing facilities and capacity, as well as limited technical capacity to design, install, operate, manage and maintain renewable energy and energy efficiency services.

It is proposed that technical assistance support is sought for the private sector to build the required capacities. One option for this could be the Private Sector Facility of the Green Climate Fund (see Section 1.6 for more information).

A summary of activities for implementing the NDC is presented in Appendix 1.

1.5 ADAPTATION

Climate change adaptation is a key priority for Bangladesh and the country has already undertaken initiatives to mainstream adaptation into national development such as in the agriculture, forestry, health, water and more prominently in the infrastructure sectors. Bangladesh is already experiencing a host of climate induced disasters including excessive rainfall, floods, river bank erosion, water logging, landslides, tidal surges, salinity intrusion and drought. Two-thirds of the country is less than 5 metres above sea level and is susceptible to river and rainwater flooding and in low lying coastal areas, to tidal flooding during storms. In an average year, approximately one quarter of the country is inundated.

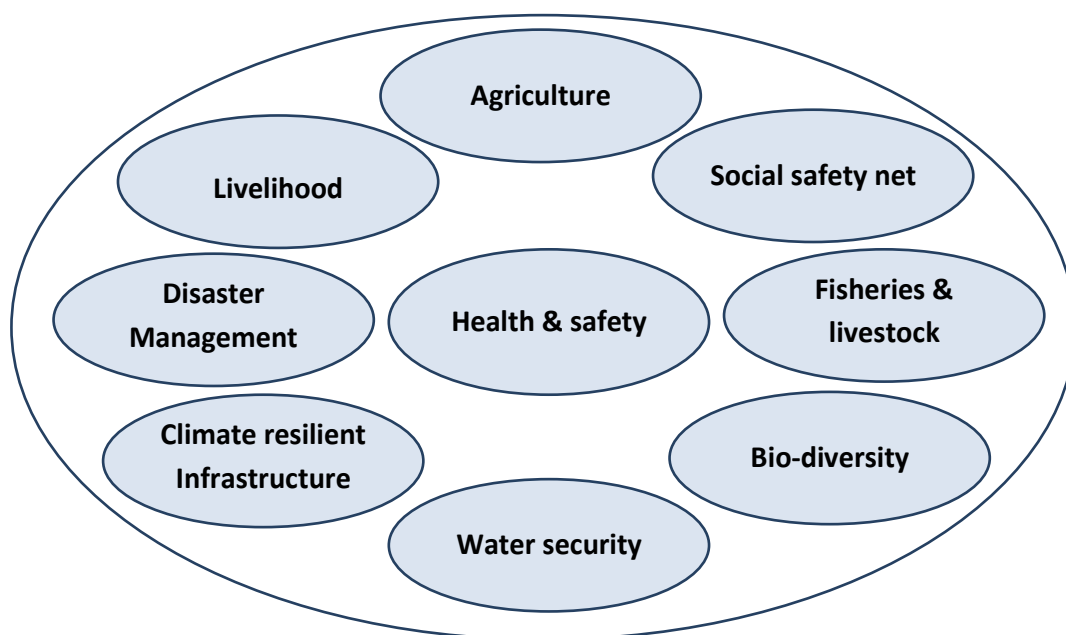
According to the IPCC Fifth Assessment Report published in 2014⁷, the framing of adaptation has moved further to the wider social and economic drivers of vulnerability and people's ability to respond. There is disagreement about what developing countries should do to protect themselves (Millner and Dietz, 2015). Categories of adaptation options have been provided. Engineered and technological adaptation options are still the most common adaptive responses, although there is growing experience of the value of ecosystem-based, institutional, and social measures for those who are most vulnerable. Such options could include building embankments in coastal areas, building high elevation roads, bridges and culverts to protect the road communication network in the event of seasonal flooding and building groynes to

7. <https://www.ipcc.ch/report/ar5/>

protect river banks from erosion. Water, Sanitation and Hygiene (WASH) have a significant impact on health and, of particular concern as described in the recent Intergovernmental Panel on Climate Change Special Report on Extreme Events, are the risks of more frequent and intense extreme weather events such as floods, cyclones and droughts, alongside increasing temperatures. Such extremes pose challenges to the capacity of WASH programmes to protect health, and there is accumulating evidence that climate change is worsening these risks. Elaboration on vulnerability to and impacts of climate change and priority adaptation actions in major sectors is presented in **Appendix 2**.

Bangladesh's major adaptation domains are set out in figure 3. Most of the adaptation items are interdependent with each other. Issues like water security have a direct relationship with health and livelihoods and have a passive relationship with the social-safety net. Climate resilient infrastructure has a major role to play to prevent river bank erosion and saving coastal population lives from tidal surges and salinity intrusion. So, to tackling adaptation demands an integrated policy, institutional and funding support regime associated with huge capacity support is required. To address this, the Government of Bangladesh has decided to streamline the National Adaptation Plan (NAP) process with other climate change related frameworks and commitments to deal with adaptation issues in an integrated manner.

Figure 3: Major Adaptation domains of Bangladesh



During the last decade, Bangladesh has taken a strong leadership role on adaptation. Bangladesh has not only introduced some innovative and integrated approaches to address adaptation in vulnerable communities, the country has also actively mobilized significant resources to tackle the challenges of adaptation and bio-diversity and conservation. Moving forward, Bangladesh needs sufficient financial support from international sources to tackle the adverse impact of climate change.

Taking climate vulnerabilities into consideration, the Government of Bangladesh has identified the following areas for interventions and adaptation priorities to address the adverse impacts of climate change.

Key Areas to address adverse impacts of climate change	
1.	Food security, social protection and livelihood
2.	Comprehensive disaster management
3.	Wetland and Coastal zone
4.	River Flood and Bank Erosion Risk Management Programme
5.	Climate Change Impact on Infrastructure
6.	Enhanced Energy Security in rural areas by promoting renewable energy
7.	Climate Change Vulnerability in Urban Areas
8.	Climate change vulnerability on crop agriculture
9.	Assessing Health Vulnerability to climate change
10.	Vulnerability of Ecosystems to climate change
11.	Water Security in coastal regions of Bangladesh due to climate change impact
12.	Policy and institutional capacity building
Adaptation priorities for Bangladesh	
1.	Food Security, Social Protection and livelihood support
2.	Improved Early warning system for tropical cyclone, flood, flash flood and drought
3.	Disaster preparedness and construction of flood and cyclone shelters
4.	Repair and rehabilitate existing infrastructure (including coastal embankments, river embankments and drainage systems, urban drainage system)
5.	Tropical cyclones and storm surge protection
6.	Inland monsoon flood-proofing and protection
7.	Climate resilient infrastructure and communication
8.	Climate resilient housing for coastal and flood prone areas
9.	Plan, design and construction of urgently needed new infrastructure (various types of shelters, low cost disaster resilient housing, protection schemes, water management structures, etc.)
10.	Enhancing urban climate change resilience through improvement of drainage system to address urban flooding and minimizing urban heat island effect
11.	River training and dredging (including excavation of water bodies, canals and drains)
12.	Tress tolerant (salinity, drought and flood) variety improvement and cultivation (including livestock and fisheries)
13.	Research and knowledge management
14.	Addressing the impacts of climate change on human health
15.	Climate change adaptation for Biodiversity and ecosystem conservation
16.	Individual and institutional Capacity Building for adaptation programmes and projects

1.5.1 The NAP process

Bangladesh's INDC contains both adaptation and mitigation sections. Nevertheless, the future NAP is considered the major national document to steer adaptation activities in the country.

To prepare the NAP, Ministry of Environment, Forest and Climate Change first developed a NAP Roadmap. Now, GCF has approved a dedicated support to Bangladesh for developing and establishing NAP process. The NAP process is expected to be built on existing experience of formulation and implementation of NAPA, BCCSAP and other programme and project activities of MoEFCC and other sectoral ministries. Bangladesh considers that NDC should contain both mitigation and adaptation activities. The NDC implementation process, via the NDC-NAP Implementation Coordination Committee, will liaise regularly with the NAP process to discuss synergies and to ensure a joined-up approach. In fact, the inputs of NAP process will essentially feed the adaptation component of NDC in due course while updating existing one or submitting next NDC.

1.6 RESOURCING THE PLAN

Implementing the NDC will require considerable resources, in the form of climate finance. Indeed, as stated in the NDC itself, the delivery of the more ambitious target to reduce GHG emissions by 15% below business-as-usual emissions in 2030 in the power, transport and industry sectors, is conditional on Bangladesh receiving adequate support from the international community. And support will be needed not just for new technologies and infrastructure, but also for capacity building, further analysis, data collection and policy support.

The NDC Sectoral Action Plans provide information on resourcing needs for specific sectors. This roadmap explains the overarching approach and next steps required on climate finance.

In Bangladesh there are diverse intermediaries, instruments and planning systems in Bangladesh's financial landscape. Although they all play a role in mobilising and channelling resources to climate-related investments, disbursement is fragmented. Between 2009 and 2013, Bangladesh needed US\$5 billion of investment in climate-related initiatives. To minimise this deficit and maximise opportunities, it needs to establish local financial intermediaries to complement existing intermediaries, use innovative economic and financial instruments and use financial planning systems to ensure better synergy across the financial landscape (TIB, 2013).

On the other hand, the resource plan for adaptation will be based on the forthcoming National Adaptation Plan, while taking input from the National Sustainable Development Strategy, the Perspective Plan (Vision 2021), the Seventh Five Year Plan, the National Disaster Management Plan, the Disaster Management Act and the Country Investment Plan of Bangladesh on Environment, Forestry and Climate Change. Bangladesh has identified, USD 42 billion to be required to implement the adaptation measures identified in the NDC. Bangladesh will look to funding from sources like the Green Climate Fund, the Adaptation Fund and the Least Developed Countries Fund to address the identified adaptation measures.

1.6.1 The climate finance landscape in Bangladesh

Most climate finance in Bangladesh to date has been targeted at adaptation and climate resilience, as would be expected bearing in mind the country's vulnerability to climate change. Nonetheless it is useful to understand the existing climate finance landscape in Bangladesh as the same structures and processes are likely to be used to fund NDC and NAP implementation and the mitigation activities to deliver it.

National funding for climate activities is channelled and accessed through the Bangladesh Climate Change Trust Fund, allocated a total of USD 340 million from the national budget. 66% of the Fund's projects are aimed at enhancing Bangladesh's adaptation capacity, comprising a large number of small-scale projects (under USD 2.5 million) across the country. Projects are implemented by government bodies as well as non-governmental and civil society organisations, research institutions and the private sector. The remaining 34% is kept as a fixed deposit, earning interest for emergency projects and programmes. Government agencies drawing from the Fund are accountable to the Ministry of Finance for financial compliance and the Trust Fund for the submission of project completion reports. NGOs, research institutions and private sector actors are accountable to the Palli Karma Sahayak Foundation (PKSF), which is in turn accountable to the Trust Fund through its secretariat, the Bangladesh Climate Change Trust.

The Bangladesh Country Investment Plan (CIP) provides a coherent set of 12 priority investment programmes to improve food security and nutrition in an integrated way. The total cost of the CIP is estimated at USD 7.8 billion. Of this, USD 2.8 billion are already financed through allocated Government budget resources and contributions by Development Partners. The financing gap is therefore USD 5.1 billion, of which USD 3.4 billion has been identified as priority requirements. The CIP was a five-year plan aligned with the 6th Five Year Plan for 2011-2015 of the Government of Bangladesh. It describes itself as a living document and is therefore aligned now with the latest five-year plan.

National private finance is provided through the Central Bank and commercial banks who offer concessional loans and refinancing, guided by the policy guidelines for green banking (Bangladesh Bank 2011).

International funding for climate activities comes from a range of sources and via various mechanisms. Some examples include:

- Green Climate Fund Bangladesh is targeting the GCF for support for mitigation and adaptation actions. The Economic Relations Division in the Ministry of Finance has been designated as the National Designated Authority (NDA) for the GCF in Bangladesh and they have submitted a proposal to the GCF for building GCF readiness, for example by strengthening the country coordination mechanism for GCF-related activities and identifying transformational investment opportunities in accordance with GCF's Investment Framework and Result Management Framework⁸. So far, Bangladesh has got approval of the first project from GCF. Out of the total USD 80 million for climate resilient infrastructure mainstreaming in Bangladesh, USD 40 million from the GCF, with a further USD 15 million of co-financing from the KfW of Germany, and US\$ 25 million from the Bangladesh Government⁹.

8. Bangladesh GCF Readiness Proposal, October 2015. https://www.greenclimate.fund/documents/20182/466992/Readiness_proposal_-_Bangladesh.pdf/

9. <http://www.greenclimate.fund/-/climate-resilient-infrastructure-mainstreaming-in-bangladesh>

- Bilateral funding sources:
 - The NAMA Facility, set up by the UK and German Governments and now also supported by the Danish Government and the European Commission, could be a source of funding for mitigation action.
 - Japanese bilateral funds are routed directly to government agencies via the coordination of the Economic Relations Division.
- International multilateral funding includes:
 - Least Developed Countries Fund under the UNFCCC
 - Adaptation Fund under the Kyoto Protocol
 - The Global Environment Facility's Trust Fund
 - The Pilot Program for Climate Resilience
 - The UN REDD+ Programme

It is important to recognise that Bangladesh has aspirations to become a middle income country by 2021 and that once it stops being classified as a Least Developed Country, certain funding options will no longer be available to it, such as the Least Developed Countries Fund mentioned above.

As well as considering funding sources, Bangladesh should look to make maximum benefit from collaborations and groups that can help facilitate access to funding. Examples include the NDC Partnership¹⁰, which Bangladesh is already a member of, and the International Solar Alliance, the Framework Agreement of which Bangladesh has signed. Bangladesh may also seek to participate in and benefit from other such groups, such as the Initiative for Climate Action Transparency, supported by philanthropic foundations and the German and Italian governments, which could help provide technical support and capacity building on MRV.

1.6.2 Oversight and coordination

The focal point for financing of NDC implementation will be the MoEFCC, working closely with the Economic Relations Division in the Ministry of Finance. The MoEFCC team will be responsible for:

- Strategic planning and coordination of the access, mobilisation, disbursement and tracking of climate finance across the country.
- Establishing and maintaining communication with government focal points and with bilateral and multilateral funders.
- Ensuring coordinated engagement with funders via these government focal points.
- Disseminating information to country stakeholders regarding funding criteria and the operational requirements and procedures of major funders.

As outlined in the second point above, number of government focal points will be established who will manage relationships with the important bilateral and multilateral funders for mitigation (and adaptation) projects.

¹⁰. <http://www.ndcpartnership.org/>

1.6.3 Developing more accurate costings for the NDC

The NDC itself, as well as the NDC Sectoral Action Plans, provide some illustrative costs of individual activities and measures. But as recognised in the NDC, more work is needed to accurately assess the scale and scope of investment needs for mitigation and adaptation activities. This will involve a comprehensive desk review of existing cost data, both from Bangladesh but also from international case studies, as well as gathering of new data on costs to help improve the evidence base in Bangladesh. Any cost data collected should include upfront capital costs, ongoing maintenance and operational costs as well as any other costs such as capacity building, training, information etc. Doing this will also involve a considerable consultation exercise with national experts to gather data and to verify estimates.

It is also suggested that capacity be built to allow for a periodic reassessment of costs of mitigation actions. This is important as costs are likely to change over time (e.g. falling costs of a new technology) and also new information and data may become available to provide more accurate estimates.

1.6.4 Assessing funding options

There are a range of possible options for funding the implementation of the NDC, including but not limited to some of those mentioned above, such as the GCF and bilateral support. Other sources include:

- Nationally Appropriate Mitigation Actions Bangladesh is currently developing a number of mitigation projects and few NAMAs and these offer the potential to receive international support.
- 'Climate-proofing' of existing national budgets, such as infrastructure spend.
- New international funding arrangements, such as the Capacity Building Initiative for Transparency, which could support MRV work in Bangladesh.
- Further engagement with the private sector.

1.6.4.1 International bilateral and multilateral funding sources

A full review will be carried out to consider Bangladesh's history of accessing funds from bilateral and multilateral sources to identify potential funders with whom the country already has a relationship. The review will also identify any new sources of multilateral and bilateral finance that could potentially support the actions set out in the NDC and the NDC implementation sectoral action plans.

The eligibility of each action against the funding criteria for existing and potential new bilateral and multilateral funding sources will then be assessed and a decision taken on the best method for the country to access each funding source, for example direct access and indirect access, or NAMA development (see below).

1.6.4.2 Nationally Appropriate Mitigation Actions

In addition to accessing finance from GCF, LDCF, adaptation fund and other bilateral and multilateral sources for both mitigation and adaptation projects, Nationally Appropriate Mitigation Actions (NAMAs) offer a clear route to accessing international support. NAMAs can be submitted to the UNFCCC's NAMA Registry¹¹, which helps match mitigation actions that are seeking support with available funding from international donors. The type of support that is most suitable will depend on the nature of the barriers to carrying out the mitigation action. For example, where the barrier is a low return on investment, financing options such as direct subsidies, feed-in tariffs and carbon market approaches are likely to be most appropriate. Where the barrier is high up-front capital costs, then provision of debt (e.g. through loans or credit lines) or provision of equity are likely to work best¹².

11. <http://www4.unfccc.int/sites/nama/SitePages/Home.aspx>

12. http://www.mitigationmomentum.org/downloads/Financing_Supported_NAMAs.pdf

For NAMA financing to be a viable route for Bangladesh, it will be important that the country is able to offer sufficiently detailed data on the expected impacts and how these will be tracked. Hence the importance of sound MRV approaches for each NAMA, including a forecast of the likely GHG emissions reductions and other non-GHG impacts against which progress can be measured.

1.6.4.3 Climate-proofing of existing national budgets

There is huge potential to ramp up investment in climate activities by 'climate-proofing' existing budgets, to ensure that activities that are being funded are carried out in a way that maximises the climate benefits. This includes activities such as:

- Reviewing existing development policies, programmes and infrastructure project pipelines to assess the potential for 'greening' these activities, for example extending or amending these to include NDC priorities, and screening the climate risks or mitigation potential associated with these projects.
- Identifying opportunities to mainstream climate change priorities into the national budgetary and infrastructure planning process.
- Considering what information on the co-benefits of climate action might be useful to these departments, to obtain buy-in and support for climate-proofing of existing budgets.

A Climate Public Expenditure and Institutional Review (CPEIR) was carried out by UNDP and others in 2012. This included an exploratory review on how climate change-related expenditure is being integrated into the budgetary process in response to national policy setting in Bangladesh. This found that the Government of Bangladesh typically spends around 6-7% of its annual combined budget on climate sensitive activity¹³.

1.6.4.4 New international funding arrangements

The Capacity Building Initiative for Transparency (CBIT) is still in its infancy and modalities and procedures are still being discussed at the international level. The Government of Bangladesh will consider the role that the CBIT might play in developing a national MRV system (see MRV section below).

1.6.4.5 Further engagement with the private sector

Work has been carried out looking at the business case for the private sector in Bangladesh to invest in climate change and access international climate finance¹⁴. This shows that climate change offers both risks and opportunities for the private sector. Many businesses in Bangladesh are already benefiting from new opportunities related to tackling climate change. For example, by developing new technologies, accessing new markets and taking advantage themselves of cost savings from efficient technologies. That said, to encourage scaled-up investment by the private sector in Bangladesh in climate-related activities, certain barriers need to be addressed, including lack of information, lack of access to finance and capacity constraints.

One way of addressing some of these barriers is via the Green Climate Fund's Private Sector Facility, a dedicated financial window to mobilise and channel private capital and expertise at scale. Work is currently ongoing to build readiness in the private sector for GCF accreditation. This will allow it to directly access this source of funding, enabling it to engage in adaptation and mitigation activities, scale-up projects, boost innovation potential, reduce vulnerabilities and harness untapped opportunities¹⁵.

13. https://www.climatefinance-developmenteffectiveness.org/sites/default/files/documents/03_02_15/bangladesh%20cpeir%20summary%20formatted.pdf

14. See here for more details - <http://cdkn.org/wp-content/uploads/2016/06/Business-case-for-the-Bangladeshi-private-sector-to-invest-in-climate-change-and-access-international-climate-finance.pdf>

15. <http://cdkn.org/wp-content/uploads/2016/06/Private-sector-engagement-in-climate-change-action-in-Bangladesh-creating-an-enabling-environment.pdf>

1.6.5 Measurement, Reporting and Verification (MRV) of climate finance

Crucial to successful leverage of climate finance for NDC implementation will be a clear and robust mechanism for ensuring transparency and accountability. Such a mechanism should allow for tracking resources received and the sources of the revenue, as well as policy measure and project-level spend, linking the two together for full transparency.

The mechanism would be managed by MoEFCC. The key next steps to setting up such a mechanism are:

- Review any finance MRV systems that are already in place and that could form a basis for the MRV of climate finance.
- Develop standard methodologies and key performance indicators for a climate finance MRV system (including agreeing a definition of what constitutes climate change-related activities).
- Develop a central tracking system that allows users to input data using standard templates.
- Carry out a mapping exercise to understand all the relevant institutions that are likely to receive climate finance, and put in place data-sharing agreements (e.g. memoranda of understanding) between them and ERD, setting out what data will be shared and under what conditions (e.g. frequency of reporting, format for reporting etc).
- Process and analyse data on a regular basis, delivering findings in a report for national and/or international audiences.

1.6.6 NDC implementation activities: finance

<i>Activity</i>	<i>Responsibility</i>	<i>Timeline</i>	<i>Indicative cost / resource needs</i>
Finance			
<i>Set up institutional arrangements on climate finance</i>	<i>ERD, working with MoEFCC</i>	<i>September 2017</i>	
<i>Development of more accurate costings for mitigation and adaptation measures</i>	<i>ERD and MoEFCC</i>	<i>August 2017 to September 2018</i>	<i>Est. 15m BDT</i>
<i>Detailed review of funding options</i>	<i>ERD</i>	<i>June 2017 to November 2017</i>	
<i>Drafting of detailed Climate Investment Plan</i>	<i>ERD</i>	<i>October 2017 to July 2018</i>	<i>Est. 20m BDT</i>
<i>Gap analysis of current finance tracking systems and institutions</i>	<i>ERD</i>	<i>August 2017 to November 2018</i>	
<i>Develop central tracking system for climate finance, with standard methodologies</i>	<i>ERD</i>	<i>September 2017 to July 2018</i>	

1.7 MEASUREMENT, REPORTING AND VERIFICATION (MRV)

Transparency, also known as measurement, reporting and verification (MRV), is central to the Paris Agreement and NDC implementation. In the context of NDCs, it refers to the process by which countries track and report on progress towards the NDC's targets, the implementation and impacts of mitigation and adaptation actions, and the finance used to support these actions¹⁶. The Paris Agreement requires each Party to the Agreement to regularly provide (a) a greenhouse gas emissions inventory, (b) information necessary to track progress towards its NDC, (c) information on climate impacts and adaptation and (d) information on support needed and received¹⁷. All Parties, except Least Developed Countries (LDCs) and Small Island Developing States, shall submit this information no less frequently than every 2 years (LDCs and SIDS can submit at their discretion). So whilst there are currently no specific requirements or deadlines for Bangladesh in relation to MRV at the international level (due to its LDC status), over time it will, under the Paris Agreement, need to start producing every 2 years the information described above. Furthermore, it is important that Bangladesh considers what information will be useful not just for international reporting but also for a domestic audience, to assist transparency and engagement on NDC implementation.

It is important however not to consider MRV as a new requirement. Like most countries, Bangladesh will already have many key elements of an MRV system for NDCs, through existing reporting on policies and projects for various audiences. In some cases, this can be adapted to meet the needs of reporting on progress in implementing and achieving the NDC, and as such, an important first step is to review existing reporting processes and structures to consider what data is already collected and that could be used for MRV of NDC implementation. This would include the GHG inventory, reporting by the Bangladesh Bureau of Statistics but also any policy reporting done by individual government ministries.

1.7.1 The GHG inventory

The NDC contains a target to reduce GHG emissions in the power, transport and industry sectors by 5% below business-as-usual emissions for those sectors in 2030, rising to 15% upon conditional of adequate international support being received to support mitigation actions. The main approach for tracking progress towards these targets will be regular updates to Bangladesh's greenhouse gas inventory. These will show the extent to which GHG emissions are changing across the whole economy and in individual sectors.

Bangladesh is currently in the process of compiling a national GHG inventory covering the years 2006- 2012. For the first time DoE assigned their staff to work with local consultants, allowing for capacity to be built within the Department. This will increase continuity for future GHG inventory compilation cycles, e.g. by allowing to establish data collection processes including data sharing agreements with data providers and contribute to improvement over time, e.g. covering emissions from fluorinated greenhouse gases, which are not covered in the inventory currently under compilation. Once the current inventory compilation has been completed, the team can develop a plan of desired improvement steps and realistically plan the implementation of these steps over the coming years, based on the resources available.

1.7.2 GHG projections

However, whilst the GHG inventory can provide a tool for evaluating trends in GHG emissions as an ex-post exercise, relying on this will not provide sufficient timescales for planning to address any concerns regarding the 2030 target. For example, if GHG emissions are reviewed in 2018, and the data suggests that

16. <http://www.cdkn.org/ndc-guide/book/planning-for-ndc-implementation-a-quick-start-guide/measuring-reporting-and-verification/>

17. <http://www.cdkn.org/ndc-guide/book/planning-for-ndc-implementation-a-quick-start-guide/measuring-reporting-and-verification/>

Bangladesh is not appropriately on track towards the 2030 targets, then the Government may wish to consider additional policy measures to further reduce GHG emissions in the power, transport and industry sectors. However, it is expected that some time (e.g. a year or more) may be needed for further analysis (e.g. on costs and mitigation potential, and on delivery options) and at least a further year needed for internal government decisions to be taken, meaning that the measure may not be implemented before 2020 at the very earliest. And the measure may only lead to scaled-up GHG emissions reductions over time, especially for measures that rely on the roll-out of new efficient technologies in the early years, when coverage is still relatively low, the GHG emissions reductions will be similarly low.

Therefore, there is a clear benefit in regularly producing and updating GHG projections, as these will show future GHG emissions and whether Bangladesh is expected to meet its NDC targets, based on current trends (e.g. GDP and population growth) and on the expected impact of the current mitigation policy framework.

As outlined above, there is no requirement for Bangladesh to produce regular GHG projections under current UNFCCC reporting requirements as well as under the Paris Agreement. But the Government might consider options to scope out how such a system might work and the potential resource and capacity building implications. The two main options are for GHG projections to be produced by external institutions (e.g. academics, or consultants) through technical assistance projects, or for the projections to be produced in-house within the government, based on the biennially updated GHG inventory data. A sensible staggered approach might be for the projections to be produced through technical assistance projects in the first instance, with a view to building capacity within government for developing the projections in due course.

1.7.3 Measurement and evaluation of individual measures

A further important element of a national-level MRV system is the measurement and evaluation of individual adaptation and mitigation measures, including (in the case of mitigation) Nationally Appropriate Mitigation Actions (NAMAs) that may be reliant on international funding. In these instances, the funding agencies are likely to want to see a clear and robust MRV system in place for individual measures, to be able to show how they are performing and whether they are delivering the GHG emissions reductions and other benefits that were originally expected. In addition, the MRV system should also provide a clear framework for the MRV of mitigation and adaptation measures, by setting out governance arrangements, common methodologies and assumptions and the process for carrying out MRV of measures and for combining and sharing results.

The WRI Policy and Action Standard provides a common process for the development of indicators for mitigation actions, based on an assessment of which changes the mitigation action is likely to bring about and the causal connections between the implementation of the action and the subsequent changes that are observed. Other countries have begun to develop a mitigation measure MRV framework based on this, for example Chile has implemented a NAMA MRV framework under which comparable MRV approaches for NAMAs in Chile are developed using this approach.

Bangladesh is in the process of developing a number of NAMAs (see Section 1.4.3 for more details) and as part of this it will prioritise the development of robust MRV processes and structures for each NAMA, as well as for other mitigation measures and also adaptation measures.

1.7.4 Governance for MRV

DoE, MoEFCC will have overall responsibility for the national MRV system for NDC implementation. Their functions in this role will be as follows:

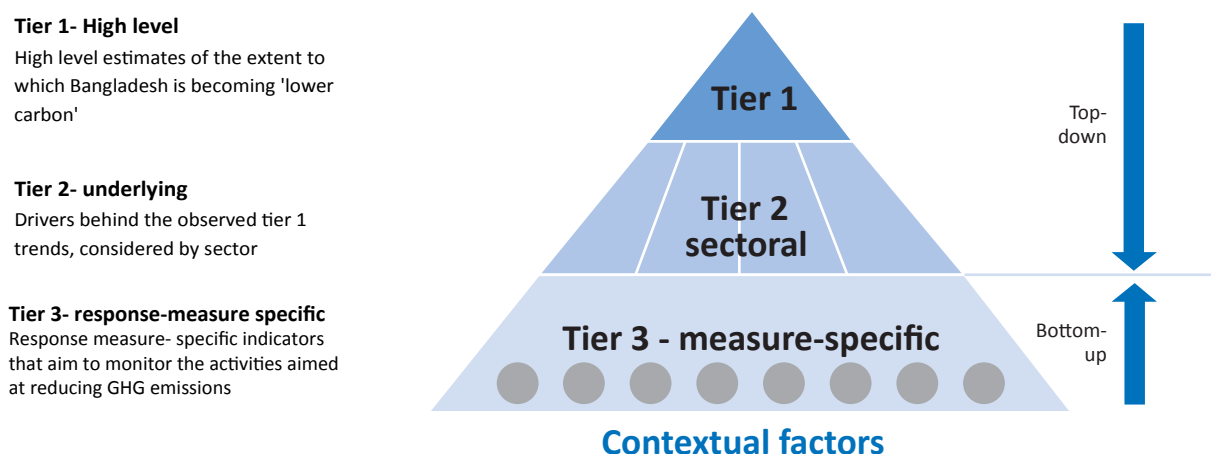
- Overall responsibility for the national MRV system for NDC implementation.
- Liaison with MRV leads for individual sectors.
- Liaison with the international community with regards to MRV and transparency under the Paris Agreement (e.g. input into relevant committees and working groups, presentation of Bangladesh's approach to MRV to international stakeholders).
- Monitoring and managing the phased implementation of the MRV system.
- Reporting on overall progress in NDC implementation.
- Central management of data through a national MRV database that collates data on overall progress towards the NDC targets, information on sectoral indicators and information of performance of individual policies and NAMAs.
- Production of central MRV guidance to other MRV-related stakeholders (e.g. sectoral leads on MRV).
- Coordination of NDC Implementation analytical support (e.g. drafting of terms of reference for the support group).

1.7.5 The MRV system

Bangladesh will work towards having a comprehensive MRV system that can perform multiple functions, including collating and reporting on information on (a) progress towards 2030 targets, (b) projections of future GHG emissions and other key parameters and (c) the performance of individual policies and NAMAs.

As outlined in the NDC sectoral mitigation action plans, each sector has developed a set of indicators that it will use to track progress on NDC implementation for that sector. These indicators can be broadly described as set out in figure 4 below. Tier 1 indicators include data on overall GHG emissions (both at the national level and sectoral level), while tier 2 indicators provide information on the drivers for the tier 1 indicators (such as levels of production, efficiency of production, GDP, population etc). Tier 3 indicators are more bottom-up in nature and will provide information on the performance of individual measures (e.g. measuring the capacity of wind and solar energy, or the numbers of people taking public transport etc).

Figure 4: Basic framework for indicators for MRV in Bangladesh



In many cases, the sectoral-level MRV will be directly connected to the national-level MRV, as the national-level data will simply be an amalgamation of data collected at the sectoral level. However, there is more likely to be a disconnect between the national and sectoral levels on the one hand, and policy or project-specific reporting as shown in tier 3 in the diagram above. It is not expected that sectoral-level information will easily aggregate into sectoral-level information, but nonetheless the information collected at the tier 3 level will be important to provide context on the tier 1 and 2 data (e.g. explaining reasons for changes in GHG emissions levels) as well as providing important information on how effectively individual policies are performing, so that decisions on whether to continue with them in their present form can be taken.

Coordination by the DoE will be important to ensure that MRV in different sectors, and being carried out by different parties, is as consistent as possible, by encouraging use of common assumptions for key parameters, such as GDP, population, carbon intensity of the grid etc. The Bangladesh Bureau of Statistics would be expected to play a key role in this regard and will be encouraged to play a verification role on common assumptions that are being used for NDC-related MRV.

In the same way that the use of common assumptions will be important, to ensure consistency, there should also be, where possible and sensible, similar methodologies and approaches being used for calculating data for NDC MRV purposes. This could relate to a range of issues, including:

- Approaches to economic analysis (e.g. use of discounting for future costs).
- Approaches to assessing the scope of a measure, and the 'boundary' within which impacts are to be measured.
- Approaches to developing 'business-as-usual' estimate against which to measure progress ex- post.

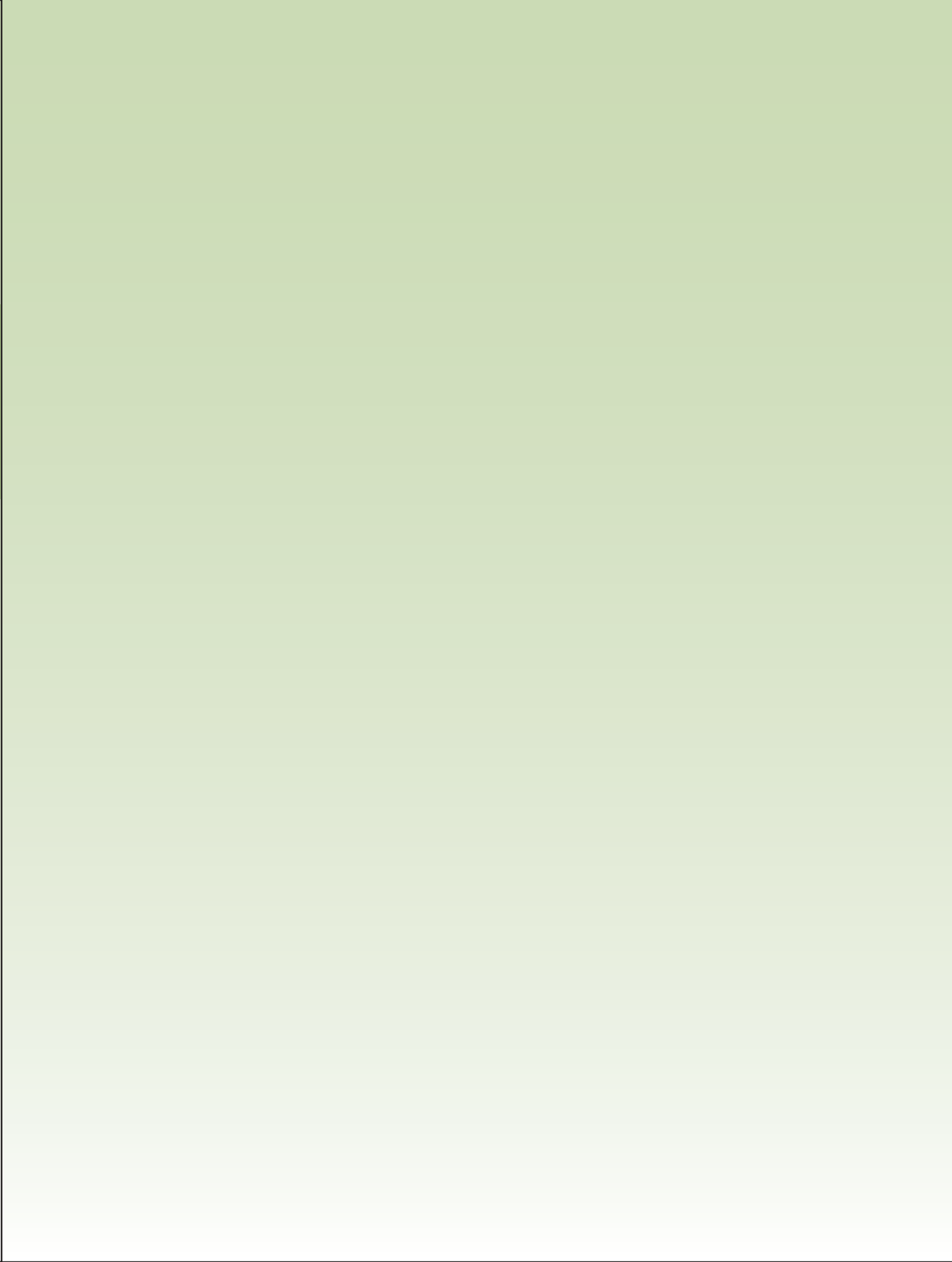
As the MRV lead for NDC implementation, the DoE will work hard over the coming years to develop the national MRV system and to provide guidance on assumptions and methodologies to be used.

1.7.6 NDC implementation activities: MRV

<i>Activity</i>	<i>Responsibility</i>	<i>Timeline</i>	<i>Indicative cost / resource needs</i>
MRV			
<i>Agree MRV institutional arrangements for the MRV systems</i>	<i>DoE</i>	<i>Immediate</i>	<i>Minimal</i>
<i>Stocktaking of current monitoring and reporting processes, to consider what can be used for MRV of NDC implementation</i>	<i>DoE</i>	<i>Immediate</i>	<i>TBD - est. USD 100,000</i>
<i>Agree MRV institutional arrangements for the power, transport and industry sectors (see sectoral action plans for more detail)</i>	<i>DoE, working with SREDA, Road Transport and Highways Division and Ministry of Industry</i>	<i>Immediate</i>	<i>Minimal</i>
<i>Agree final list of indicators for MRV of power, transport and industry sectors</i>	<i>DoE, working with SREDA, Road Transport and Highways Division and Ministry of Industry</i>	<i>Immediate</i>	<i>Some staff time</i>
<i>Produce step-wise plan for GHG inventory improvement</i>	<i>DoE</i>	<i>Immediate</i>	<i>TBD - est.USD 80,000</i>
<i>Ongoing GHG inventory improvement</i>	<i>DoE</i>	<i>By December 2018</i>	<i>TBD</i>
<i>Initial assessment of options for GHG projections for Bangladesh</i>	<i>DoE</i>	<i>By 2018</i>	<i>TBD-est. USD 200,000</i>

NDC ACTION PLAN FOR POWER SECTOR





2. NDC ACTION PLAN FOR POWER SECTOR

2.1 INTRODUCTION

In September 2016, Bangladesh ratified the Paris Agreement and its Nationally Determined Contribution (NDC) was registered on the UN Framework Convention on Climate Change (UNFCCC) NDC Registry. The NDC describes Bangladesh's plans for tackling greenhouse gas (GHG) emissions and adapting to unavoidable climate change. In the NDC, Bangladesh is committed to reduce GHG emissions in the power, industry and transport sectors by 5% below 'business-as-usual' GHG emissions by 2030, or by 15% below 'business-as-usual' GHG emissions by 2030 if sufficient and appropriate support is received from developed countries.

To deliver the overall targets described above, the NDC anticipated that the power sector would contribute GHG emissions reductions of 5% below 'business-as-usual' by 2030, or by 18% below 'business-as-usual' by 2030, conditional on support from developed countries. This action plan describes how Bangladesh intends to deliver the GHG emissions reductions in the power sector, to support the overall targets described above. This action plan covers the period from 2016 to 2019 and from 2020 to 2025 and describes what needs to be done over this timeframe, by whom and by when, to deliver the required GHG emissions reductions in the power sector. It is envisaged that the action plan will be a 'living' document and will be regularly updated. Recognising that adaptation is the key priority for Bangladesh, the action plan prioritises actions that will deliver both GHG emissions reductions and strengthened climate resilience. As well as setting out what needs to be done, the plan also looks at the resource needs to implement it, how the activities will be measured and evaluated and how the work will be managed and coordinated. This reinforces one of the key thematic objectives: mitigation and low-carbon development of Bangladesh Climate Change Strategy and Action Plan (BCCSAP) adopted by Bangladesh Government in 2009.

The Government of Bangladesh is already taking action to develop a low carbon power generation system. More than 3.1 million Improved Cook Stoves and nearly 4.5 million Solar Home Systems have already been distributed across the country and under the Solar roof-top program around 14 MW of solar has been installed on the vacant roof-tops of Government and private buildings. Nearly 1000 solar irrigation systems are being installed in different parts of the country. The Government has extended a re-financing scheme (through state owned intermediary IDCOL) to finance alternative energy generation projects like small scale solar and micro grids, to improve energy access for those living in off-grid areas. As of now, 519.62 MW renewables are being implemented having a share of 2.77% in the overall energy generation mix¹⁸. As set out in section 2.3.2, this will be supported by action in other sectors to improve energy efficiency, to help limit the demand for electricity. This action plan builds on these achievements to set out how Bangladesh will deliver on the commitments set out in its NDC.

2.2 VISION AND SCOPE OF THE PLAN

2.2.1 Vision

The power sector is a vital component of Bangladesh's plans for economic development. As set out in the 2010 Power System Master Plan, the aim should be to achieve the 'three Es'-economic growth, energy security and environmental protection. A key element of this is the expansion of renewable energy, not only to meet carbon targets but also to shield the country from costs of importing energy. In addition, renewables can be a cost effective, pragmatic solution for providing electricity to off-grid

18. Please see <http://www.sreda.gov.bd/> for more information

areas, which is a significant challenge in Bangladesh. The current status of renewables is summarised below (source: SREDA, October 2018).

Technology	Off-Grid	On-Grid	Total MW
Solar PV	268.29	17.35	285.64*
Wind	2	0.9	2.9
Hydro	-	230	230
Biogas to Electricity	0.68	-	0.63
Biomass to Electricity	0.40	-	0.4
Total	271.37	248.25	519.62

* From solar homes system programme. Does not include solar irrigation or solar mini grids.

Total Power Generation Capacity of Bangladesh is now 18,768.62 MW (Source: SREDA, October 2018), which includes off-grid renewable energy and captive power generation. The share of renewables is nearly 3% within the overall energy-mix.

The revised Power System Master Plan (2016) envisages 35% power generation from coal and 35% from natural gas. The Government has previously committed to 1300 MW of wind capacity and 1700 MW of solar capacity by 2021. The Government has also committed Bangladesh to 10% renewables by 2021.

In addition to increasing low carbon power generation, the Government has a goal to provide electricity to all by 2021 and to provide energy security for development and welfare.

2.2.2 Scope

The scope of the action plan is electricity generation (including fossil fuels, renewables and others such as nuclear) and electricity transmission and distribution. Small-scale renewables are included, such as solar home systems or use of solar to power irrigation. Energy efficiency measures are an important part of managing demand for electricity, but are not explicitly covered by this action plan. For more information on what the Government of Bangladesh is doing on energy efficiency, please refer to the Energy Efficiency and Conservation Master Plan and the Sectoral Mitigation Action Plan for Industry.

2.3 DELIVERING THE PLAN

2.3.1 Mitigation measures in the power sector

There are a range of measures in the power sector that will deliver the targets set out in the introduction section. These targets were set based on certain assumptions regarding the level of uptake of different technologies and the government is committed to delivering this overall target for the power sector. That said, there is still considerable uncertainty regarding many of these measures. For example, solid and reliable data on future potential may not exist (e.g. regarding wind power potential see below). The government will therefore keep this action plan under review and will consider whether any of the assumptions underpinning the NDC need to be revised, for example a lower level of uptake from one measure being offset by a greater level of ambition for another measure (for example, whether more energy from biogas might be possible as a way of offsetting lower than expected uptake of wind power, or whether higher levels of solar power could offset lower than expected levels of steam repowering).

There will be significant levels of new power generation built in Bangladesh over the coming years to meet increasing domestic demand and to support development and growth. By 2030, 80% of the generation capacity will be the capacity that was built between now and then. Therefore whilst there are some options for tackling existing generation (e.g. repowering of steam turbines), the majority of the GHG reductions in the power sector are likely to be delivered by ensuring modern fossil fuel generation (e.g. ultra-super-critical and super-critical coal, LNG imports etc.) and increasing uptake of renewable energy.

To increase uptake of renewable energy technologies, Government could provide incentive to the solar renewable energy developer through a suitable tariff mechanism. A similar approach could be extended to other technologies, such as wind and biomass/biogas, although further work will be needed to decide the level of such tariffs for these other technologies.

2.3.1.1 Solar power

Bangladesh expects to deliver both utility-scale solar power as well as smaller-scale solar such as rooftop solar on large private buildings/factories, government buildings and solar home systems (SHS) for off-grid residential properties, and solar mini-grids and solar PicoPV systems. Government has recently approved the Net Metering Guideline for encouraging renewable energy distributed generation. Progress has already been made on the latter, with 161 MW of solar home PV capacity (including commercial properties) installed by 2016. Solar home systems will continue to be rolled out through the programme managed by IDCOL, with the programme expected to continue till 2021. IDCOL has a target to finance 6 million SHS by 2021¹⁹, with an estimated generation capacity of 220 MW of electricity, although the attainment of this target will depend on rates of rural electrification, with higher rates of rural electrification diminishing the demand for SHS for off-grid properties.

There are 17 mini-grids in operation under IDCOL finance and more will be added in coming days. The mini-grid project has successfully created access to low-emission electricity for almost 5000 rural households in Bangladesh. IDCOL has further targets to install 50 solar mini-grids by 2018.

Bangladesh Government is assessing different type's incentive mechanisms to promote solar renewable energy throughout the country. The sole objective of this assessment is to introduce a combination of suitable incentive mechanisms like FIT/Net metering/Renewable Portfolio Obligation (RPO)/benchmarking of the tariff based on market and movement of economy to scale-up solar technologies like Roof-top, solar mini and micro-grid, utility scale solar etc..

For utility-scale solar, the main barrier is availability of land. The scarcity of land from general population pressures pushes up prices, with the government rightly prioritising land for agriculture purposes. Furthermore, Char land (newly accreted land in river areas) that might potentially be used for utility- scale solar, has higher costs involved to protect any infrastructure from flooding. Where viable, the Government will look to utilise Government-owned or 'no-ownership' land to solar PV application, to minimise costs. Where land does need to be purchased, the Government will look into the possibility of the GCF, or other international funds, to help offset these costs to open up more land for development of utility-scale solar, for example, through meeting land development costs, overall reduction of local project costs and reduced tariffs.

19. IDCOL website, accessed February 2017

A variety of financial incentives are already in place to support the development of solar power, including:

- Tax incentives for investors and operators, including corporate income tax exemptions.
- Various levels and types of duty exemptions.
- Waiver of VAT, customs duty and other surcharges on equipment and spare parts (percentage of plant cost).
- Tax exemption and repatriation facilities for equity, dividends, royalties and technical assistance fees.
- Risk allocation through PPA and Implementation Agreements, as well as sovereign guarantee from the GoB for PPA payments.

Next steps for delivering adequate solar capacity may include:

- Encourage distribution licensees to continue to scale up rooftop solar PV, particularly in large metropolitan areas of Dhaka and Chattogram, as well as at industrial zones;
- Encourage rooftop solar PV uptake among factories in SEZs and other industrial clusters. This would require both engagement and relevant incentive mechanisms for industries;
- Support the continued rollout of solar PV-based agricultural pumps. It is important to note that while this is an immediate means of reducing GHG in the agricultural sector by switching from diesel based pumps to solar irrigation pumps, the actual installation and uptake of these pumps is likely to be small over the standard power planning time-horizons. This is because, it is expected that power will be supplied to the irrigation pumps from the grid in the electrified areas. With the current expansions plans and the Government objectives of providing electricity access for all, the overall potential from solar irrigation pumps is likely to be relatively low. This view is echoed in the 2016 PSMP which anticipates less than 50MW of installed capacity in solar irrigation pumps.
- Explore the development of possible cross-cutting mechanisms (and encourage private sector innovation) to address the limitation related to the prioritization of agricultural land usage. While current land-use and agricultural models may already incorporate technology and process advances that boost total agricultural output, further synergies may be explored by allocating agricultural land to solar farms under multi-purpose land use schemes. This allows continuation of agricultural activity (grazing, free-range poultry, etc.) alongside the solar farm. Further business process synergies may be explored through 'stewardship' schemes/ measures, whereby both environmental protection and availability of centralized agro- infrastructure is provided by project developers to offset some of the potential impacts to agricultural output;
- For stability and security of the National Grid, a study on impact of renewable energy integration into the grid is essential.
- Create a detailed action plan for load-balancing. One of the major limitations to increased development of solar power is the current shape of the load curve (with an evening peak), which means that solar is always offsetting conventional thermal plants during its hours of operation. Exploring the use of distributed energy storage for commercial users (including a set of incentives for them to maintain the distributed energy storage systems), may allow for some of the evening peak to be met by daytime solar generation.

Land-use

Solar PV is generally perceived as a land-resource-intensive plant. However, various recent studies from the National Renewable Energy Laboratory of the US Department of Energy have identified the capacity weighted average land use (based on total area) for 2-axis solar PV in the US was 8.1²⁰ acres/MW, while that for wind it was nearly 10 times as much at 83 acres/MW²¹. However, the numbers here refer to the total land area (total land area defined as all land enclosed by the site boundary) covered by solar and wind farms. In comparison to solar farms, wind turbines are spaced out which allows wind energy to cohabitate much better with most aspects of farming, grazing, and other productive uses of the underlying land. Considering only the total direct area impact (defined as land directly occupied by generating equipment, access roads, substations, service buildings, and other infrastructure) of wind farms, the capacity weighted average land use (based on total direct area impact) is only 3.21 acres/MW, compared to 6.1 acres/MW for solar PV. It is also important to note that this measure only takes into account installed capacity as opposed to energy output. The energy output per acre would vary based on both location and the technology adopted at the site. This is further evidenced by the 2014 Central Electricity Regulatory Commission of India's decision to recommend that land requirements be benchmarked at 5 acre/MW²² for crystalline PV projects. This decision has subsequently been adopted by state renewable energy policies in Gujrat, Tamil Nadu, and Karnataka as well as for the MNRE's (Ministry for New & Renewable Energy in India) proposed solar park for Ultra Mega Solar Power Projects²³ in India. There is a need to carry out detailed assessment of land use requirements and benchmark costs for solar PV farms in Bangladesh. Based on the above estimates from neighbouring India (with a better solar regime) it is likely that the average land use requirements would vary between 3-4 acres/MW in Bangladesh.

2.3.1.2 Wind power

There is currently considerable uncertainty over the potential for wind power in Bangladesh. An onshore wind power potential mapping study is currently being carried out and will inform decisions on the desired level of uptake in onshore wind. To date, there is very little wind power capacity in place and this is almost entirely on land. But onshore wind has encountered various barriers, including a low annual factor, damage by cyclones etc. The Government of Bangladesh has no firm plans to explore offshore wind potential. For the time being, this NDC sectoral plan, therefore, assumes that all wind capacity will be realised onshore.

The next steps to delivering this are as follows:

- Complete the onshore wind mapping study as soon as possible and publish results. The current wind mapping study covers site measurements at 9 locations with the 24 month measurement data for Shitakunda, Parki Beach(Chattogram), Natore and Chandpur already available. This data is critical to site selection and investment decisions in relation to wind farms. Final data from all sites will allow the Government to competitively tender for IPPs at suitable site locations.
- Carry out a detailed wind power study. This would include both technical (including integrating variable renewable energy into the grid, specific connections requirements for wind plants, required ancillary services and other critical grid code compliance measures) and non-technical studies (including land use and planning requirements, socio-economic impact studies, etc.).

20. Land-Use Requirements for Solar Power Plants in the United States, NREL, June 2013

21. Land-Use Requirements for Modern Wind Power Plants in the United States, NREL, August 2009

22. The CERC decision was based on Petition No. SM/353/2013 (Suo-Motu), and comments/ suggestions from 21 power developers and experts in India.

23. TNo. 30/26/2014-15/NSM, Implementation of a Scheme for Development of Solar Parks and Ultra Mega Solar Power Projects in the country commencing from 2014-15 and onwards (i.e. from the year 2014 – 15 to 2018 – 19), MNRE, 12th December 2014

2.3.1.3 Biomass

There is the potential for biomass-based electricity to be generated from sugar cane, rice husks or wheat straw and animal waste from livestock industry. The 2012 JICA preparatory study on Renewable Energy Development revealed cow/buffalo waste as the most available source of biomass as a generation resource. The raw materials from sugar, rice husks, etc. are generally a scarce commodity with other potential uses, and this could be a limiting factor to take-up. Furthermore, current usage of sugar cane and rice husks to produce energy is inefficient and biomass is geographically scattered across Bangladesh and also has seasonal variation. It is therefore, reasonable to assume that more would need to be done to encourage more efficient generation of energy from biomass and to increase overall levels of electricity generation from biomass. One option to increase biomass-based electricity generation could be a feed-in tariff, although the viability of such an approach might be limited by the factors mentioned above. The Government may consider potential suitable incentive mechanism as decided by the Bangladesh Government in the tariff while procuring bio-mass electricity in the national grid systems.

Financial support is likely to be needed for biomass generation from rice husks, where the price of the raw material has increased significantly in recent years, from 3-4 taka per kg to 7 taka, with the risk that this could rise to around 10 taka. IDCOL has financed 2 rice husk power plants in Gazipur and Thakurgaon. It would be important to disseminate findings from these early stage projects to better inform additional investment in the technology.

The scope for generation of electricity from sugar cane is greater, with the possibility of delivering more than expected by the NDC by 2030 under the right conditions and with an appropriate incentivised tariff. It is important to note that the scope for increased delivery of electricity from sugar cane could be achieved through more efficient cogeneration process (such as boosting the existing boiler pressures) as opposed to through increased uptake. Higher values of electricity output per ton of sugarcane can be obtained with the high pressure condensing extraction steam cycles (CEST) than with the conventional backpressure steam turbines (BPST), and also in higher pressure BPST units. Electricity output has been increased from 10 kWhr/ton in 22 bar (300C) BPST configurations to 60 kWhr/ton in 67 bar (480C) configuration in Brazil. In India, the some CEST configurations are used to generate upto 140 kWhr/ton of sugarcane in 87 bar (570C) configurations²⁴.

In addition to energy crops, waste-to-energy may also provide an avenue to potentially increase energy output. It is important to note from the onset that waste-to-energy is (and must be treated) as a waste treatment facility as opposed to a power plant. Electricity must therefore, be recognized as the by- product of the investment and not the key driver for revenue models. A 2016 GIZ funded study on waste-to-energy identified several options/ models that may be adopted by municipalities throughout the country. Among the various options, it explored the possibility of generating 4-5 MW electricity from waste in the Keraniganj area (depending on a suitable waste management plan). This not only provides a sustainable means to waste management, but also frees up land used as landfills which could be used for various brownfield developments.

Some of the next steps for consideration for the NDC may include:

- Disseminate findings and key learnings from IDCOL financed rice-husk based biomass plants. This will be essential in raising awareness and generating interest for additional investment.
- Pilot relevant utility scale waste-to-energy plant in a suitable municipal area. This would need to be followed by dissemination of key learnings, establishment of relevant waste management plans and procedures, and a potential scale up of the scheme (if found to be successful).

24. Challenges in Bioenergy Production from Sugarcane Mills in Developing Countries: A Case Study, Guido Colombo, William Ocampo-Duque and Fabio Rinaldi, MDPI Journals 2014, accessed on 12/06/2017.

2.3.1.4 Biogas

Biogas can be categorized into two major categories - domestic and industrial (based on size). Also, kitchen waste could be used to generate gas or electricity for household purposes. The potential for electricity from biogas is greater than for biomass as the raw material is waste and has fewer competing uses. Furthermore, the biogas sector is largely controlled by the private sector who will want to actively manage their waste streams and maximise the potential returns from them. Nonetheless, having the feed-in tariff for biomass, especially for the industrial scale, could encourage poultry and dairy owner to sell surplus power to electricity grid. With the right economic signals through the feed-in tariff, significantly greater levels of generation from biogas than expected in the NDC could be possible. The Government will keep this under review and consider the potential for greater ambition in future. Some potential actions for the biogas sector may include:

- Develop capacity of partner organizations (NGOs) that are currently or have been involved in the biogas digester schemes. This is seen as a critical bottleneck to the increased uptake of biogas digesters.
- Programmes are needed on slurry management to allow for improvement of the handling of the slurry. In addition, the Government may consider options for facilitating the sale of the slurry as a bio-fertilizer.
- Awareness and stakeholder outreach: Many end-users/ potential adopters of bio-digesters have a negative perception of the technology and the products based on past experiences (and word of mouth) involving technical and structural issues with the digesters. It is important to build end-user/ adopter capacity and awareness of the challenges and responsibilities of operating a bio-digester.
- In parallel with single family biomass systems, communities can be motivated to site a single plant in a common place at a reasonable size to distribute biogas and electricity altogether.
- Developing local manufacturing capacity: only a few local manufacturers can properly maintain biogas plants and there is limited manufacturing capacity in glass fibre bio-digesters.

2.3.1.5 Repowering of steam turbines

Re-powering is a retrofit mitigation measure. It involves setting up a front-end state-of-the-art gas turbine (new), then a new waste-heat boiler using the flue gas from the turbine. The old steam turbine then runs from the steam of the new boiler. Roughly 70-80% of a new project cost is required for the retrofit. This measure has potential for the period up to 2020, but not much beyond that. The NDC envisaged 800 MW of additional generation capacity to be brought online by 2030 through repowering of steam turbines. Already one 300 MW project has been completed and a 200 MW is currently starting, both funded by the World Bank. This therefore, leaves a further 300 MW of capacity that needs to be delivered through repowering. A priority there is to secure funding for this, possibly from international donors.

2.3.1.6 Clean coal technologies

The rapid growth in electricity demand, paired with limited choices (and constraints) in exploiting available indigenous resources have meant that coal based generation options are the highest prioritised plants in the Bangladesh power sector development plan. The revised Power Systems Master Plan (2016) envisages 30 GW of new coal capacity by 2030. To meet this target whilst also meeting the GHG target set out in the NDC, Bangladesh aims to ensure that new capacity is made up of clean coal technology. In particular, all new capacity should use super-critical technology, or even ultra-super- critical coal technology.

Super-critical and ultra-super-critical generation is an efficient form of generation that operate at pressures above the critical pressure, meaning that water turns into steam immediately and less fuel is used, leading to lower GHG emissions. Bangladesh's goal is to reduce emission by adopting ultra-super critical technology and high efficiency power projects. Support will be needed in terms of finance, technology transfer and capacity building to help ensure that all new coal generation is either super-critical or ultra-super-critical.

It is important to note that despite coal being the preferred option for the development of the electricity sector in the country, it has among the highest CO₂ emissions per kWh of output among conventional thermal technologies. The most efficient modern coal plants (USC plants) have emissions (~800g of CO₂ equivalent/kWh²⁵) that are twice the emissions from CCGT plants (~400g/kWh). Advanced coal technologies such as IGCC (integrated gasification combined cycle) plants, and CCS options remain extremely expensive and nascent technologies. However, it is important for Bangladesh to explore new technologies that could possibly reduce its carbon footprint. This is of particular importance to a country such as Bangladesh given its population of 160 million people. As the country develops, if it continues to adopt the traditional development pathways of industrialization and a coal/fossil-fuel based energy economy, this will likely give it a carbon footprint that is nearly half of that of the United States current carbon footprint (with a population of 350 million). Such a development trajectory also creates legacy (and stranded assets) which makes it unsustainable for any developing country and for the world. Hence, it is essential that despite its commitment to coal, the Government of Bangladesh aims to actively pursue alternate/non-conventional/non-fossil fuel based options.

Some of the key actions under the NDC may include:

- Establish procedures and processes for actively monitoring and reporting total emissions from coal based generation;
- Explore innovative technologies and options for operating, maintaining and retrofitting (where possible) coal generation assets to reduce the sector's overall carbon footprint.

2.3.1.7 Other generation options

Nuclear: In December 2016, the Executive Committee of the National Economic Council (ECNEC) of the Government of Bangladesh approved the planned Rooppur Nuclear Power plant, with an estimated cost of USD 12 billion for the first 2 units. The first unit of the plant is expected to come into operation by 2024 and will help reduce the overall carbon footprint of the sector. Carbon emissions from nuclear power plants are known to vary between 5.5 gCO₂ eq/kWh²⁶ to over 100 gCO₂ eq/kWh. The variation arises due to various issues including from nuclear-specific issues such as the grade of the uranium ore and the method of uranium enrichment. Despite these issues, the carbon emissions are between 8-16 times lower than conventional thermal generation from coal. It is also important to note that despite the significant investment in the Rooppur Plant, only 10% of the total generation mix in the country is expected to be from

25. Carbon Footprint of Electricity Generation, UK Houses of Parliament, Postnote Update, June 2011

26. Carbon Footprint of Electricity Generation, Postnote Update #383, June 2011, Parliamentary Office of Science & Technology, UK

nuclear by 2041²⁷. Therefore, there is a clear need and opportunity for the Government of Bangladesh and the international community to engage on measures by which further decarbonisation of the sector may be achieved.

Hydropower: Various hydropower assessment studies have been undertaken in Bangladesh including but not limited to the USAID Regional Hydropower Resources Report for Bangladesh, the Small Hydropower Development Report, as well as studies carried out under the 2010 and 2016 Power System Master Plans. Much of the country's remaining hydropower potential is estimated in the Sangu and Matamuhuri River basins (approximately 167 MW²⁸). Small hydropower potential is estimated to be even lower at approximately 0.15MW²⁹. Overall, domestic hydropower is not expected to have a significant contribution to the NDC targets.

Regional Interconnection: In contrast to Bangladesh's limited hydropower potential, the neighbouring states of Nepal, Bhutan, Myanmar and the North-eastern States of India, all have significant hydropower generation potential which may be exported to Bangladesh through an expanded regional transmission network. However, the political willingness for such regional interconnections has been lacking. Bangladesh currently imports 600MW from India on the Bheramara-Baharampur HVDC inter-connections (500 MW) and the Tripura-Cumilla HVDC inter-connections (100 MW) respectively. Capacity expansion of the interconnector is ongoing with the potential for another 500MW of power trade with India. Other interconnectors include the proposed Rangai-Barapukuria, Rangai-Jamarpur and Purnea-Barapukuria interconnectors (among others). The 2016 PSMP anticipates that over 9000MW of power could be imported from neighbouring countries, accounting for approximately 18% of total installed capacity by 2040. With most of this power coming from hydropower plants, regional interconnections present an ideal opportunity for Bangladesh to reduce carbon emissions from the power sector. Key actions here would include:

- Increased high-level dialogue with India to reach an agreement on regional transmission interconnectors and power trade;
- Explore hydropower investment options in Bhutan and Nepal;
- Establish regional power trade coordination committee.

Tidal and Wave Energy: Wave and tidal power aim to harness the energy from the movement of water either on the surface (wave) or through tidal streams. Despite the significant potential from marine renewable energy both in terms of electricity generation and carbon emissions reduction, the technology remains at very early stages of development with only a handful of such plants being operational in the world. The current development costs of marine renewable energy remains a drawback with estimated LCOE being in excess of USD 550/MWhr³⁰, compared to under USD 100/MWhr³¹ for utility scale solar and wind. Currently, marine renewable energy does not seem to have significant potential for Bangladesh. However, further studies would need to be undertaken to accurately determine both the potential and viability of marine renewable energy in the country.

27. 2016 Power System Master Plan

28. USAID Regional Hydro-power Resources: Status of Development and Barriers

29. World Small Hydropower Development Report 2013

30. 2010 Severn Tidal Power, Feasibility Study Conclusions and Summary Report, DECC, UK

31. Lazard's Levelized Cost of Energy Analysis – Version 10

Low lift pumps: Currently, 37,538 deep tube wells, 1,355,852 shallow tube wells and 181,469 low lift pumps³² are working in Bangladesh to provide water for irrigation. About 79% of the total cultivated area in Bangladesh is irrigated by groundwater, whereas the remaining is irrigated by surface water. More than 90% of the pumps within Bangladesh are run by old and energy inefficient diesel engines. With the help of solar irrigation systems, these energy inefficient low lift pumps can be easily replaced to a sustainable low carbon solution, which will also save significant Government subsidies that are currently being spent on diesel-based irrigation.

2.3.1.8 Other innovative measures

Other measures may include options such as centralised power plants (CPPs). This involves the use of collective gas allocations (made to individual industrial users) to build a new centralised power plant that supplies all the relevant factories. Many medium-sized factories in industrial zones and clusters (as well as some large scale commercial users), have been provided gas allocations by Petrobangla for self-generation. Most of these factories have refused to connect to or rely on grid supply citing various power quality issues associated with the grid. These factories use low efficiency open cycle gas turbines or aero derivative engines (usually 1-5 MW in size, and operating at 20³³-30³⁴% efficiency) to generate their electricity for use in their factories. Schemes whereby, these individual gas allocations can be aggregated and used to generate power from a larger, more efficient combined cycle unit (operating at 50% efficiency or higher) to supply all the factories in the area (if required under 'islanded' grid conditions), may be explored to significantly reduce GHGs.

2.3.2 Actions required in other sectors

There are a number of actions that will be important in other sectors to help facilitate carbon reductions from the power sector. For example:

- Efficient use of electricity and primary energy uses in industry (see the Sectoral Mitigation Action Plan for Industry and the Energy Efficiency and Conservation Master Plan for more details). For example:
 - Raising awareness of efficient use of electricity, for businesses and the public.
 - Introduction of different incentive schemes to promote Industrial Energy Efficiency measures.
 - Energy efficient and zero carbon homes.
- Introduction of a market based incentive scheme to promote renewable energy generation mainly by the private sector.
- Rationalization of import tax and all applicable duties to promote energy efficient appliances and imported energy efficient building materials.

2.3.3 Barriers and challenges

Whilst there are clear reasons for supporting the transition to a low carbon power supply (see section 2.3.1 for more details), there are also certain barriers to realising this that will need to be addressed. These include:

32. Department of Agricultural Extension, 2018.

33. Lower efficiencies due to inadequate maintenance of gensets

34. Rated electrical efficiencies of some of the leading gas turbines and engines including the Rolls Royce 501s that are under 5MW with efficiency of 29%, the Siemens SGT-100s at 30-31%, the Kawasaki Heavy Industries M1A-17D at 26%, Hitachi Zosen GT10s at 29.5%.
Source: Manufacturer Specifications Documents

- Dedicated budgetary allocation to promote renewable energy.
- Relatively new in the arena of clean coal technology.
- Low cost financing to support the implementation of energy efficiency measures. The initial cost of renewable energy based projects and the required equipment is not always affordable. These can cause issues in moving from renewable energy potential to actual implementation. Initiatives should be taken to motivate investors to invest in clean energy-based projects.
- Land availability for a small and densely populated country like Bangladesh it is not always very feasible to implement renewable energy projects as they often require large areas of unused lands. Technologies should be adopted which is concerned with implementing renewable energy based projects by ensuring proper usage of land and investment.
- Lack of expertise and experience in implementing new renewable energy-based activities can be an issue.

2.4 MEASUREMENT, REPORTING AND VERIFICATION (MRV)

A key aspect of this action plan will be to understand what is happening to GHG emissions from the power sector and whether measures that are being introduced to encourage energy efficiency are being successful or not. This is done through measurement, reporting and verification. It is suggested that a set of indicators be used to assess progress in decarbonising the power sector. These include:

- GHG emissions from the power sector (tCO₂ e)
- Grid carbon intensity (gCO₂ /kWh)
- Tera of energy saving
- Installed capacity for different generation types (MW)
- Capacity entering planning and construction (MW) this can give an indication of how capacity is likely to change in the future
- Numbers of installations (e.g. number of solar panels installed)
- The technology used in specific installations
- Efficiency, lifetime, working period and location of installation

MRV for the power sector action plan will be the responsibility of SREDA. In this role, their responsibilities will be:

- Coordinating the MRV system for the power sector, checking with others that appropriate data is being collected.
- To liaise with relevant data providers, both within and outside of Government.
- To conclude data sharing agreements with relevant data providers, setting out information such as what data is needed, the appropriate metrics, the level of verification needed and what the timetable is for providing the data on an annual basis.
- To develop technical guidance as necessary, to describe the MRV approach and methodologies for the power sector.
- To develop a central repository for storage of MRV data relevant to the power sector action plan.

2.5 ADAPTATION

Whilst the focus of this sectoral action plan is on mitigation and on achieving the GHG emissions reduction target set out in the NDC, the main focus of Bangladesh's activities is still on adaptation and on increasing the country's resilience to the impacts of climate change. The primary vehicle for doing this is through the National Adaptation Plan (NAP) process³⁵.

Bangladesh therefore intends to maximise the synergies between mitigation and adaptation by focusing efforts on those measures that will deliver benefits for both reducing GHG emissions and strengthening climate resilience. An example of such a measure in the power sector is the use of solar power to drive irrigation, thus reducing emissions but also improving water supply and water management.

As electricity cannot be stored on a large scale, supply and demand need to be constantly balanced. Both will be affected by climate change, posing significant challenges to the power sector³⁶.

There are a number of ways that the power sector might be affected by climate change. These are generic impacts, but a more precise vulnerability assessment for Bangladesh, as part of the NAP process, will give more specific information on the impacts that different sectors in Bangladesh will face.

- Impacts on electricity grids from storms of increased frequency and ferocity.
- Warming temperatures can lead to higher river temperatures and consequently lower availability of cooling water, which could result in reductions in generating capacity.
- Higher demand for electricity than forecast (e.g. due to increased demand for air conditioning).
- Reduced water availability for cooling.
- Rising sea levels affecting coastal and off-shore energy infrastructure.

There are a number of things that the power sector can do to increase its climate resilience. A selection of these is set out below. Again, these should be considered in more detail as part of the work on vulnerability assessment under the NAP process.

- Managing water resources more effectively, e.g. use municipal waste water, brackish water or sea water instead of scarce fresh water.
- Transmission and distribution measures, e.g. programmes for pruning and managing trees near transmission and distribution (T&D) lines; placing T&D networks underground.
- Planning, e.g. modifying the siting of infrastructure during renovations or while planning new developments.
- Climate resilient infrastructure, e.g. fortifying coastal, off-shore and flood-prone infrastructure against flooding and sea level rises.
- Climate modelling and forecasting, e.g. modelling climate impacts on existing and planned assets in collaboration with meteorological services.

35. The NAP process was established under the Cancun Adaptation Framework. It enables countries to formulate and implement NAPs as a means of identifying medium- and long-term adaptation needs and developing and implementing strategies and programmes to address those needs.

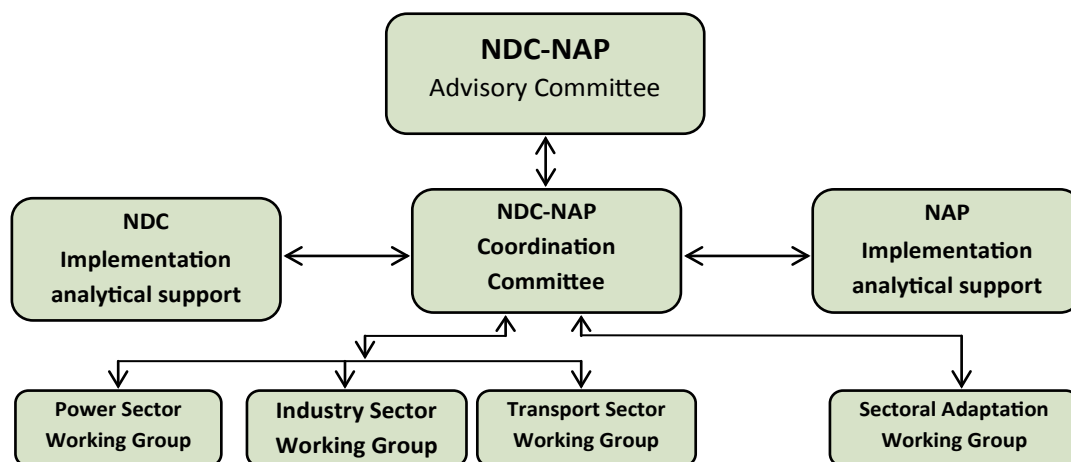
A roadmap for developing the NAP was prepared in 2015, and institutional arrangements have been set up for the NAP process, through the formulation of an Inter-Ministerial Steering Committee, a Technical Advisory Committee and a core NAP formulation team.

36. www.wbcsd.org/content/wbcsd/download/1415/18297

2.6 GOVERNANCE AND COORDINATION

The governance arrangements for driving forward and coordinating NDC implementation are set out in the NDC Implementation Roadmap. As explained in the NDC Implementation Roadmap, the aim is to include and integrate NAP implementation side by side with NDC implementation under one single framework, as shown in Figure 5 below.

Figure 5: Governance arrangements for NDC implementation



The NDC implementation power sector action plan will be coordinated and led by the Sustainable and Renewable Energy Development Authority (SREDA) in the Ministry of Power, Energy and Mineral Resources. SREDA was set up in 2014 as a nodal agency to promote, facilitate and disseminate sustainable energy, so covering both the areas of Renewable Energy and Energy Efficiency, to ensure the energy security of the country³⁷. This was done to encourage better coordination amongst the various stakeholders with an interest in the power sector in Bangladesh. SREDA operates under the Power Division of the Ministry of Power, Energy and Mineral Resources (MPEMR) as a coordination body for the development of the renewable energy in the country.

In the context of NDC implementation, SREDA's role will be to:

- Chair the NDC Implementation Power Sector Working Group.
- Coordinate the policy response for that sector, working with all power sector stakeholders as appropriate.
- Track progress at the sector level towards the 5% unconditional and 18% conditional targets for the power sector and publishing reports detailing this progress. Putting in place data sharing agreement as necessary to collect data to support this tracking of progress.
- Reporting to the NDC implementation technical committee on power sector NDC implementation issues and progress.
- Liaising with the NDC Implementation Coordination Team in MoEFCC to agree analytical needs on NDC implementation.

37. <http://www.sreda.gov.bd/index.php/site/page/dc5c-f792-6b94-d61b-eda8-70c3-83fd-af84-5850-40c7>

- Suggesting ways and means to improve implementation.
- Ensuring adequate capacity development for smooth NDC implementation.

The NDC Implementation Power Sector Working Group will discuss sector-related issues, including discussions on mitigation measures, agreement on recommendations to make to the NDC Implementation Advisory Committee and tracking progress. The members of the Working Group (in addition to SREDA) will include:

- Ministry of Environment, Forest and Climate Change, including Department of Environment, for the link to wider NDC implementation and for assistance in accessing climate financing
- Ministry of Finance, and in particular the Economic Relations Division, for assistance in accessing climate financing and for general policy support
- Energy and Mineral Resources Division of the Ministry of Power, Energy and Mineral Resources.
- The Bangladesh Power Development Board.
- The Bangladesh Rural Electrification Board.
- The Infrastructure Development Company Limited (IDCOL).
- Ministry of Industry, to provide data from industry
- National Board of Revenue, to provide support in considering reduction of import barriers
- Ministry of Commerce, for the link to the private sector and also for support in considering reduction of import barriers

Their role will be to discuss and agree power sector activities and to ensure (a) an appropriate balance of mitigation activities and (b) that NDC implementation in the power sector properly reflects wider important considerations for Bangladesh in relation to the power sector (for example, rural electrification, security of supply etc).

The Power Division will represent the NDC Implementation Power Sector Working Group on the NDC Implementation Coordination Committee. Through this Committee, the delivery of the Power Sector Action Plan will be coordinated with mitigation activity in other sectors.

The Power Division will also be responsible for coordinating stakeholder engagement on power sector issues, such as running open consultations on policy proposals, organising NDC implementation workshops for the power sector and responding to specific queries regarding NDC implementation in the power sector. They will also liaise with MoEFCC in relation to wider NDC implementation stakeholder engagement (that will be coordinated by MoEFCC) and contributing from a power sector perspective to wider stakeholder engagement exercises.

As adaptation is a key element of the NDC and of this sectoral action plan for the power sector, it is suggested that the power sector working group will also look at adaptation issues that relate specifically to the power sector. The working group is therefore likely to need some technical input on adaptation and climate resilience-related issues. The Power Sector Working Group is expected to call on the Adaptation Working Group to provide support and possibly even to carry out studies on behalf of the Power Sector Working Group to help develop adaptation policy for the power sector. As outlined in the overarching NDC Implementation Roadmap, depending on what institutional arrangements are agreed for the National Adaptation Plan process, these NDC implementation governance arrangements may be amended to fit with the NAP process.

NDC ACTION PLAN FOR TRANSPORT SECTOR





3. NDC ACTION PLAN FOR TRANSPORT SECTOR

3.1 INTRODUCTION

In September 2015, Bangladesh submitted its Intended Nationally Determined Contribution (INDC) to the UN Framework Convention on Climate Change (UNFCCC). The INDC describes Bangladesh's plans for tackling greenhouse gas (GHG) emissions and adapting to unavoidable climate change. In the INDC, Bangladesh committed to reduce GHG emissions in the power, industry and transport sectors by 5% below 'business-as-usual' GHG emissions by 2030, or by 15% below 'business-as-usual' GHG emissions by 2030 if sufficient and appropriate support is received from developed countries.

To deliver the overall targets described above, the INDC anticipated that the transport sector would contribute GHG emissions reductions of 9% below 'business-as-usual' by 2030, or 24% below 'business-as-usual' by 2030, conditional on support from developed countries. This action plan describes how Bangladesh intends to deliver the GHG emissions reductions in the transport sector, to support the overall targets described above. This action plan covers the period from 2016 to 2019 and from 2020 to 2025 and describes what needs to be done over this timeframe, by whom and by when, to deliver the required GHG emissions reductions in the transport sector. It is envisaged that the action plan will be a 'living' document and will be regularly updated. Recognising that adaptation is the key priority for Bangladesh, the action plan prioritises actions that will deliver both GHG emissions reductions and strengthened climate resilience. As well as setting out what needs to be done, the plan also looks at the resource needs to implement it, how the activities will be measured and evaluated and how the work will be managed and coordinated.

3.2 VISION AND SCOPE OF THE PLAN

3.2.1 Vision

The Perspective Plan of Bangladesh 2010-2021: The vision of the perspective plan is to establish a safe, low cost, modern and technologically dependable, environmentally friendly inter-modal transport system with a view to reducing the financial cost and time for both commercial traffic, cargo and for public transportation.

The main strategies include:

- The Dhaka-Chattogram Highway (NH1) is to become a six-lane road while the other highways should gradually become four-lane by 2021.
- Expand and improve the railway system with the goal of increasing the market share of freight and passenger transport of rail;
- Establish a modern Mass Rapid Transit System (MRTS) in Dhaka and increase the number of modern high-capacity buses. Other options may include Construction of an overhead monorail system, elevated expressway and Circular waterways around Dhaka city.

Bangladesh aims to become a middle-income country by 2021 and the **Seventh Five Year Plan** has as one of its three themes the need to grow GDP. The transport sector has a key role to play in this an effective and robust transport infrastructure is vital for economic growth, whilst conversely congestion can hamper growth.

At the same time, the Seventh Five Year Plan has an aim for the economic development of the country to be done along a sustainable development pathway. There will be a strong need for improved efficiency in the transport network to ensure that Bangladesh remains within environmental limits whilst continuing to grow. This includes limiting GHG emissions from transport but also improving air quality and a range of resulting benefits (such as improved health from better air quality). The government recognizes in the plan that the transport infrastructure challenge is enormous. In the previous plan, many road projects were initiated but completion rates were slow. Also investments in railways and inland water have lagged behind. The urban transport issues in terms of congestion and traffic management remain overwhelming in the capital city of Dhaka. The Five Year Plan therefore focuses on these issues. A specific focus is also put on the improvement of the multimodal transport network, aiming at a significant increase in the share of traffic in rail and waterways. Also urban traffic management and the maintenance of (especially) road transport infrastructure are seen to be key focus areas, as already highlighted in earlier policy documents and strategies.

The **Integrated Multi-Modal Transport Policy** that was agreed in 2013 intends to extend choice in transport and secure mobility in a way that supports sustainable development. The overall objective is to create a transport system that is safe, efficient, clean and fair by favouring greener, cleaner vehicles along with better public transport and measures that assist non-motorised transport and walking. It also aims at reducing the rate of road traffic growth. To achieve this policy aim, the Government aims to work with industry to promote sustainable goods distribution. The Government furthermore sets to foster innovations in bus transport, encourage CNG vehicles, support solar powered refrigeration units for trucks; and use inland ports to accommodate waste matter from vessels to prevent it being dumped in waterways. One of the specific policy performance targets for the road sector includes the mandatory use of Social and Environmental guidelines for all road and bridge projects. Also environmental standards for road transport are to be established.

The **Road Master Plan(2009)** for Bangladesh is intended to be the guiding document for investment in the road sector over the next 20 (twenty) years. It has been compiled following a thorough diagnosis of the existing problems of the Roads and Highways Department (RHD) road network, and the future challenges to be faced. The main objectives of the Master Plan are to set out a comprehensive investment programme for new road construction, rehabilitation and maintenance of RHD network. Road Master plan emphasis on proper maintenance of existing road network for preserve the asset value and enhance and develop the strategic road network to meet economic and traffic growth.

The **Revised Strategic Transport Plan (RSTP), 2016-2035**: Goal of RSTP is to ensure mobility and accessibility to urban services that are vital for the people and the society, by providing a transport system characterized by safety, amenity, and equity and sustained by an efficient public transport system. RSTP includes the following projects:

- 5 MRT Line and 2 BRT Line be opened by 2035
- Implementation of Traffic Management and Traffic safety
- Arterial road development at Mirpur and Eastern Fringe Area to support urban development
- South part of ring road to be opened before completion of Padma bridge
- Restructuring of bus network, BRF (bus route franchise) & replacement of bus terminals
- Implementation of TDM measures
- Arterial road and ring road development outside Dhaka Metropolitan Area
- Redevelopment of inter-urban roads

The Government of Bangladesh accords the highest priority to implement **Sustainable Development Goals (SDGs)** declared by the United Nations. In SDGs, transport priorities are specified in Target 9.1 and Target 11.2. Target 9.1 focuses developing quality, reliable, sustainable and resilient transport infrastructure and Target 11.2 highlights providing access to safe, affordable, accessible and sustainable transport system for all by expanding public transport and improving road safety. An action plan is being formulated for achieving transport related targets of SDGs.

Bangladesh **National Road Safety Strategic Action Plan** is the key policy document to reduce accidents from Road. Currently 8th National Road safety strategic action plan (2017- 2020) is in place. The goal of 8th National Road safety strategic action plan is to achieve the SDG target to reduce the number of road accident fatalities and injuries by 50% by 2020. Safety improvement through road infrastructure improvement also increases the efficiency of traffic movement.

The **Railway Master Plan (2013)** guides the overall development of Bangladesh Railway (BR) in the foreseeable future and allows BR to go for planned and systematic development as opposed to ad-hoc initiatives. It gives attention on the main corridors where 90% of traffic takes place and focuses on the infrastructure requirement to be implemented during the period 2010 to 2030. The national climate change policies, development strategies and the relevant transport strategies all point to the importance of developing further rail transport. This is thereafter structured within the railway master plan which lays out the required infrastructure needs to implement the policies and strategies.

National Transport Policy

The **Bangladesh Climate Change Strategy and Action Plan (BCCSAP, 2009)**, which is currently being reviewed and updated, includes Programme ten under Theme five, which covers 'Improving energy consumption pattern in transport sector and options for mitigation'. Specific actions under Theme five include (1) promotion of low cost public transport modes such as rapid transit; (2) reducing the use of fossil fuels by improving the efficiency of energy usage, (3) review of political, institutional and fiscal planning and (4) substitution of bio-fuels, fossil fuels as appropriate.

The transport priorities listed in the **National Sustainable Development Strategy 2010-21 (2013)** comprise an expansion and renewal of the railway network, increased focus on upgrading and maintaining the existing road infrastructure (rather than for the build of new road infrastructure), and the development of rural transport infrastructure by integrating road and inland water transport and improving channel and waterway conditions. Concerning urban transport, especially pedestrian traffic is to be prioritised (with measures such as the sufficient provision of sidewalks and the creation of pedestrian-only zones for 24h or specific periods of the day). Also public transport means are to be developed, especially with regards to the bus system (i.e. increase of the network and capacities; introduction of Bus Rapid Transit Systems) and the rail system (i.e. development of a rail-based mass transit system in the Dhaka Metropolitan Area).

The **2nd National Communication** of 2012 identifies the following potential mitigation measures in the transportation sector:

- Urban transport planning and traffic management to decrease congestion;
- Urban MRTS;
- Vehicle maintenance and eco-driving;
- Expansion and modernization of railways and a mode shift from road to rail and from road to waterways.

Bangladesh's Climate Change Strategy and Action Plan of 2009 identifies the following mitigation actions for transport:

- Promotion of low cost public transport;
- Improved energy efficiency of vehicles;
- Substitution of fossil fuels with bio fuels.

3.2.2 Scope

This action plan covers the whole transport sector in Bangladesh, including road, railways, waterways and domestic aviation. It describes how the sector will meet the unconditional and conditional GHG reduction targets set out in Bangladesh INDC, 2015 and mentioned in section 3.1 above.

Transport is a key sector for tackling climate change. In 2005, the transport sector contributed to 15% of CO₂ emissions from energy-related sectors³⁸. The large majority of this (around 70%) came from trucks and buses, with around 20% from cars. Around 7% of the transport CO₂ emissions in 2005 came from shipping, with the rest from railways and aviation. Thus it can be seen that road transport is the key sector for tackling GHG emissions from transport. Road transport is hence a key focus for this sectoral action plan. Whilst shipping and railways are at a lower proportion of CO₂ emissions from transport, they hold a strategically important role as a key approach for tackling road-based CO₂ emissions will be to encourage shift from road to these modes. It is not expected that there will be many options for tackling CO₂ emissions from aviation although this may need to be a focus for future updates to this plan as the aviation sector grows in future.

Indeed, as a rapidly developing country, transport across all modes is expected to grow significantly in coming years. Roads are the backbone of Bangladesh's transport sector, carrying over 80% of national passenger traffic, mostly via privately operated diesel buses. The vehicle growth rate over the last five years was around 6-8% with 3.04 million registered vehicles till May 2017 (BRTA 2017). In 2016, the transport sector consumed 2.62 million MT of oil products and 1,136 MMcm natural gas.

Bangladesh Railways, whilst primarily used for passenger transport, handle approximately 7% of national passenger and freight traffic overall. Bangladesh Railways carries its maximum number of passengers between Chattogram and Dhaka, the nation's most important transport corridor. More than any other mode, railways have the potential to significantly increase the capacity and demand responsiveness of Bangladesh's transport network, and with a relatively small physical footprint. Hence, the government is also working to improve the railway sector by introducing new railway lines, improving the efficiency of locomotive engines, and modernising signalling systems; noting that the Ministry of Railways has adopted a railway expansion and modernisation programme as part of the Seventh Five Year Plan.

The development of railway network will help to reduce emissions by encouraging modal shift from road to rail. Bangladesh Railway has developed a Nationally Appropriate Mitigation Action (NAMA), currently implemented through Asian Development Bank and Nordic Development Fund support. The NAMA aims for transformational change in reversing the trend for decreasing rail usage in long-haul passenger and freight transport in Bangladesh thereby fostering a low-carbon transport solution. The scope for the NAMA is inter-urban passenger and freight transport within Bangladesh. The rail NAMA is well embedded within the national policies and strategies and commensurate with the national development goals. The major cause of the GHG impact of the rail investment program is towards mode-shift from high emitting transport means towards low emitting transport means.

38. See page 63, Figure 3.1 of the Second National Communication of Bangladesh - <http://unfccc.int/resource/docs/natc/bgdnc2.pdf>

A small remaining proportion of passengers travel via water networks (and even less by domestic airlines). There are 32,000 mechanised diesel-powered water vehicles, such as engine boats and engine-coupled launches, which ply regularly. In the Seventh Five Year Plan, the Government is committed to supporting the development of a safe and low-cost inland transport network based on Bangladesh's vast inland waterways. In this regard, a comprehensive development plan has been prepared by BIWTA for implementation during the Seventh Five Year Plan.

3.3 DELIVERING THE PLAN

3.3.1 Mitigation measures in the transport sector

The transport sector in Bangladesh will contribute to GHG emissions reductions in a number of ways.

These can be grouped according to the 'Avoid-Shift-Improve' framework³⁹ :

- Avoid reducing the demand and need for transport.
- Shift encouraging people to switch to lower-emitting modes of transport.
- Improve increasing fuel and vehicle efficiency.

A number of measures are set out below, in section 3.3.1.1 (on what Bangladesh is already committed to do to meet the unconditional target) and in section 3.3.1.2 (on what further steps Bangladesh might take to meet the conditional target, given sufficient international support). Section 3.3.3 looks at the barriers and challenges to delivering this and what can be done to address them. It shows that data availability is an ongoing issue. To further develop this transport sector action plan, the following steps would need to be realized:

- More detailed analysis of the current situation of transport and GHG emission in Bangladesh and projections to 2030. This needs to be done in a quantitative manner to identify sources and areas of emissions.
- Identification of on-going and planned mitigation measures plus additional mitigation measures and quantification of their GHG and Sustainable Development impact as well as core financial aspects (capital costs, operating costs, economic internal rate of return and financial internal rate of return). This will enable further prioritization of mitigation actions and to identify gaps between targets and planned measures.

Therefore for many of these measures, a logical next step would be to carry out further analysis to measure the specific emissions reduction potential of these measures, to further enhance the business case for taking them forward. This is particularly the case for measures needed to meet the conditional target, which will need international support.

3.3.1.1 Meeting the unconditional target in the transport sector

The Government of Bangladesh expects the transport sector to meet its unconditional GHG reduction target (9% below 'business-as-usual' emissions in 2030) through existing and planned measures to modernise the transport network and encourage greater efficiency of travel. This will generally be achieved through ongoing efforts to reduce travel need (avoid), moving demand for transport towards more sustainable mode ('shift'), and through reduction the generation of CO₂ by improvement of fuel quality and engine technology (improve).

39. http://www.sutp.org/files/contents/documents/resources/E_Fact-Sheets-and-Policy-Briefs/SUTP_GIZ_FS_Avoid-Shift-Improve_EN.pdf

3.3.1.1.1 Avoid measures

Some measures to avoid the need to travel may be possible under the unconditional scenario. For example, ICT has a key role to play in reducing demand for transport. Measures such as e-ticketing and e-billing are already being deployed. ICT has also been used to good effect in a number of different sectors, as a way of managing demand for transport. People living outside Dhaka can access to all kind of public service through District e-service centers and Union Information and Service Centers (UISCs). Over 4500 such 'Union Digital Centers' have been set up, through the Access to Information Programme of the Prime Minister's Office and supported by UNDP and USAID⁴⁰. Video conferencing (VC) among Government offices has been introduced to avoid travel need. Honorable Prime Minister inaugurates development projects from her office through VC which reduce travel need of Honorable Prime Minister and other officials.

In the education sector, initiatives such as online publication of public exam results, online submission of applications etc. is reducing travel demand. Government recent initiative to reserve 40% seat for residents of nearby area of a school also reduce some school related trips in certain areas. In Dhaka, some other travel demand management techniques, including staggering office times for government offices, financial institutions, educational institutions and closing of shops in different days of the week are also in place.

3.3.1.1.2 Shift measures

For the unconditional scenario, the NDC assumes a 10% (by 2030) reduction in passenger km travelled by road, with a subsequent increase in passenger km for rail. To this end, mass rapid transit systems should be encouraged, in particular in Dhaka. The railways in Bangladesh have the potential to play a major role in the context of national and regional transport and trade as the country has a unique geographical location.

One Metro line (MRT line 6) is being built in Dhaka as suggested in Revised Strategic Transport Plan (RSTP). The feasibility study of another two metro line (MRT line 1 & 5) is being commenced. Government is constructing the first metro line 6 in Dhaka with the help of the Japanese International Cooperation Agency (JICA). Once metro line 6 is built, it will be able to carry 60,000 passengers each direction per hour. This will lead to approximately 1.6 million passengers per day assuming 20 hours operation and 80% efficiency. The length of the metro line is 20 km. Subsequently, the total passenger- km carried by the metro will be 38.4 million passenger-km per day or 140 billion passenger-km per year. As per data from the Revised Strategic Transport Plan for Dhaka⁴¹, it can be estimated that the total passenger-km per year for the road sector in Dhaka city is 940 billion. Therefore, the metro line 6 alone can take away about 14.9% of the passenger load from road sector to rail sector in Dhaka City. Of course it should be noted that this figure applies only to Dhaka City and such a level of reduction in passenger load for road transport cannot be assumed from this measure nationally.

Government is also currently working on bus rapid transit in Dhaka. Bus Rapid Transit (BRT) is a high-quality bus-based transit system that delivers fast, comfortable, and cost-effective services, through the provision of dedicated lanes, off-board fare collection, and fast and frequent operations. The Government is building a BRT line-3 between Gazipur and Jhilmil (Keraniganj). The BRT system will introduce sustainable public transport system, launching environmental friendly articulated buses, transporting 12000 passengers per direction per hour, which will substantially reduce the use of private transports. It is estimated that implementation of BRT will reduce CO₂ emissions by 42 tons** per day by: (i) replacing part of existing fuel-inefficient fleet with modern larger capacity BRT buses; (ii) improving average speeds in the corridor.

40. <http://a2i.pmo.gov.bd/innovation-brief-union-digital-center/>

41. The draft revised STP can be found here - http://www.rthd.gov.bd/details_view.php?id=5229

** Environmental Impact Assessment (EIA) report of BRT project.

As per Urban NAMA both BRT and MRT can reduce 1.4 Mton of CO₂ by 2030. An efficient and effective mass transit system should have inter connected and easily accessible. Therefore, the other 5 mass transit line (MRT line 1, 5, 2 & 4 and BRT line 7) need to start construction as early as possible.

According to Inter-Urban Rail NAMA approximately 3.03 million ton CO₂ e avoided including black carbon during 2018-2030 period. The major challenges are the investment requirement is US\$ 13.6 billion during 2015-2030 period.

High occupancy articulated buses and double Decker buses have been added to urban public transport through Bangladesh Road Transport Corporation (BRTC). Current fleet of BRTC comprise of 971 buses. BRTC is planning to purchase another 600 modern bus to be used all over Bangladesh.

BR inherited a number of structural and physical weaknesses as a part of its legacy, since it was not specially designed and constructed to serve the present Bangladesh. Due to truncation from the main system, BR is limited in its ability to serve the country effectively and efficiently without proper re-orientation and development. Since the partition of India in 1947, there was hardly any expansion of the railway in East Pakistan. Since the birth of Bangladesh in 1971, instead of constructing new railway lines, some of the branch line railway sections were declared redundant and subsequently closed and no proper attention given to maintain the existing asset. As a result, the railway of this area inherited from British India started declining.

BR, as of 2016, has a network of 2877.10 km of routes consisting of two different gauges of which approx. 2,656 km are under operations. 8% of the route has double track or partial double track. Since 1970 the total route length has only varied marginally. BR manages around 300 diesel locomotives, 1,500 passenger carriages and nearly 10,000 freight wagons. Wagons carry a maximum load of 40 tons. The average freight train speed is 23 km/h. The average speed of passenger trains is around 32km/h. Low punctuality is a matter of great concern for rail customers. The freight movement has remained constant since the mid-seventies at around 700 million tkm per annum transporting 2.5 to 3.5 million tons of goods over a lead distance of 250 km. Passenger movement has increased in the last decade reaching 8 billion pkm with around 65 million passengers and a lead distance of 130 km. Compared to the seventies the passenger number has dropped but the lead distance has more than doubled thus resulting in increased pkm. In the same period however the population of Bangladesh increased by a factor of 2.5 from around 65 million inhabitants in 1970 to nearly 170 million in 2015 whilst GDP at constant prices increased by a factor of 6 in the same period.

Planned investment is required to increase the role of railways in the transport sector of Bangladesh. This shall be realized through the expansion of railway infrastructure and increased railway efficiency. The rail expansion with additional lines, double tracking, rehabilitation and increased capacity utilization also requires significant investment in rolling stock as well as improved capacity utilization of existing rolling stock with improved maintenance. The focus is on inter-city passengers and long-haul freight along specific corridors as these are the areas where rail is considered to have a potential competitive advantage.

Although no assumptions were made in the NDC regarding shifting transport from road to shipping, this is an important measure. Inland water transport can be a relatively cheap mode of transport compared to road and rail. And the potential for shifting transport, both passengers and freight, from road to waterways is significant of the roughly 24,000 km of river in Bangladesh, around 3,800 km is navigable year round,

and more is navigable during monsoon season⁴². In recognition of its importance, a number of measures were announced in the Seventh Five Year Plan to encourage greater use of inland waterways, including dredging projects such as the project to develop the navigability of “Madaripur-Charmuguria-Tekerhat-Gopalganj” river routes⁴³, which is scheduled to be completed by 2019/20. A medium-term project is also currently being implemented and a longer term dredging project (“Capital dredging of 53 river routes”) has recently started. In addition, a circular water bus and water Taxi in Hatirjheel lake have been introduced in Dhaka taking steps to ensure better schedule management could help encourage use of this mode of transport.

Finally, the importance of promoting walking and cycling, in particular in urban areas, should not be overlooked. One important way of doing this is to remove the various impediments to walking and cycling, such as the state of many pavements in urban areas. Improving these is likely to encourage more people to walk for journeys of short distance, as well as generally improving the local environment. Development of cycle lanes could also be considered although they may be difficult to maintain because of the high traffic volumes on Dhaka's roads occupying almost the full road.

The Government is currently working on a draft of the Road Transport Act 2017, which includes a provision for imposing control over the use of cars. More generally, promotion and awareness-raising can play an important role in encouraging people to minimize use of private car. This could help reduce demand for transport, and/or encourage a move to other modes (public transport, walking, cycling). World car-free day has been celebrated in Bangladesh in a number of ways in recent years. Dhaka North City Corporation (DNCC) plans to declare two streets in the capital to be car-free, “to ease congestion and pollution”. In addition, recent initiative, ride sharing also decreases the number of personal car from road.

3.3.1.1.3 Improve measures

For the unconditional scenario, the NDC assumes a 5% (by 2030) reduction in fuel consumed by road transport per km travelled. This will be delivered through the improvement of transport infrastructure for more efficient running. Upgrading of all major highways from 2 lane to 4 lane could be an option for more efficient running of vehicles as major movements of both passenger and freight are on highways. Dhaka-Chattogram and Dhaka-Mymensing road is already upgraded to 4 lane highway. Upgrading to 4 lane of Joydebpur-Elenga road is going on under SASEC I project. Upgrading of Elenga-Rangpur, Dhaka bypass, Dhaka-Sylhet will commenced soon. Segregated slow moving lanes for slow and non-motorised transport are also another approach for efficient movement of traffic on highways as well as road safety. For example, starting from man-pulled vans to high speed cars share the same road. As a result, the motorized vehicles cannot run at their optimum speed resulting in traffic jams and inefficient use of fuels causing more CO₂ emissions. Hatimukrul-Banpara is the first example of such initiatives constructed in 2004. Upgrading of Joydebpur-Rangpur will also have slow moving lane. Roads and Highways Department is building country's first 55 Kilo-meter expressway from Dhaka to shibchar (Madaripur).

Improvement of intersection on highways in urban areas also add positive impact on vehicle movement and reduced congestion. Examples of such initiatives are Bholta interchange development, Mohakhali and Zillur Rahman flyover in Dhaka. The construction work of the Dhaka Elevated Expressway, from the airport to Palashi, has started which is expected to relief congestion inside Dhaka city.

42. Bangladesh Waterways Assessment - Logistics Capacity Assessment.

43. See page 350 of the Seventh Five Year Plan.

A number of measures are also already being taken to improve the fuel efficiency of the vehicles used in Bangladesh. CNG fuel is often used for both private and public vehicles, recently some hybrid cars are being imported and zero tailpipe emission battery-powered vehicles are used widely in most urban areas as public transport. However, proper planning is required as charging stations for hybrid vehicle is not widely installed and the battery disposal system is not yet established.

Adequate training for the driver and proper maintenance of vehicle can also add positive impact in reducing emission. The driver training program is being run by 03 training institution and 14 training centers through BRTC.

The full potential of the railway can only be realised through planned investment in track, signalling, rolling stock, maintenance and human resource development. BR must significantly improve its service quality and operational efficiency as well as establish better connectivity by applying modern technology and practices adopted around the world. Moreover railway networks need multi-modal integration with road and inland water transport systems as well as improved infrastructure facilities to be able to carry more traffic efficiently.

On the whole, while some progress has been made, there are major capacity and institutional constraints that need to be addressed if the full development potential of the railways is to be realized. BR suffers from major operational constraints including rail network shortage, mismatch of broad and meter gauge systems, shortage of rolling stock and safety equipment and financial deficits. The railway modernization challenge is a long-term challenge that will require considerable new investments, pricing and institutional reforms. Renewed focus on modernizing railways will be necessary for its sustainable development.

3.3.1.2 Meeting the conditional target in the transport sector

The Government of Bangladesh expects the transport sector to meet its conditional GHG reduction target (24% below 'business-as-usual' emissions in 2030) through a range of additional measures, mostly around 'improve measures' that will require further support from the international community.

3.3.1.2.1 Avoid measures

Demand for transport is expected to grow significantly as Bangladesh continues to grow its economy. However, there may be things that the Government could do to limit this growth in demand for transport in certain areas. Development of self contained new towns around Dhaka (satellite city) could be one approach, such as the Purbachal New Town, north east of Dhaka. RAJUK, the public agency responsible for coordinating urban development in Dhaka and the project developer for Purbachal New Town, intends to develop the area as a self-contained town with all modern facilities and opportunities⁴⁴.

Further steps to reduce the need to travel can be made through sustainable urban planning, and in particular by the promotion of 'compact cities', by ensuring key facilities are located alongside residential areas and encouraging compact, mixed-use land use. It should be noted that sustainable urban planning can also be used to encourage shift measures (e.g. provision of cycling infrastructure) and improve measures (e.g. encouraging car sharing). For example, the creation of effective walkways and cycling facilities will also help people change their modes of travel from the motorized vehicles.

44. <http://www.rajukdhaka.gov.bd/rajuk/projectsHome?type=purbachal>

Indeed, as Dhaka is constructing metro rail 6 and BRT line 3, it is an opportune time to apply transit-oriented development (TOD) measures along those transit corridors. Separate interventions are urgently needed by RAJUK to facilitate such TOD measures. Land near to MRT and BRT stations should be allowed additional Floor area ratio (FAR) and need TOD rules and regulations.

Finally, demand management of road transport could be delivered by some form of congestion charging, which could also encourage modal shift from private car to public transport. Such congestion charging schemes has been successfully implemented in other, often developed, countries. It is likely to have significant resource implications (e.g. in terms of monitoring infrastructure) and may not be a measure for the immediate term, but could be an option that Bangladesh could consider in the longer term. Furthermore, detailed analysis would be needed to assess the potential costs and benefits before taking any decisions. Urban transport trips, especially in Dhaka, are currently made up to a large extent by non-motorized transport and public transport. There is therefore a risk that congestion charging would have a relatively limited impact.

It should be noted that any of the above 'avoid' measures would provide additional GHG savings to those assumed in the NDC (which did not assume any reduction of transport demand).

3.3.1.2.2 Shift measures

For the conditional scenario, the NDC assumes a 25% (by 2030) reduction in passenger km travelled by road, with a subsequent increase in passenger km for rail. Shifting 25% of passenger load to rail from road will require a major transformation in the rail sector. This will require huge investment to make the rail sector more reliable by purchasing new engines, passenger rolling stock, renovating and contracting new rail lines and modernising rail traffic signals. For example, MRT line 2 and 4 will establish efficient and environment friendly connection with Savar and Narayanganj area while BRT line 7 links eastern fringe area to central Dhaka. Construction of these 3 transit line need USD 5742 million (RSTP 2016).

The **Railway Master Plan (2013)** focuses its attention on the main corridors to regain lost market share and improve its competitive position versus road. In terms of **finance** the rail Master Plan on which the activities and the Rail NAMA are structured consists of 235 projects costing USD 30 billion in the period 2010 to 2030. Phase I until 2015 thereby had an investment volume of 16.41 billion USD. As per the Rail NAMA, once the planned projects are implemented the rail sector will grow significantly and thus help towards reverting the historic trend of decreasing mode share in freight and passenger transport. In passenger transport, the share of rail could be more than double by 2030 against its current share and thereby stop the declining mode share trend. Also in freight transport, a fundamental shift can be observed. In the last 4 decades, freight rail transport has been constant or declining resulting in a massive decrease of mode share. With the NAMA the rail's share for freight transport could also be more than double against its present share. The intervention has therefore a large scaling-up potential.

As per the Rail NAMA, BR will also have major financial benefits, notably the net income from its services in the passenger and the freight sector. In economic terms the sustainable development savings from air pollution, fuel savings and reduced accidents account for a benefit of around 3 billion USD over the investment life-span of 40 years i.e. this covers around 10% of the investment costs. The investment cost per ton CO₂ abated including economic benefits is around 1,660 USD/tCO₂e. This is not the CO₂ abatement cost as the rail project has income and benefits apart from GHG reductions. Finance for the NAMA could be structured through the Green Climate Fund with a blending of national and international resources and of credit and grant facility.

Considering the reality, instead of current road based transportation system, Dhaka may also adopt rail-based mass transit system, which should be developed in a planned and comprehensive manner integrated with other modes of transport to ensure door-to-door services. To enhance the development effects of the system, the construction of urban facilities (compact and mixed use types) at and around the stations for the improvement of inter-modal connectivity is important. The needs of the pedestrians and cyclists, and the users of para-transits and non-motorized vehicles must be considered and understood. Transport policies must improve every aspect of travelling from point of origin to final destination having minimum impacts on environment.

Additional GHG savings can come from shifting passengers from road to waterways where appropriate but also, crucially, from shifting freight from road to both rail and waterways. Section 3.3.1.2 above mentions some of the projects currently underway to improve the navigability of inland waterways. In addition, the Seventh Five Year Plan also committed to exploring the possibility of working with the private sector to speed up the rate of dredging of inland waterways.

At present there is not a specific car parking policy in place. Introducing a policy, for example increased parking charges, could discourage people from taking private cars and instead to take public transport. Alternatively, a parking policy could focus on improving parking facilities, to discourage illegal parking on the road which can cause congestion. Such measures would need to be carefully introduced so as not to unfairly penalise those that are reliant on private car transport and have few other options, so more work would need to be done on such a measure before being in a position to introduce it. It is also likely to be a policy that is only effective for the major urban areas, such as Dhaka.

Measures will also need to be taken to guard against modal shift in the wrong direction, from public road transport or from other modes (e.g. shipping or rail) to private car use. For example, after the opening of the Padma Bridge, there is likely to be a major shift from waterways to land transport. Consideration should be given to alleviating measures that could ensure that road traffic levels do not increase too drastically as a result. However, new rail link from Dhaka to southern districts via Padma bridge may act as counter measure of this wrong direction movement.

3.3.1.2.3 Improve measures

For the conditional scenario, the NDC assumes a 15% reduction in fuel consumed by road transport per km travelled. There are a number of measures that could be used to achieve this.

- Further improvements to vehicle fuel efficiency of key modes: The focus for this will be the road sector, as it is the biggest contributor to overall transport GHG emissions in Bangladesh. Here the public and private sectors can play a role by procuring more energy efficient vehicles such as hybrid cars, trucks and other vehicles. But other transport modes will also be able to play a role, in particular railways. BR is taking steps to reduce emission of the railway system itself including:
 - Replacement of old locomotives with new units with lower fuel consumption and GHG emissions.
 - Usage of low sulphur diesel fuel. Whilst low-sulphur diesel will not have a direct GHG impact, it does have an indirect impact as it allows for the usage of more efficient engines and reduces maintenance requirements. High sulphur diesel result in high maintenance efforts and if latter are not realized the fuel consumption and GHG emissions tend to increase.
 - Improved locomotive maintenance facilities which again result in increased maintenance quality and thereby improved fuel efficiency of locomotives.

- Better road traffic management: Government is trying to overcome congestion situation in Dhaka by the following measures:
 - Better managing of traffic signals to improve flow of traffic. To do this, more robust traffic modelling data is needed. It will also be important to build capacity in the Metropolitan Police for traffic management and traffic signal management.
 - Training of bus drivers, through an awareness and eco-driving programme. This could be done through workshops, by adapting current driving training and through media campaigns. Nonetheless, if not accompanied by moves to introduce a bus franchising (see below) then such measures may have limited success.
 - Making and implementing stringent rules for traffic violation and for the stopping of buses in undesignated areas.
 - Introduction of a bus franchise system: This will remove unfair competition of drivers to get passengers in their buses and will make it easier to encourage better driving practices. Dhaka Transport coordination Authority (DTCA) has drafted a franchising system by dividing Dhaka with 10 companies. Such a franchise system could also encourage the replacement of smaller buses, with larger buses with higher carrying capacities. In line with this plan 4000 modern buses are being planned to introduce in Dhaka city by which will improve the fuel efficiency of the bus stock.

Increased capacity at vehicle registration authority for emissions measurement stations: As outlined in section 3.3.3 on barriers and challenges, lack of data on vehicle fuel efficiency is a major barrier. It limits the ability to make accurate estimates of CO₂ emissions from road transport, which would be needed if any measures to encourage a reduction in tailpipe CO₂ emissions from road vehicles are to be considered.

In addition, emission data for railway should also be collected to better understand the efficiency of the mode. BR has fuel usage data and from this, GHG emission data can be calculated.

- Green freight: Most of the trucks in Bangladesh are has heavy duty diesel (HDD) engine having pre-Euro emission standard. These HDD engines are one of the major contributors of CO₂. Gradually phase out of old trucks with Euro II/III emission standard can reduce GHG emission. There may be scope for reducing the empty running of freight road vehicles by encouraging freight operators to share information on their vehicle movements, so returning empty-running freight vehicles get utilised to carry freight. However there may be challenges to doing this, not least the question of how to have efficient and effective coordination between the large numbers of freight operators. It is suggested that a scoping study is carried out to look at the feasibility of such an option. This should include an assessment of freight transfer, transfer points etc, so that there is a better understanding of existing freight movements. In addition , Eco driving can also reduce the emission of GHG from freight movement.
- Old vehicle scrapping: Scrapping of old vehicles could be one option for reducing emissions but is challenging in a country like Bangladesh. Due to the prevalence of reconditioning engines, the life of old vehicles is very often extended. However, one approach could be to offer incentives for the scrapping of old vehicles. 287 vehicles of BRTC has been classified BER (beyond economical repair).
- Reduction of road roughness: In Bangladesh, many roads have holes and bumps which can create stop-start conditions for traffic, worsening the efficient running of vehicles. According to the Needs report published by Roads and Highways department using HDM4 model, the overall road condition of National highway (good to fair) is 79.61% . Government target is to improve the situation (good to fair) to 90% by 2021. Hence reducing the road roughness could help lower GHG emissions.

Baseline data on the International Roughness Index as a measurement of road riding surface quality (IRI) is maintained by Roads and Highways Department can be used in this regard. Expert judgement from RHD suggests that road transport GHG emissions could be reduced by 2-3%, by increasing the proportion of national highways that are in good condition from 80% to 90%, and by increasing the proportion of regional highways that are in good condition from 70% to 80%. Before doing this, a more detailed assessment would be needed of the expected costs and benefits.

- Roads and Highways department (RHD) plans to upgrading of all major highways from 2 lane to 4 lane highway with separate lane for slow moving traffic. Recently RHD completed detail design and feasibility of 1752 KM national highway to be upgraded to 4 lane.

3.3.1.3 Policy delivery mechanisms

A range of policy options may need to be considered to encourage the above measures, and once a decision has been taken to bring forward a specific measure, further analysis will be needed on the appropriate policy delivery mechanism, be it regulation, fiscal incentives, information and labelling etc. For example, one approach for promoting fuel efficient and hybrid vehicles could be to reduce import duties and taxes on such vehicles.

Bangladesh will consider the scope for creating Nationally Appropriate Mitigation Actions (NAMAs) in the transport sector that can attract international support for their implementation. Bangladesh is already working on two NAMAs in the transport sector a road transport NAMA supported by the Asian Development Bank and a railway transport NAMA supported by the ADB and the Nordic Development Bank. Opportunities for further NAMAs in the transport sector will be kept under review.

3.3.2 Actions required in other sectors

There are a number of actions that will be important in other sectors to help facilitate carbon reductions from the transport sector. For example:

- Supply of low carbon fuels, e.g. bio-fuels. This will be a particular issue for Bangladesh, as it is such a space-constrained country.
- Build up vehicle maintenance/service industry.
- ICT support, e.g. real-time information on public transport.

3.3.3 Barriers and challenges

Whilst there are clear reasons for supporting the transition to a low carbon transport sector (see section 3.2.2 for more details), there are also certain barriers to realising this that will need to be addressed.

3.3.3.1 Data

The lack of robust data in the transport sector means that the precise impact on GHG emissions of certain measures cannot be known with any degree of certainty. Following the adage that you cannot manage what you cannot measure, improving the quality of data on the transport sector is a critical prerequisite for making progress in moving towards a low carbon transport sector.

A particularly important data set that is lacking is vehicle km, passenger km and freight km. Frequently, countries collect such information in the form of traffic or mobility surveys that are led with households or vehicle owners. Sample techniques are applied to ensure that results from the surveyed population (the sample) can be extrapolated to the whole vehicle fleet in a country, e.g. based on household, vehicle and/or trip characteristics. Such surveys may, for example, be based on requesting respondents to fill in travel

diaries (i.e. log all trips carried out with a vehicle over a certain period of time, e.g. 1 week). The Bangladesh Road Transport Authority (BRTA) could play a role in future in collecting such data. Also freight transport statistics can be established this way, i.e. by consulting the owners of heavy goods vehicles to ask for their trip-making behaviour and the goods (and tons) that are transported. Also odometer readings collected in mandatory regular vehicle tests/certification procedures can be used for establishing vehicle km statistics. Hence the haulage industry could play a key role in collecting such data in future. All the data on vehicle km could then be shared with Bangladesh Bureau of Statistics for them to publish on a regular basis.

Another key data set that is lacking is on vehicle fuel efficiency. Collecting such data requires detailed knowledge of the overall vehicle stock in a country and emission values of the respective vehicles. Typically, such statistics are only available for the new vehicle fleet (i.e. for vehicles that are newly registered) in case appropriate vehicle registration procedures (that require the reporting of vehicle emission values) are in place. Proxies need to be used for the older vehicle fleet, but the automotive sector should be able to assist in developing such proxies.

3.3.3.2 Lack of understanding of co-benefits of transport sector mitigation

Transport sector measures may sometimes not be prioritized due to a potential lack of consideration or understanding of co-benefits of transport sector mitigation actions. Often the importance of transport for driving economic growth puts the build of (often road) transport infrastructure high on the transport agendas. However, co-benefits of measures that contribute to congestion reduction and increased public health and can also spur even further economic growth may not be fully considered. It is recommended that a study is carried out to comprehensively assess the potential co-benefits of sustainable transport measures in Bangladesh and their potential cost savings. These could include air pollution abatement, enhanced health protection, reduced journey times, diminished accident rates, improved productivity and energy security⁴⁵. For this study, a comparison will be done for different transport modes in terms of construction cost, maintenance cost, longevity, CO₂ emission/km, accident savings, improvement of social condition and any other relevant co-benefits.

3.3.3.3 Lack of capacity/understanding of related costs

Without cost assessments, stakeholders may strive for a non-optimal mix of (transport) mitigation actions and/or may be deprived from relevant funds. Assessing the costs of transport mitigation measures is the key to

- ensuring that stakeholders fully grasp the potential cost-effectiveness (or even negative costs) of relevant transport mitigation measures, so that these can be prioritized and well-founded transport action plans can be established, and
- generating needed funding for measures that have been confirmed and are deemed fit for implementation.

In the early stages of the NDC revisions and/or implementation processes, capacity should be developed to establish cost assessments of the (transport) mitigation measures.

45. https://sustainabledevelopment.un.org/content/dsd/susdevtopics/sdt_pdfs/meetings/workshop0909/Session2-Fabian.pdf

3.3.3.4 Accessing finance

Further work needs to be carried out to accurately cost up the measures described in section 3.3.1 before potential funders are identified and approached. In some cases, initial assessments have been made. For example, the Bangladesh Road Transport Authority (BRTA) has made an assessment that the cost of enacting the measures that they would have responsibility for (GHG emissions measurement and developing a central repository for data), estimating the costs of these measures combined to be US\$10m. Over the coming few years, the Government of Bangladesh will work to produce further estimates and to refine these as much as possible, whilst also reaching out to funders that may be interested in supporting transport projects in Bangladesh.

3.3.3.5 Lack of coordination among agencies

The transport sector issues are to be addressed in a holistic manner with an integrated policy approach rather than piece-meal sub-sectoral approach that has been adopted so far. Different modes of transport will have to fit into the transport chain by virtue of their quality and competitiveness of service. For transporting freight and passengers through a multimodal chain, all the component parts are to be seamlessly linked and efficiently coordinated to offer the shippers and travellers a full range of options from which to select preferred routings and methods of transport. Implementation of multimodal practices would require an integrated policy approach to guide transport investment decisions on the basis of appropriate assessments of impacts of all modes of transport to ensure that investment meets the policy objective of sustainable development. The intrinsic advantages of the individual transport modes would be exploited to develop synergies between the modes in the interest of the economy and the environment.

3.4 MEASUREMENT, REPORTING AND VERIFICATION (MRV)

A key aspect of this action plan will be to assess the progress in reducing GHG emissions from the transport sector and undertake monitoring and evaluation to ensure that the mitigation measures implemented contribute to NDC commitments thus encouraging a shift to a lower carbon transport system. This is done through a measurement, reporting and verification (MRV) system which use a set of indicators to track the implementation and effectiveness of the actions undertaken.

As a starting point it is necessary to understand the existing GHG measuring and reporting systems currently being used in Bangladesh then to further identify where improvements can be made depending on the mitigation action developed for the transport sector.

Specific indicators that need to be considered include:

- Modal share data for different modes
- Freight distance (vehicle km and tonne km) by mode
- Passenger travel distance by mode
- Fuel efficiency (gCO₂ /km) of vehicles
- Numbers of low carbon cars
- Fuel consumption for different modes
- Numbers of people undergoing driver training.
- Average speed of vehicles on road
- Roughness Index of nationwide road network

As outlined in section 3.3.3.3 above, it is important to also collect data on co-benefits of low carbon transport actions, to support the case for such action and to improve the evidence base on overall cost effectiveness. As part of the proposed study mentioned in section 3.4, it is suggested that a list of key indicators be compiled, and be added to the list above for the MRV of the transport sector action plan for NDC implementation.

There is also the need to track implementation and assess the effectiveness of adaptation action undertaken for the sector. This is something that will be considered in more detail as part of the separate National Adaptation Plan process.

It is proposed that Road Transport and Highways Division (RTHD) of the Ministry of Road Transport and Bridges is the overall lead for MRV of the transport system, and will liaise with the Ministry of Shipping, Ministry of Railways and Ministry of Civil Aviation and Tourism to collect data on the respective modes. Each of those ministries will liaise with modal stakeholders as necessary, for example with BRTA, Metropolitan Traffic Police etc. RHD will collate information to track the performance of the transport sector in reducing GHG emissions and will report up to the NDC Implementation Coordination Committee (see Section 3.6 on governance for more details).

Much of the data that is needed to report on the indicators above is expected to be held and regularly updated by the Bangladesh Bureau of Statistics. This would include numbers of vehicles on the road (by vehicle type) and numbers of rolling stock, number of vehicles registered (by vehicle type), freight tonnage carried by railway (by freight type), passenger numbers by railway, numbers of passengers and passenger kilometres for domestic aviation, number and types of aircraft, number and type of inland waterway vessels, number of passengers on waterways and tonnage of freight on waterways (by freight type).

The Government, led by the Road Transport and Highways Division, will carry out a review in 2017 of additional data needed to track progress, including co-benefits, to consider how data for such indicators might be gathered, based on the mitigation measures outlined in Section 3.3.1.

3.5 ADAPTATION

Bangladesh's transport infrastructure is facing severe climate change impacts^{46,47}. Increased flood and erosion damage the road and rail infrastructure and their embankment. Accelerated wear and fatigue due to extreme temperatures cause damage to transport infrastructure. There is increased obstruction by debris after floods, cyclones and storm surges. Salinity intrusion impacts infrastructure in coastal area including corrosion of reinforced concrete structures. According to a study by the World Bank⁴⁸, increasing salinity in coastal areas can result in increasing the predicted road maintenance expenditure share by 252%. Increased frequent landslides due to intense rainfall in hilly areas and localised ground subsidence are also causing damage to transport infrastructure. Climate change adaptation measures are crucial to reduce the severity of these impacts and to improve planning and risk management caused by these impacts on transport infrastructure.

46. Abdul Quium (2015), Transport Infrastructure - Adaptation to climate change and extreme weather impacts. Available at: http://www.uncrd.or.jp/content/documents/345702_Abdul_Quium_Presentation_Kathmandu_Final.pdf

47. Ministry of Environment, Forest and Climate Change, CLIMATE CHANGE AND INFRASTRUCTURE IN BANGLADESH INFORMATION BRIEF. Available at: <https://cmsdata.iucn.org/downloads/infrastructure.pdf>

48. World Bank (2014) Climate Change, Groundwater Salinization and Road Maintenance Costs in Coastal Bangladesh Available at: <http://documents.worldbank.org/curated/en/828391468004833607/pdf/WPS7147.pdf>

Ensuring that the transport system is resilient to climate change and that it also contributes to increasing resilience will consequently reduce negative impacts on the national economy. This could be done in different ways. For example:

- Planning transport infrastructure so that it is less susceptible to flooding and increased rainfall(e.g. raised roads, increased capacity of drainage structures, raised bridges etc), and also so that it can help contain flooding (e.g. raised railway and road embankments).
- Building infrastructure so that it is more resilient to extreme temperatures, (e.g. strengthened railway lines that do not buckle in high temperatures and use of stronger material).
- Risk mapping of climate stress vulnerability of transport infrastructure.
- Integration of climate change in to the infrastructure design practice.
- Updating design and construction standards and materials to ensure that future infrastructure is more resilient to anticipated climate and extreme weather events.
- Improve storm and flood warning systems and employ emergency response team for reducing impact of debris damages and blockages.
- Improve embankment protection and supplement dry season river flows for reducing impact of saline intrusion.
- Improve traffic information systems for the public that can reduce impact.

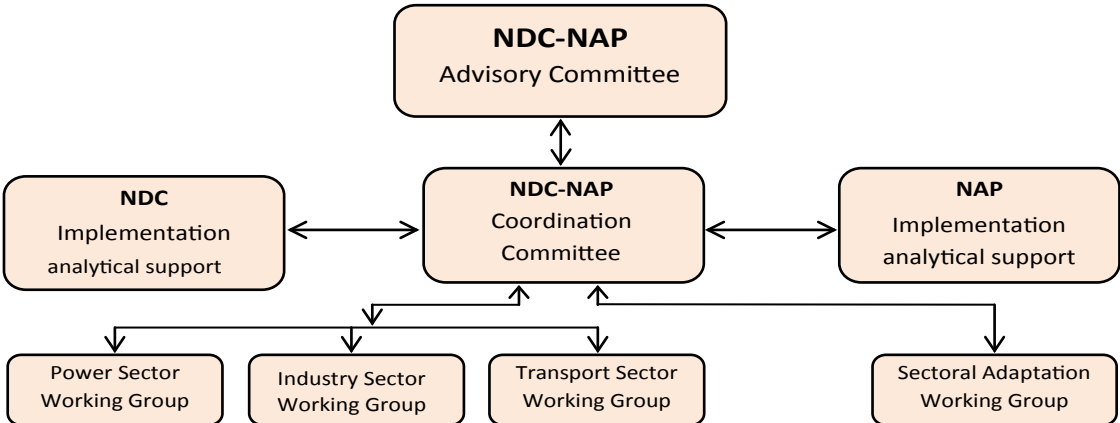
There are also additional measures that may be needed for undertaking developing adaptation measures. For example,

- Research, training and technology transfer to identify use of stronger materials for use in extreme temperatures, debris damage and blockage
- Modelling studies to improve standards and codes for measures that can address more intense rainfall, river flooding and storm surges.

3.6 GOVERNANCE AND COORDINATION

The governance arrangements for driving forward and coordinating NDC implementation are set out in the NDC Implementation Roadmap. As explained in the NDC Implementation Roadmap, the aim is to include and integrate NAP implementation side by side with NDC implementation under one single framework, as shown in Figure 6 below.

Figure 6: Governance arrangements for NDC implementation



Having these kind of governance arrangements are particularly important for the transport sector, and could be part of wider efforts to increase institutional efficiency of the transport sector as a whole. The Government's different ministries and agencies responsible for transport sector development have at times followed a sub-sectoral approach with no or very little coordination between sectors, resulting in some policy conflicts or inefficiencies. Having a single approach to NDC implementation for the whole transport sector could help address some of these problems and will support the development of a more holistic, multi-modal approach to transport problems.

The Road Transport and Highways Division (RTHD) under the Ministry of Road Transport and Bridges, will be responsible for the implementation of this plan. In particular, RTHD will need to work closely with the Ministry of Railways, Ministry of Shipping and Ministry of Civil Aviation and Tourism, with these three institutions being considered effectively as co-chairs of the working group with RTHD. In the context of NDC implementation, RTHD's role will be to:

- Chair the NDC Implementation Transport Sector Working Group.
- Coordinate the policy response for the transport sector, working with all transport sector stakeholders as appropriate.
- Track progress at the sector level towards the 9% unconditional and 24% conditional targets for the transport sector and publishing reports detailing this progress. Putting in place data sharing agreements as necessary to collect data to support this tracking of progress.
- Reporting to the NDC implementation technical committee on transport sector NDC implementation issues and progress.
- Liaising with the NDC Implementation Coordination Team in MoEFCC to agree analytical needs on NDC implementation.
- Suggesting ways and means to improve implementation.
- Ensuring adequate capacity development for smooth NDC implementation.

A Transport NDC Working Group will meet regularly to discuss the implementation of the NDC sectoral action for transport and to report up to the cross-cutting NDC Implementation Coordination Committee. The members of the Working Group and their roles are outlined below.

Organisation	Role
Roads Transport and Highways Division, Ministry of Road Transport and Bridges	Overall coordination of the NDC sectoral action plan for transport Chair of the Transport NDC Working Group Liaison with relevant transport stakeholders Reporting to NDC Implementation Coordination Committee Provision of information on average speed of vehicles on Highway network Provision of information on roughness index of inter urban road network Work as secretariat for NDC sectoral action plan for transport
Ministry of Railways	Co-Chair and Member of Transport NDC Working Group Overall responsibility for rail sector Collection of data to support MRV of rail sector

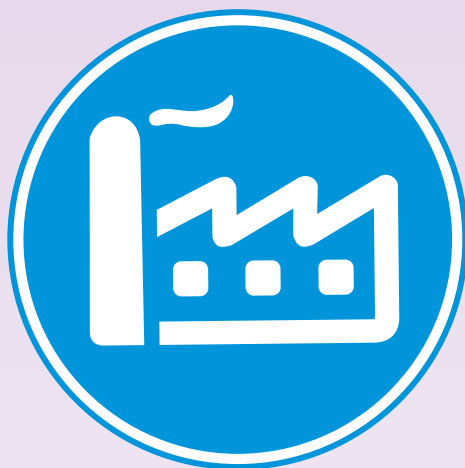
Organisation	Role
Ministry of Shipping	Member of Transport NDC Working Group Overall responsibility for shipping sector Collection of data to support MRV of shipping sector
Ministry of Civil Aviation and Tourism	Member of Transport NDC Working Group Overall responsibility for aviation sector Collection of data to support MRV of aviation sector
Ministry of Environment, Forest and Climate Change	Member of Transport NDC Working Group Link to overall NDC implementation and guidance on climate change related issues
Roads and Highways Department (RHD)	RHD is responsible for construction and maintenance of the major road network of Bangladesh. Upgrade all major highway from 2 lane to 4 lane with separate slow moving lane. Improve major intersection to reduce congestion. Collect data on roughness of major roads
Bangladesh Road Transport Authority (BRTA)	Maintain vehicle data along with mileage data
Bangladesh Road Transport Corporation (BRTC)	Provide their improvement plan for providing public sector road transport service
Dhaka Transport Coordination Authority	Responsible for overall transport coordination in Dhaka city. Can coordinate Dhaka City stakeholder inputs to the working group
Bangladesh Railway	Responsible for planning, construction, operation and maintenance of the entire railway network in Bangladesh
Bangladesh Inland Water Transport Authority (BIWTA)	Responsible for policy on inland waterways in Bangladesh
Bangladesh Bridge Authority (BBA)	Responsible for bridges and tunnels (over 1500m in length)
Local Government Engineering Department (LGED)	Responsibility for rural roads
Police Department (e.g. including Metropolitan Traffic Police, Highway Police etc)	Maintenance of traffic signals and enforcement of parking rules
Department of Environment (DoE)	Provide requirement for emission measurement devices with cost of equipment and training. Also the cost for server and other logistics for a central data repository

As explained above, RTHD will represent the NDC Implementation Transport Sector Working Group on the over-arching NDC Implementation Coordination Committee. Through this Committee, the delivery of the Transport Sector Action Plan will be coordinated with mitigation activity in other sectors.

RTHD will also be responsible for coordinating stakeholder engagement on transport sector issues, such as running open consultations on policy proposals, organising NDC implementation workshops for the transport sector and responding to specific queries regarding NDC implementation in the transport sector. They will also liaise with MoEFCC in relation to wider NDC implementation stakeholder engagement (that will be coordinated by MoEFCC) and contributing from a transport sector perspective to wider stakeholder engagement exercises.

As adaptation is a key element of the NDC and of this sectoral action plan for transport, it is suggested that the Transport Working Group will also look at adaptation issues that relate to the transport sector. The working group is therefore likely to need some technical input on adaptation and climate resilience related issues. The Transport Working Group is expected to call on the Adaptation Working Group to provide support and possibly even to carry out studies on behalf of the Transport Working Group to help develop adaptation policy for the transport sector. As outlined in the overarching NDC Implementation Roadmap, depending on what institutional arrangements are agreed for the National Adaptation Plan process, these NDC implementation governance arrangements may be amended to fit with the NAP process. In addition, the transport working group itself could include certain transport experts that have links to adaptation-related issues. For example, a key agency could be the Meteorology Department, which is key for getting past and current meteorological data to serve as a basis for climate modelling and estimating climate risks for new infrastructure projects. In addition, for the major and medium rivers of the country that need data on the highest flood level of rivers to inform bridge building, the agencies keeping track of this data should also be involved.

NDC ACTION PLAN FOR INDUSTRY SECTOR





4. NDC ACTION PLAN FOR INDUSTRY SECTOR

4.1 INTRODUCTION

In September 2015, Bangladesh submitted its Intended Nationally Determined Contribution (INDC) to the UN Framework Convention on Climate Change (UNFCCC). The INDC describes Bangladesh's plans for tackling greenhouse gas (GHG) emissions and adapting to unavoidable climate change. In the INDC, Bangladesh committed to reduce GHG emissions in the power, industry and transport sectors by 5% below 'business-as-usual' GHG emissions by 2030, or by 15% below 'business-as-usual' GHG emissions by 2030 if sufficient and appropriate support is received from developed countries.

To deliver the overall targets described above, the INDC anticipated that the industry sector would contribute GHG emissions reductions of 4% below 'business-as-usual' by 2030, or by 10% below 'business-as-usual' by 2030, conditional on support from international funding sources to implement climate change mitigation measures. This action plan describes how Bangladesh intends to deliver the GHG emissions reductions in the industry sector, to support the overall targets described above. This action plan covers the period from 2016 to 2019 and from 2020 to 2025 and describes what needs to be done over this timeframe, by whom and by when, to deliver the required GHG emissions reductions in industry. It is envisaged that the action plan will be a 'living' document and will be regularly updated. Recognising that adaptation is the key priority for Bangladesh, the action plan prioritises actions that will deliver both GHG emissions reductions and strengthens the country's resilience to climate change. As well as setting out what needs to be done, the plan also looks at the resource, as well as capacity⁴⁹, needs to implement it, how the activities will be measured and evaluated and how the work will be managed and coordinated. The thematic programme T5P1 of the Bangladesh Climate Change Strategy and Action Plan (BCCAP) also mentions the improvement of energy efficiency in production and consumption of energy. The recently enacted "*National Industrial Policy-2016*" is set to promote environment and climate friendly industrialization and prioritises a number of measures to encourage green industrial development in the country. *The 7 five year plan (2016-2020)* has as its core themes inclusive and sustainable growth that does not encroach on the welfare of the future generation.

The Government of Bangladesh is already taking action to encourage energy efficiency in industry. In 2016 it published the National Industrial Policy, which has as one of its aims to promote and energy efficient industrial sector. In addition, the Energy Efficiency and Conservation (EE&C) Master Plan provides for ongoing energy management programme and energy audit roll-out across industry. This action plan builds on these achievements to set out how Bangladesh will deliver on the commitments set out in its INDC.

4.2 VISION AND SCOPE OF THE PLAN

4.2.1 Vision

As Bangladesh moves towards its target of becoming a middle-income country by 2021, it is expected that industry will continue to grow to meet increasing domestic consumer demand as well as to continue to boost exports to other markets to contribute towards economic growth. Therefore, an imperative for industry in Bangladesh to become more energy and resource efficient to keep costs of energy, as well as raw materials, down and to increase productivity.

As set out in the Energy Efficiency and Conservation Master Plan (EECMP), Bangladesh aims to achieve a reduction in primary energy consumption per GDP for all sectors of 15% and 21% reduction

49. More information on capacity needs for NDC Implementation can be found in the separate analysis paper submitted to the Paris Committee on Capacity Building.

by 2021 and 2030 respectively⁵⁰. It will be important for industries in Bangladesh to play a key role in this as it accounts for about 50% of national primary energy consumption⁵¹ and the potential for improvements is large. Also, the Government of Bangladesh is spending about a significant amount of its national budget on subsidising energy consumption by consumers, including industrial users. More efficient energy consumption means less energy consumption per unit GDP, which in turn will mean less energy consumption per unit of GDP income, less subsidy per unit of Government income and hence more money available for the Government to spend on development.

4.2.2 Scope

The scope of the action plan is **industrial energy efficiency**. It does not cover GHG emissions from industrial processes or fugitive emissions (cement and fertilizer are the two main process-related GHG emitters and the overall emission contribution of these two sectors are gradually coming down⁵² as the Government of Bangladesh is phasing out old fertilizer factories with new ones and the use of limestone for the preparation of clinker are limited to only two cement factories). The industry sector is made up of a number of sub-sectors. The sub-sector that has witnessed highest growth is the ready-made garments sub-sector, with the index of industrial production doubling between 2000 and 2012, with the beverages, pharmaceuticals, construction materials like bricks, textiles and cement sub-sectors also experiencing strong growth⁵³. From a GHG emissions perspective, the biggest sector so far is construction (mainly brick manufacturing), which accounted for 55% of total manufacturing energy-related GHG emissions in 2012⁵⁴. Other significant emitting sectors are textiles and leather (24%) and other non-specified industries (6%).

Whilst this action plan covers all industrial sub-sectors, the focus of efforts will be on the following sub-sectors:

- Textiles and leather (because it covers 24% of GHG emissions from manufacturing sub-sectors)
- Chemicals (because it covers 4% of GHG emissions from manufacturing sub-sectors)
- Brick (because it covers 55% of GHG emissions from manufacturing sub-sectors)
- Cement (because it is a growing sub-sector)
- Food, beverages paper and tobacco (because it covers 3% of GHG emissions from manufacturing sub-sectors and is a growing sub-sector)
- Ready-made garments
- Steel re-rolling mills
- Sanitary ware and insulators factories
- Plastics
- Leather

50. Energy Efficiency and conservation master plan up to 2030

51. Energy Efficiency and conservation master plan up to 2030

52. The Third national GHG inventory accounted process emission and found 62% less process emission from the previous inventory.

53. See page 33 in the Second National Communication - <http://unfccc.int/resource/docs/natc/bgdn2.pdf>

54. As per the assessment of the on-going third national communication

4.3 DELIVERING THE PLAN

4.3.1 Mitigation Measures in the Industry Sector

The industry sector has an unconditional target to reduce GHG emissions by 4% below 'business-as-usual' (BAU) and a conditional target to reduce GHG emissions by 10% below BAU. These figures are based on the proportion of each industrial sub-sector carrying out an energy efficiency audit (based on the timetable set out in the Energy Efficiency and Conservation Master Plan and the modalities set out in the Energy Auditing Regulation document) and an assumed efficiency improvement per sub-sector, based again on figures in the Energy Efficiency and Conservation Master Plan, on expert judgement and on consultation with SREDA and Ministry of Industry.

This action plan does not attempt to prescribe what industry should be doing to improve energy efficiency and reduce its GHG emissions. Instead the Government aims to set the appropriate policy and legislative framework to incentivise industry to tackle its GHG emissions in the way that best works for them. Below, this broad policy and legislative framework is described, with particular reference to the Energy Efficiency and Conservation Master Plan, which sets the direction of travel on the energy efficiency vision of the Government of Bangladesh. Further down in this section, we look at a number of possible options that industry might consider, with a few more detailed case studies showing the potential and costs of such measures.

4.3.1.1 The energy efficiency policy framework

Energy management and audits

Under the Energy Efficiency and Conservation Master Plan, Designated Consumers (DCs) are obliged to “implement energy management at their industrial facilities and comply with the requirement of energy audit reporting to SREDA, in the manner laid out in the energy auditing regulation document”. DCs are large industrial energy consumers and commercial buildings. There are about 100 DCs currently in Bangladesh, expected to increase to 1000 by 2030. The “energy management” they have to implement includes the following:

- a) Establish an energy management system
- b) Appoint an energy manager
- c) Compliance to benchmark (energy intensity target)
- d) Annual EE&C reporting to Government (SREDA)

The report mentioned in (d) above allows assessment against the benchmark values mentioned in (c). Those meeting the benchmark are “awarded by SREDA”, and whilst the benchmark targets are not binding at the moment, the intention of SREDA is to make them mandatory, with penalty systems in the future as per the manner laid out in the energy audit regulation. Energy consumers that are not DCs are also expected to conduct energy management, with a focus on (a) and (b) above.

In 2018, a training programme of certifying energy managers and auditors will be initiated. The forthcoming energy audit regulation is expected to set out those rules and laws.

However, it is recognised that energy audits by themselves will not be enough to drive the energy efficiency improvements needed to meet the GHG targets set out in the NDC. Indeed, the difference between the 4% and 10% unconditional and conditional targets for industry under the NDC is based on the proportion of the audited sub-sector that then goes on to implement energy efficiency measures. This is affected by factors such as capacity and financing to implement energy audit recommendations. For example, under various different donor and government programmes, a number of factories have been audited and many recommendations for implementation came from these audits. However very few initiatives from those audits actually got implemented due to the barriers mentioned above.

Financing energy efficiency measures

Concessional financing is important to help fund uptake of energy efficiency measures and to bridge the time gap before the measures become self-financing. Such concessional financing offer attractive rates of interest and can be repaid through savings from reductions in energy consumption. The Energy Efficiency and Conservation Promotion Loan Programme will promote the adoption of the energy management programme described above as well as helping create new markets in industrial energy efficiency. The first phase will focus on flagship projects, to demonstrate the viability of energy efficiency measures, and the second phase will focus on nationwide roll-out.

To support in the implementation of the first phase, Japan government has already provided 11.988 billion Japanese Yen under the energy efficiency and conservation promotion Financing Project to SREDA to implement 7 to 10 flagship projects. After the trial implementation of those priority projects, SREDA will move forward to extend the scope of concessional financing based on the availability of the funding to support the financing of more energy efficiency measures in the large as well as small scale of industries.

Apart from concessional financing support from SREDA, commercial banks also have a key role here to support financing for energy efficiency measures in industry. It will therefore be important to help the commercial banks to build capacity so that they will be able to complete the due diligence of energy efficiency projects before actual financing. This will help to extend the financing outreach for industrial energy efficiency measures implementation.

In some industrial sub-sectors, concessional financing may not be sufficient to drive energy efficiency activity, and further incentive mechanisms might be needed. SREDA will keep this under review. As explained in the Energy Efficiency and Conservation Master Plan, preferential taxation is another approach to create the right incentives for energy efficiency. In addition, subsidies are offered for distributors of energy efficient technologies, to ensure that industrial operators have access to the best available technology.

Information and awareness-raising

Collection of information by the Government is important to allow a clear understanding of progress and to facilitate sector level Measurement, Reporting and Verification (see Section 4.4 below). SREDA is facilitating this by developing an energy consumption database, with businesses being encouraged to submit data and specifically being required to submit if they are due to receive concessional financing. A dashboard for the chemicals industry has already been developed and it is planned to extend this to other sectors, such as textiles and garments. Doing this will likely require international support. In addition, the Ministry of Industries has plans to create a central data cell for collating information on industrial energy efficiency. An issue with such centralised data hubs is that industry can be reluctant to submit data due to concerns around confidentiality. This may be addressed by drawing up confidentiality agreements with individual industrial installations to clearly articulate what data will be shared and in what format, to what degree of detail etc.

Further it needs to be supported by extensive capacity development activities and linking up with the available soft financing sources under a programmatic energy management approach. Awareness raising is crucially important. In some cases, poor energy management practices are currently observed in industries simply due to a lack of knowledge of the effects and costs to the business of such practices. It is important, the available soft financing sources like Green fund of Bangladesh bank to be extended to these measures and help achieving country's GHG reduction target attaining sustainability in the industrial operation. An energy efficiency schooling programme is raising awareness of different approaches to saving energy. Capacity is not just needed in the industry sector, but also in the financial sector. And the Government is expected to act toward enabling policy and financing framework to provide right support to industries for the implementation of energy efficiency measures.

Other measures

ESCOs: Another important element needed to support the implementation of recommendations stemming from energy audits, is greater use of Energy Service Companies (ESCOs). More information on ESCOs is included in Section 4.3.2 below.

In the EE&C Master Plan, efficient lighting is considered a 'low hanging fruit' option for saving electricity in larger commercial, industrial and residential facilities. Therefore, SREDA's current focus is to promote LED lighting in the ready-made garment industries under the ESCO (Energy Services Company) model. The objective of introducing ESCO is to develop and test a self-sustaining business model in efficient lighting sector, which will eventually be replicated to other industrial sectors.

Green buildings: Whilst not a measure that will improve the energy efficiency of industrial manufacturing processes, industry is able to further reduce overall GHG emissions through greater use of green buildings. SREDA is given the mandate to develop Green building guidelines and to act as an accreditation agency to issue certification to Green Buildings. Currently, they are endorsing the LEED certification system and a number of buildings and textile facilities have achieved the prestigious green building certification from LEED. In addition, preparation of Green Building Guidelines (GBG) is expected to be completed by 2017. GBG will be a voluntary programme that provides recommendations not only on energy/water use efficiency but also on the reduction of environmental impacts caused by building construction, use and decommissioning.

Environmental permitting: Should environmental permitting be introduced to industry in the future then this could provide a further approach to encouraging industry to act on audit findings, by requiring installations to install EE measures.

Others: Government will do its bit in stimulating demand for energy efficiency measures by looking for scope for greater green procurement. By updating procurement policy, priority could be given to energy saving technologies. Whilst the government has no plans to introduce green procurement for the time being, it will consider in future the potential role for green procurement so as to reduce the carbon footprint.

4.3.1.2 Examples of specific mitigation measures in industry

Cross-cutting measures

The energy efficiency improvements in industry will be mostly driven by a number of cross-cutting measures:

- Cogeneration
- Waste heat recovery mainly from captive generators/boilers
- Condensate recovery
- Heat recovery from the Cooling system of Generator
- Implementation of EE measures like leak sealing of steam and air flow systems
- Efficient chillers
- Efficient boilers
- Efficient motors

More information on these measures is included at Appendix 6, and is summarised in the tables below.

Measure	Cogeneration
Description	Description Cogeneration (Combined Heat and Power or CHP) is the simultaneous production of electricity and heat, both of which are used. Cogeneration can offer energy savings ranging between 15-40% when compared against the supply of electricity and heat from conventional power stations and boilers ⁵⁵ .
Resources required	Medium to large scale of upfront investment by the owner of the facility
Complexity	Standard technology and equipment are available in the market
Implementation time-line	Medium to long term possibly by 2030

Measure	Waste heat recovery (mainly from captive generators/boilers)
Description	Waste heat is available in the industrial facilities where electrical power is generated from the reciprocating gas engine based captive power plant. The average efficiency of this type of engine is roughly around 30~35%, which means a good amount of useful energy is being left in the form of exhaust, that has potential for recovery to produce secondary low pressure steam heating up boilers feed water by installing pre-heater and hot water as per requirement for the same industrial facilities with the help of waste heat recovery equipment like waste heat recovery boilers.
Resources required	Small to medium scale of upfront investment by the owner of the facility
Complexity	Standard technology and equipment are available in the market
Implementation time-line	Short to medium term possibly by 2020

Measure	Condensate recovery
Description	Condensate is the hot, treated water produced as steam releases its heat energy. It's a valuable resource that contains around 25% of the useful energy in the original steam. It makes sense to return it to the boiler, instead of dumping it to drain. It may be impractical to return all the condensate to the boiler for various reasons, but in most applications a goal of 75-80% condensate return is reasonable.
Resources required	Small upfront investment by the owner of the facility
Complexity	Can be implemented with modification of existing steam condensate polishing unit/installing steam condensate polishing unit and equipment
Implementation time-line	Short term possibly by six to twelve months

55. http://www.cogeneurope.eu/what-is-cogeneration_19.html

Measure	Heat recovery from the Cooling system of Generator
Description	Useful energy can be recovered to produce hot water for industrial operation or to pre- heat the water of the boilers from the low gradient heat of the cooling system of the captive generators. It has good potential wherever captive power generation systems are in operation.
Resources required	Small to medium scale of upfront investment by the owner of the facility
Complexity	Standard technology and equipment are available in the market
Implementation time-line	Short to medium term possibly by 2020

Measure	Implementation of EE measures like leak sealing of steam and air flow systems
Description	Leaks in steam distribution and air flow systems cause huge amounts of energy being drain-out from the industrial facilities. Proper identification of this leaks and timely repair can ensure a significant energy savings in the industrial facilities.
Resources required	Small upfront investment by the owner of the facility
Complexity	Can be implemented with little modification and equipment support and by using high quality steam traps and sealing materials.
Implementation time-line	Short term possibly by six to twelve months

Measure	Efficient chillers
Description	Chillers with higher coefficient of performance (COP), can ensure optimized delivery of cooling capacities of chiller. In the textile facilities, where it requires huge space cooling, efficient chiller can play an important role in reducing the overall demand of energy for space conditioning.
Resources required	Medium to large scale of upfront investment by the owner of the facility
Complexity	Standard technology and equipment are available in the market
Implementation time-line	Medium to long term possibly by 2030

Measure	Efficient boilers
Description	Boilers having efficiency 90% or higher can be an ideal choice for the industrial owners to effectively address the issue of overall energy reduction in the operation and gain economic benefit.
Resources required	Medium to large scale of upfront investment by the owner of the facility
Complexity	Standard technology and equipment are available in the market
Implementation time-line	Medium to long term possibly by 2030

Measure	Efficient motors
Description	The incremental efficiency difference of the energy efficient motors over the traditional induction motors can ensure significant reduction of demand for electrical energy and ensure economic benefit.
Resources required	Small to medium scale of upfront investment by the owner of the facility
Complexity	Standard technology and equipment are available in the market
Implementation time-line	Short to medium term possibly by 2020

Sector-specific measures

There are also a number of potential measures in specific sectors, in particular those that are the larger GHG emitters:

- Chemicals and fertilisers new energy-efficient plant with advanced technical features of carbon and energy recovery, process safety and process optimization
- Garments-standard energy efficiency improvement measures (e.g. boilers, lighting and natural ventilation etc)
- Textiles-changing to efficient air jet looms and high efficient centrifugal chillers, attaining water and energy efficiencies, introducing less energy and water consuming chemical dyes, rain water harvesting, efficient boilers and motors etc.
- Steel-moving from induction furnaces to electric arc furnaces, scrap pre-heating using furnace waste heat, Combustion control of the furnace
- Cement-moving from traditional rolling mills to vertical rolling mills, and more efficient drive systems with converting traditional wet process to dry process.
- Food & beverage-CO₂ recovery from the exhaust of boilers/captive generators
- Paper-CO₂ recovery from the exhaust of the boilers/generators for the production of filler materials like Calcium Carbonate
- Brick-Mainly tunnel kilns and introduction of non-fired brick-making technology

An important thing to note here is that many of these measures can deliver cost effective GHG emissions, as well as energy, reductions, with costs of installation and operation being more than offset by the reduced energy costs, as indicated by the Marginal Abatement Cost Curve in figure 4.3-1 of the Energy Efficiency and Conservation Master Plan.

4.3.2 Actions required in other sectors

There are a number of actions that will be important in other sectors to help facilitate energy efficiency in industry. For example:

- Decarbonisation of power supply, to make the impact of growth of electricity intensive industry less pronounced. This is particularly important in the case of steel production (which is mainly based on electric furnaces), electricity used in electrolytic processes in the chemicals sector and electricity used in textile sector.

- Development of a supply chain capable of identifying and implementing energy efficiency measures, where on site expertise is missing e.g. energy services companies (ESCOs). An ESCO is a company that offers energy services which may include implementing energy-efficiency projects (and also renewable energy projects) and often on a turn-key (i.e. ready-to-go) basis⁵⁶. Typical ESCO projects have a number of elements, including project financing, procurement and installation of equipment, purchase of fuel and management of the project. It also involves an 'Investment Grade Audit', which unlike a typical energy audit, attempts to more accurately predict a building's future energy use⁵⁷.

A current assessment has revealed the use of light-emitting diode (LED) lighting in lieu of fluorescent lights in garment industry as a key measure that can reduce energy consumption by 50% and expenditure by 30%⁵⁸. In this regard, with the technical support of SREDA and BUET and financial support of a local financial institution IDLC, a Memorandum of Understanding was signed in January 2016 between GIZ, Purbani Group (a local ready-made garments factory), Energy + Electric & Electronics and IDLC Finance Limited, to successfully implement a pilot ESCO project and transform the energy saving potential into reality. As the project's technical partner, Bangladesh University of Engineering and Technology (BUET) conducted an investment grade energy audit to assess the lighting demands of the project's partner Karim Textile of Purbani Group. This project is currently in the implementation phase and the success of this project should pave the way for more commercial ESCO ventures in other potential areas of industries in Bangladesh.

4.3.3 Barriers and challenges

Whilst there is a clear imperative for reducing energy consumption in industry, there are also certain barriers to realise those will need to be addressed. These include:

- Low energy prices due to energy subsidies, meaning that there is less incentive for industry to make efficiency improvements. Subsidised energy means that the cost avoided by saving energy is lower than it otherwise would be. This will tend to increase the payback of energy efficiency investments to the point that they may look unattractive relative to other uses of investment capital. This may be especially pertinent regarding investments that would reduce the use of natural gas in industry, as it is understood that gas is particularly highly subsidised in Bangladesh. The clear way to address this barrier is to consider a phasing out of these subsidies.
- Lack of expertise for identifying energy saving opportunities. For example, it was found in work on the NAMA relating to waste heat recovery that there is little understanding of boiler efficiency to the point that “most of the boilers in the country are not tuned properly”. This can be addressed by the plan set out in the EECMP whereby SREDA and related governmental organisations establish an EE&C focusing committee in each industrial sector.
- Lack of expertise for implementing energy saving opportunities. Overcoming this barrier will be assisted by SREDA's planned activities, as set out in the EECMP and also by fostering the development of energy services companies whose business it is to identify and implement energy efficiency opportunities.
- Lack of capital for investment. This may be a lack of capital in absolute terms, or in relative terms because other investment opportunities have a more attractive return associated with them and

56. <http://iet.jrc.ec.europa.eu/energyefficiency/esco>

57. <http://iet.jrc.ec.europa.eu/energyefficiency/esco>

58. Renewable energy and energy efficiency programme of SED, GIZ

therefore, attract the investment capital. Both of these may be alleviated by the availability of loans at low or zero interest rates for projects specifically to improve energy efficiency. Moreover, preferential taxation on purchases of high efficiency equipment, such as an enhanced tax free allowance on such investments, can produce a very significant increase in cash flow in the year of implementation. Low interest loans and preferential taxation vehicles are stated parts of the EE&C Finance Incentive Programme under the EECMP.

- Under-developed local supply chain (e.g. lack of companies able to supply turn-key energy efficiency solutions such as combined heat and power, efficient furnace design and implementation etc.).
- Competing priorities for investment, such as expanding production capacity instead of making existing capacity more efficient. In so far as the payback period is shortened by them, low or zero interest rate loans would tend to improve the attractiveness of energy efficiency projects over competing projects. The same would be true of projects with enhanced tax allowances.
- Lack of concessionary/soft financing to motivate industrial entrepreneurs to implement capital intensive EE measures identified in the energy audit.
- Lack of awareness amongst the industrial payers regarding modern EE technologies and their near term pay-off.

4.4 MEASUREMENT, REPORTING AND VERIFICATION (MRV)

A key aspect of this action plan will be to understand what is happening to GHG emissions and energy efficiency in the sector and whether measures that are being introduced to encourage energy efficiency are being successful or not. This is done through measurement, reporting and verification. It is suggested that a set of indicators be used to assess progress in improving energy efficiency and reducing GHG emissions in the industry sector. These should follow two broad principles:

- Measuring energy consumption in primary energy. This way, improvements in the efficiency of generation of final energy consumed within industry (i.e. heat and power) is not excluded from the measurement (as would be the case if it was measured in delivered energy terms). CHP is an example of improving the efficiency of generation of consumed energy, and may be an important abatement opportunity.
- Identifying an appropriate activity that can be used to check that changes in energy consumption are due to actual changes in efficiency and not something else (such as changing levels of production). Ideally, the measure of activity chosen should correlate well with energy consumption. This would allow a meaningful specific energy consumption to be determined. This would allow a meaningful specific energy consumption to be determined.
- Taking steps to check that changes in energy consumption are due to actual changes in energy efficiency and not changing product mix. The apparent energy efficiency performance of an installation can improve or deteriorate for reasons of changing mix of product produced, rather than inherent changes in the efficiency with which energy is consumed. Some installations may produce a range of products with inherently different energy intensities of manufacture. For the same level of energy efficiency, if the more energy intensive products are produced in greater relative quantities than a reference period, then the installation may look as if it has deteriorated in energy efficiency terms, when in fact it has performance at the same level. Some installations make a large amount of

one commodity product, such as cement clinker or urea fertiliser, using the same energy consuming processes. In such cases, a simple measure of specific energy consumption would suffice for tracking changes in energy efficiency. However, in other sectors there may be a wider range of product outputs from the installation, with different inherent energy intensities of production, and the relative proportions of production of these products is susceptible to change over time. Such situations are likely to exist in the more downstream Chemical and Textile industries. In such cases, to derive a meaningful trend in energy efficiency performance, it will be necessary to track the levels of production of individual products (or product groups), defined to reflect their different inherent energy intensities of production. In this way a reference energy consumption for a period of time in the past, against which it is desired to measure current performance, that reflects the current mix of product output, can be established. This would allow a more meaningful trend of energy efficiency performance to be established. This approach is used in the UK's Climate Change Agreements (CCAs), and is used to track performance in those sectors with diverse and changing product mix outputs, most notably the Chemicals sector.

It is proposed that SREDA acts as a central coordinator for MRV of the industry sector, and in this role it should propose specific indicators, agree these with stakeholders, develop guidance on methodologies etc. They should liaise closely with MoI and with the Ministry of Environment, Forest and Climate Change, climate change team. SREDA will need to establish which organisations hold the data that is needed and set up agreements with them (e.g. a memorandum of understanding or any suitable contract) for this data to be shared on a regular basis.

Much of the data that is needed to report on the indicators above is expected to be held and regularly updated by the Bangladesh Bureau of Statistics. This would include numbers of industrial units, production levels by sub-sector and by type of unit, structure of key sub-sectors (e.g. jute, textiles etc.) and gross value added of key industries and industrial growth rates.

The Government, led by SREDA, will carry out a review in 2017 and 2018 of additional data needed to track progress, including co-benefits, to consider how data for such indicators might be gathered, based on the mitigation measures outlined in Section 4.3.1.

4.5 ADAPTATION

Bangladesh is a highly climate vulnerable country, and as such, adaptation and strengthening climate resilience is a key priority. As explained in the NDC, Bangladesh is already experiencing a host of climate impacts, including floods, storm surges, drought and river bank erosion. Furthermore, climate change will drastically hamper economic growth of the country. The Asian Development Bank estimated that Bangladesh may experience a 2% GDP annual loss by 2050 because of climate change⁵⁹.

Bangladesh's approach to adaptation and climate resilience is being developed through the National Adaptation Plan (NAP) process, which is currently ongoing. In addition, the 2009 Bangladesh Climate Change Strategy and Action Plan (BCCSAP, 2009) recognises that strengthening climate resilience is a top priority for the country. However it does not go into detail on how specific sectors are affected by climate change, nor what those sectors can do to strengthen climate resilience, both in those sectors and more widely. Currently BCCSAP is being updated by Ministry of Environment, Forest and Climate Change with the support of GIZ.

59. http://www4.unfccc.int/ndcregistry/PublishedDocuments/Bangladesh%20First/INDC_2015_of_Bangladesh.pdf

There are a number of ways that the industrial sector can be directly affected by climate change impacts:

- Impact on the availability of resources (e.g. water).
- Salinity intrusion especially in the coastal industrial areas.
- Impact of climate change on the management of industrial process. For example, certain elements or characteristics of the process may be sensitive to the climate in general and to climate change in particular⁶⁰.
- Incidence of serious climate incidents, such as floods, storms, river bank erosion causing damage to the physical infrastructure of industrial facilities as well as their communication infrastructure (mainly roads).

The industry sector in Bangladesh should look to minimise the future impacts of climate change on their processes by taking climate risks systematically into account in planning and decision-making processes, including at an early stage of site selection, site development⁶¹ and selection of process for the industry. Through the NAP process, Bangladesh will look to develop the appropriate information, guidance and risk analysis tools to help the industry sector do this. The Government will also consider scope for training for industrial developers and planners on how to factor in climate risks into the siting and development of industrial processes.

Industry can also play a role in strengthening climate resilience. This is recognised in the UN's Sustainable Development Goals, and in particular SDG 9: "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation". A first key step will be to better understand the specific vulnerability of the industrial sector to climate change, and as such a detailed vulnerability assessment of the whole value chain for key industrial sub-sectors is recommended.

Further work will be needed, in the context of the NAP process, to evaluate what actions industry can take to strengthen its resilience to climate change. It is suggested that a workshop is convened in 2017 to bring together key representatives of the industry sector to further discuss options for improving climate resilience in industry.

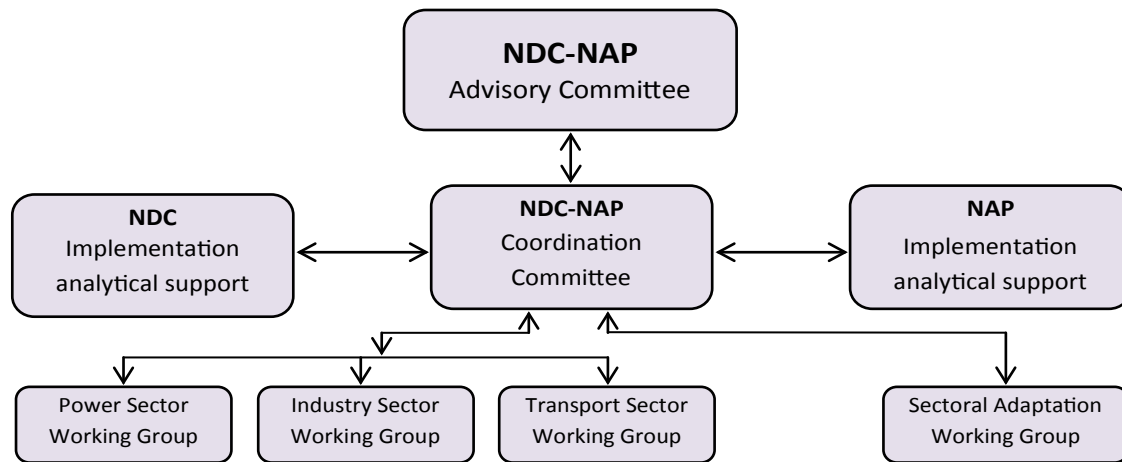
4.6 GOVERNANCE AND COORDINATION

The governance arrangements for driving forward and coordinating NDC implementation are set out in the NDC Implementation Roadmap. As explained in the NDC Implementation Roadmap, the aim is to include and integrate NAP implementation side by side with NDC implementation under one single framework, as shown in figure 7 below. It is important that the key agencies like the Ministry of Industry and SREDA develop their technical, financial and other relevant capacities to roll-out the NDC vision in the industrial sectors. Details on the capacity requirements of these agencies are provided in the analysis paper on capacity building.

60. <http://www.iddri.org/Publications/Adaptation-to-climate-change-and-industrial-vulnerability>

61. <https://www.giz.de/en/worldwide/30543.html>

Figure 7: Governance arrangements for NDC implementation



The Ministry of Industries will act as the overall coordinator for implementation of the NDC sectoral mitigation action plan for industry, working in close partnership with the Sustainable and Renewable Energy Development Authority due to their key role in energy efficiency in industry. In this process, the Ministry of Industries will liaise with all the relevant industrial association like FBCCI, DCCI, MCCI and all the sectoral associations in sectors such as steel, textile, garments, bricks etc. in order to extend its reach in the targeted industries and sensitize them in implementing energy-efficient measures. In its role, the Ministry of Industries is primarily responsible for developing new policies and strategies for promotion, expansion and sustainable development of the industrial sector in Bangladesh. It has a role as facilitator with industry, with the aim of creating increased industrial activity in the country and to support industry's role as a key driver of economic growth and employment. In order to provide necessary analytical assistances to the NDC-NAP coordination committee, the analytical team should be formed with the relevant officials, qualified experts, practitioners and academia having necessary skills and knowledge in related fields.

In the context of NDC implementation, the Ministry of Industries' role will be to:

- Chair the NDC Implementation Industry Sector Working Group.
- Coordinate the policy response for the industry sector, working with all relevant industry sector stakeholders as appropriate.
- Track progress at the sector level towards the 4% unconditional and 10% conditional targets for the industry sector and publishing reports detailing this progress. Putting in place data sharing agreements as necessary to collect data to support this tracking of progress.
- Monitoring implementation of the NDC in relation to the industry sector, and reporting to the NDC implementation coordination committee on industry sector NDC implementation issues and progress.
- Liaising with the NDC Implementation Coordination Team in MoEFCC to agree analytical needs on NDC implementation.
- Suggesting ways and means to improve implementation.
- Ensuring adequate capacity development for smooth NDC implementation.

The NDC Implementation Industry Sector Working Group will discuss sector-related issues, including discussions on mitigation measures, agreement on recommendations to make to the NDC Implementation Advisory Committee and tracking progress. The members of the Working Group will include the following organisations. However, it is expected that this would be kept under review and others could also be added later if it is felt appropriate.

- The Ministry of Industries, as chair of the Industry Sector Working Group and lead coordinator for the industry sector in relation to NDC implementation.
- The Sustainable and Renewable Energy Development Authority (SREDA), for their lead role on industrial energy efficiency and for implementation of the Energy Efficiency and Conservation Master Plan. Whilst the Ministry of Industries will be the lead organisation on NDC implementation for the industry sector, in practice SREDA will also effectively act as a co- partner in this role.
- Ministry of Environment, Forest and Climate Change, including Department of Environment, for the link to wider NDC implementation and for assistance in accessing climate financing.
- Ministry of Finance, and in particular the Economic Relations Division, for assistance in accessing climate financing and for general policy support.
- Bangladesh Bank in particular for their fund channelling and financial policy related roles.
- The Infrastructure Development Company Limited (IDCOL).
- National Board of Revenue, to provide support in considering reduction of import barriers.
- Ministry of Commerce, for the link to the private sector and also for support in considering reduction of import barriers.
- Ministry of Textiles and Jute, for links to the Textiles and Jute sector.
- Bangladesh Chemical Industries Corporation, for links to the chemicals sector.
- Industrial Trade Associations, who's input could be primarily coordinated by Federation of Bangladesh Chambers of Commerce, but specific trade associations could also be involved in the working group, such as:
 - Dhaka Chamber of Commerce and Industry
 - Metropolitan Chamber of Commerce and Industry
 - National Association of Small and Cottage Industries of Bangladesh and Bangladesh Small & Cottage Industries Corporation-they will play a key role in reaching out to Bangladesh's numerous small enterprises that are not covered by the Energy Efficiency and Conservation Master Plan (which focuses on bigger industrial energy users).
 - Bangladesh Steel and Engineering Corporation
 - Bangladesh Chemical Industries Corporation
 - Bangladesh Sugar and Food Industries Corporation

The working group's role will be to discuss and agree industry sector activities and to ensure (a) an appropriate balance of mitigation activities and (b) that NDC implementation in the industry sector properly reflects wider important considerations for Bangladesh in relation to the industry sector (for example, improvements in productivity, contribution to GDP growth etc).

The Ministry of Industries will represent the NDC Implementation for Industry Sector Working Group on the NDC Implementation Coordination Committee, alongside the Sustainable and Renewable Energy Development Authority. Through this Committee, the delivery of the NDC Sectoral Mitigation Action Plan for Industry will be coordinated with mitigation activity in other sectors.

The Ministry of Industry will also be responsible for coordinating stakeholder engagement on industry sector issues, such as running open consultations on policy proposals, organising NDC implementation workshops for the industry sector and responding to specific queries regarding NDC implementation in the industry sector. They will also liaise with MoEFCC in relation to wider NDC implementation stakeholder engagement (that will be coordinated by MoEFCC) and contributing from an industry sector perspective to wider stakeholder engagement exercises.

As adaptation is a key element of the NDC and of this sectoral action plan for industry, it is suggested that the industry sector working group will also look at adaptation issues that relate to the industry sector. The working group is therefore likely to need some technical input on adaptation and climate resilience-related issues. The Industry Working Group is expected to call on the Adaptation Working Group to provide support and possibly even to carry out studies on behalf of the Industry Working Group to help develop adaptation policy for the industry sector. As outlined in the overarching NDC Implementation Roadmap, depending on what institutional arrangements are agreed for the National Adaptation Plan process, these NDC implementation governance arrangements may be amended to fit with the NAP process.

APPENDICES

Appendix 1: Summary of activities for implementing the NDC

Appendix 2: Major sectoral impacts, vulnerability and adaptation to climate change and Adaptation action past and present

Appendix 3: Activities for implementing the power sector mitigation action plan

Appendix 4: Activities for implementing the transport sector mitigation action plan

Appendix 5: Activities for implementing the industry sector mitigation action plan

Appendix 6: More detail on cross-cutting mitigation measures in industry

Appendix 7: Bangladesh's Intended Nationally Determined Contributions

Appendix 1: Summary of activities for implementing the NDC

<i>Activity</i>	<i>Responsibility</i>	<i>Timeline</i>	<i>Indicative cost / resource needs</i>
Governance			
<i>Draft detailed terms of reference for the NDC Implementation Advisory and Technical Committees</i>	<i>MoEFCC, DoE</i>	<i>Immediate</i>	<i>Minimal</i>
<i>Write to proposed members of NDC Implementation Advisory and Technical Committees, inviting them to join</i>	<i>MoEFCC, DoE</i>	<i>Immediate</i>	<i>Minimal</i>
<i>Draft detailed terms of reference for the NDC implementation analytical support</i>	<i>DoE</i>	<i>Immediate</i>	<i>Minimal</i>
<i>Arrange NDC Implementation Stakeholder engagement workshop, to socialise the roadmap and NDC implementation more widely</i>	<i>DoE</i>	<i>Immediate</i>	<i>Est. 250,000 BDT</i>
Capacity building			
<i>Develop system of electronic data archiving for mitigation-related data</i>	<i>DoE</i>	<i>By June 2018</i>	<i>TBD</i>
<i>Seek international support for comprehensive data review of mitigation data in power, industry and transport</i>	<i>MoEFCC</i>	<i>Continuous</i>	<i>Minimal</i>
<i>Draft terms of reference for comprehensive data review</i>	<i>DoE</i>	<i>Immediate</i>	<i>Minimal</i>
<i>Launch tender for comprehensive data review</i>	<i>DoE</i>	<i>Immediate</i>	<i>Minimal/Some staff time</i>
<i>Seek international support for capacity building on mitigation modeling</i>	<i>MoEFCC</i>	<i>Immediate</i>	<i>Minimal</i>
<i>Draft terms of reference for capacity building on mitigation modelling</i>	<i>DoE</i>	<i>Immediate</i>	<i>Minimal/Some Staff time</i>
<i>Launch tender for capacity building on mitigation modeling</i>	<i>DoE</i>	<i>Immediate</i>	<i>Minimal/Some Staff time</i>
<i>Consider options for international sharing of best practice on policy design</i>	<i>MoEFCC</i>	<i>By 2018</i>	<i>TBD</i>
<i>White report on possible impact assessment approach for GoB</i>	<i>MoEFCC</i>	<i>December 2018</i>	<i>TBD</i>

Activity	Responsibility	Timeline	Indicative cost / resource needs
NDC updating			
<i>Decision on priority sectors for consideration of inclusion in NDC coordinated by DoE</i>	<i>NDC Implementation Advisory Committee Coordinate by DoE</i>	<i>TBD</i>	<i>Minimal</i>
<i>Assessment of abatement potential of selected sectors</i>		<i>TBD</i>	<i>Est 20m BDT</i>
Finance			
<i>Set up institutional arrangements on climate finance</i>	<i>ERD, working with DoE</i>	<i>Immediate</i>	<i>Minimal</i>
<i>Development of more accurate costings for mitigation measures</i>	<i>ERD</i>	<i>Immediate</i>	<i>Est 15m BDT</i>
<i>Detailed review of funding options</i>	<i>ERD</i>	<i>Immediate</i>	<i>Minimal</i>
<i>Drafting of detailed Climate Investment Plan</i>	<i>ERD</i>	<i>By 2018</i>	<i>Est 20m BDT</i>
<i>Gap analysis of current finance tracking systems and institutions</i>	<i>ERD</i>	<i>By 2018</i>	<i>Minimal</i>
<i>Develop central tracking system for climate finance, with standard methodologies</i>	<i>ERD</i>	<i>By 2018</i>	<i>Minimal</i>
MRV			
<i>Agree MRV institutional arrangements for the MRV systems</i>	<i>MoEFCC, DoE</i>	<i>Immediate</i>	<i>Minimal</i>
<i>Stocktaking of current monitoring and reporting processes to consider what can be used for MRV of NDC implementation</i>	<i>DoE</i>	<i>By 2018</i>	<i>TBD</i>
<i>Agree MRV institutional arrangements for the power, transport and industry sectors (see sectoral action plans for more detail)</i>	<i>DoE, working with SREDA, Road and Highways Division and Ministry of Industry</i>	<i>Immediate</i>	<i>Minimal</i>
<i>Agree MRV institutional arrangements for the power, transport and industry sectors (see sectoral action plans for more detail)</i>	<i>DoE, working with SREDA, Road and Highways Division and Ministry of Industry</i>	<i>Immediate</i>	<i>Minimal</i>
<i>Agree final list of indicators for MRV of power, transport and industry sectors</i>	<i>DoE, working with SREDA, Road and Highways Division and Ministry of Industry</i>	<i>Immediate</i>	<i>Some staff time</i>
<i>Produce step-wise plan for GHG inventory improvement</i>	<i>DoE</i>	<i>By 2018</i>	<i>TBD – est. USD 80,000</i>
<i>Ongoing GHG Inventory improvement</i>	<i>DoE</i>	<i>By 2018</i>	<i>TBD</i>
<i>Initial assessment of options for GHG projections for Bangladesh</i>	<i>DoE</i>	<i>Immediate</i>	<i>TBD</i>

Appendix- 2: Major sectoral impacts, vulnerability and adaptation to climate change and Adaptation actions past and present

A. Major sectoral impacts, vulnerability and adaptation to climate change

This section of the roadmap considers a number of sectors that are highly vulnerable to climate change impacts and needs considerable intervention to increase its resilience. The section first runs through these sectors to assess how they are impacted by climate change. It then considers previous action on adaptation, possible future actions and likely costs.

A.1 Agriculture and food security

Based on socioeconomic projections, geographical location and future hazards, Yohe et al. (2006) concluded that Bangladesh will be extremely vulnerable to climate change under all scenarios, including a scenario combining mitigation and enhanced national adaptive capacity. Although in the last four decades, the agriculture sector has made very significant progress in crop production and food insecurity management through interventions (agriculture and fiscal) in the risk prone areas, these gains could be threatened with changes in climate. Some of the causes for concern in the agriculture sector are as follows:

- Temporal and spatial distributional changes of water resource can harm the agriculture sector.
- Significant changes in land classes that are widely used for crop production.
- Global mean temperature increase and the increased frequency and/or severity of extreme weather events can increase agricultural sector losses.
- Sea level rise and intrusion of salinity can increase loss of agricultural lands and food insecurity in the coastal regions.

A.2 Water security in Bangladesh

The water sector in Bangladesh is one of the most vulnerable to the changes in climatic parameters. The key climate change vulnerabilities for the water resource sector in Bangladesh are:

- Melting glaciers in the Himalayas is a concern for Bangladesh's sustained water supply, especially during the dry season. Due to high variability of seasonal water supplies, dry season water is vital for supporting ecosystems, agriculture and fisheries and water navigation. The IPCC (2014)⁶² projected 45% and 68% Himalayan glacier loss by 2100 under RCP4.5 and RCP 8.5 scenario⁶³, respectively. However, due to melting, in the first few decades, water supplies will increase but later it will decrease due to shrinkage of the glaciers.
- Rate of evaporation from the soil, open water and plants would increase due to rises in temperature. Therefore, soil storage would capture the larger amount of infiltrated water. This would result in reduction in deep percolation to shallow aquifers as the upper limit of infiltration is limited by soil type. As a result, groundwater recharge is likely to be reduced (Farquharson et al., 2007).
- Future rates of sea-level rise are expected to increase coastal flooding, erosion, and saltwater intrusion into surface and ground waters (IPCC, 2013).

62. https://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full_wcover.pdf

63. The Representative Concentration Pathways (RCPs), describe four different 21st century pathways of GHG emissions and atmospheric concentrations, air pollutant emissions and land use.

- Recent study, “Assessment of Sea Level Rise on Bangladesh Coast through Trend Analysis” (DoE, 2016) found that the overall trend in the coastal zone during the last 30 years has been 6- 21 mm/year. The study further reveals that sea level has risen at a higher rate than in the past, thus consolidating the notion of rising sea level (DoE, 2016).
- Increased temperature and higher rates of soil moisture loss could lead to longer and high impact droughts in the country.

A.3 Health

A changing climate impacts the health and well-being but it can be difficult to determine the degree of complexity, scale and directness. Consequently, as a function of vulnerability of the local population i.e. rural areas of Bangladesh and geography and environment, the impacts would also vary (Michael, 2003). Due to important interactions with ecological and social processes, it would be difficult to determine the contribution of environmental and biological influences of climate change on health (Githeko and Woodward, 2003). The changes in exposure to heat waves, winter cold, increases in floods, cyclones, storm surges, droughts, increased productions of air pollutants and aeroallergens like spores and molds are all considered to have more direct impacts on health in Bangladesh in terms of lives lost, injuries, and disease outbreaks (Michael, 2003). More than 12.4% of the domestic heads of Sundarbans community, which are particularly vulnerable to climate change, have suffered from illness and 28.5% of the same category has fallen into accidents due to these natural calamities (Masum, 2012). World Bank (2014) concludes, “According to data collected by the European Detailed Mortality Database, between 1980 and 2010, Bangladesh experienced 234 natural disasters, causing more than US\$17 billion in total damage. The total number of people killed as a result of natural disasters between 1980 and 2010 was about 191,836; on average, 6,188 people are killed each year⁶⁴ (World Bank, 2014, p.18-19).

A.4 Fisheries

Fish physiology i.e. growth, reproduction, metabolism etc are directly influenced by changing temperature (Chowdhury et. al.2010). Temperature extremes and erratic rainfall have direct impact on fish physiology, growth, mortality, reproductive system, feeding behaviour, production and migration in inland and marine waters. High temperatures may induce growth of aquatic microphytes. Higher production of microphytes can reduce productivity of water, and causes habitat degradation and oxygen depletion. Indirect impacts of climate change on fish are the changes and effect on the fish habitat/ecology on which fishes depend for food and shelter (Mustafa, 2010). High/extreme temperature may affect physical and chemical parameters of water affecting fish physiology, migration, growth, reproduction etc. Temperature rise may affect distribution patterns of some marine fishes and they may migrate to higher latitudes for cooler water (Chowdhury, 2010). Increase of environmental temperature activates physiological activity of fish demanding more oxygen and ultimately depleting dissolved oxygen in water which hampers growth and the reproduction system of fish. Due to high temperatures and erratic/insufficient rainfall, fish do not ovulate properly and eggs are not fertilized properly and hatching rates become low. This would ultimately result in lower fish stocks, which would impact on livelihoods and on the fishing industry.

64. Please note that natural disasters can be directly or indirectly caused by climate change and vulnerabilities pertaining to both need to be addressed through appropriate channels.

A.5 Livestock

The change of climate has both direct and indirect impacts on livestock. Global climate change is expected to alter temperature, precipitation, atmospheric carbon dioxide levels and water availability in ways that will affect the productivity of crop and livestock systems (Hatfield et al., 2008). Sea level rise will inundate new coastal areas, which will affect livestock by reducing grazing areas and fodder production. Like human beings, livestock and poultry may suffer due to natural disasters, higher temperatures, salinity intrusions and floods. As compared to other sectors, there are very few economic analyses done on the climatic effects on the livestock sector worldwide. The most important impacts of climate change in the livestock sector are reduced grazing areas, fodder crisis, reduced growth and decrease in production of milk, meat and eggs. In 2007 cyclone SIDR hit 17 districts in the coastal region of Bangladesh. The cyclone's surge was over 5 meters. There was enormous loss to livestock due to that catastrophe. The preliminary damage and loss assessment for crops, livestock, and fisheries is estimated to be BDT 30.2 billion (US\$ 437.6 million), of which BDT 1.5 billion (US\$ 21.3 million) is damage to assets and BDT 28.7 billion (US\$ 416.3 million) is production loss⁶⁵.

A.6 Livelihood

The five categories of livelihood assets/capitals - natural, physical, financial, human and social – are adversely affected by different climatic events. For example, flood, cyclones, tidal surge, river erosion, drought etc. can cause damage to:

- Infrastructure, housing (physical capital);
- Land, crop, forest, fresh water (natural capital);
- Wage and income (financial capital);
- Sickness and school dropout (human capital); and
- Forced migration, disintegration of family structures (social capital).

Sea level rise, cyclones and salinity cause land loss, land degradation, contamination of water etc. forcing millions to leave their habitat. River erosion is a serious threat to the population living near the banks of major rivers who may become shelter less, landless and may lose all their livelihood assets. Most of the victims of river erosion become internally displaced people. Having lost all livelihood assets they fall into the trap of perpetual poverty.

A.7 Forest, biodiversity and ecosystems

Increases in temperature, precipitation, salinity and extreme weather events such as floods, cyclones and droughts of a tropical country like Bangladesh will create negative impact on forests (MOEFCC, 2016; IPCC, 2001). According to a projection, by 2050 the Sundarbans will be permanently inundated due to rise in sea levels. As a result, the swamped vegetation will gradually die and the rotting vegetable will give rise to release of more detritus, which will primarily boost up the aquatic population; all the terrestrial fauna in this mangrove forest will possibly move towards the North and then disappear, meaning that the composition of aquatic fauna is likely to alter. Inundation is one of the resultant effects of the rise in sea level, which will lead to death of species that do not thrive under higher inundation. This will result in the loss of habitat of fauna and elimination of water holes which supply water for forest wildlife and in turn, the number of tigers will also decline due to shortage of prey in the jungle. This mangrove ecosystem is likely to experience higher salinity due to sea water flow inside the forest and the low salinity zone or fresh

65. See pages 43-46 of the report prepared by the Government of Bangladesh on Cyclone Sidr – http://reliefweb.int/sites/reliefweb.int/files/resources/F2FDFF067EF49C8DC12574DC00455142-Full_Report.pdf

water zone of the northern part of the Sundarbans will possibly get obliterated by endangering the ecosystem. The decrease in the quantity of Sundri trees (*Heritiera fomes*) is one of the consequences of the presence of the saline water in mangrove forests.

Along with global sea level rise, the continuous natural subsidence in the Sundarbans is causing a net rise of 2.2 mm per year in sea level in these areas⁶⁶. The IPCC is forecasting that the droughts and floods will get worse, which will eventually submerge the Sundarbans. They also believe that 75% of Sundarbans mangroves will be destroyed due to rise in sea level combined with the other forms of anthropogenic stress on Sundarbans. The supporting services of the Sundarbans include acting as a habitat for plants and animals, pollination, nutrient cycling, and acting as a nursery ground for fisheries and wildlife. These changes in the supporting services will have visible effects on the provisioning services of Sundarbans, such as timber, fuel wood, fish, thatching materials, honey and waxes.

B. Adaptation actions past and present

Over the last three decades, the Government of Bangladesh has invested over \$10 billion (at constant 2007 prices) to make the country more climate resilient and less vulnerable to natural disasters. Flood management embankments, coastal polders and cyclone shelters have been built, and important lessons learnt on how to implement such projects successfully in the dynamic hydrological conditions of Bangladesh and with active participation of communities. Bangladesh submitted the National Adaptation Programme of Action (NAPA) in 2005 (revised in 2009) and prepared the Bangladesh Climate Change Strategy and Action Plan in 2009. To enhance climate change adaptation activities in all key policies and sectors, Bangladesh established the Bangladesh Climate Change Trust Fund (BCCTF) from the Government's own budget.

The CCT under MoEFCC has undertaken 441 adaptation and mitigation projects with support from the BCCTF. Of the total, 378 projects were/are being implemented by government organizations. Non-Governmental Organisations/Civil Society Organisations through Palli Karma-Sahayak Foundation (PKSF) implemented the remaining 63 projects. Over the last 7 years, the major adaptation investments were on infrastructure development, especially construction/ reconstruction of the polders/embankments, afforestation, river dredging to ensure water flow in the rivers, drainage infrastructure in urban areas, climate resilient housing for vulnerable communities, water supply and sanitation and climate resilient agriculture. Bangladesh Water Development (BWDB) under the Ministry of Water Resources (MoWR) received the highest resources from BCCTF for construction and reconstruction of embankments/polders and water infrastructure under the Comprehensive Disaster Management and Infrastructure thematic pillar of the BCCSAP. The Local Government and Engineering Department (LGED) and Department of Public Health and Engineering (DPHE) implemented a number of adaptation projects related to drainage system and water supply and sanitation services. Department of Environment (DoE) took the lead on mitigation and some adaptation projects. Department of Forests (DoF) was awarded the afforestation/reforestation projects besides the coast, urban areas and other places e.g. parks. The Department of Agriculture Extension (DAE), Bangladesh Agriculture Development Corporation (BADC), Bangladesh Rice Research Institute (BRRI) and Bangladesh Institute of Nuclear Agricultural (BINA) implemented projects on agricultural related issues. Bangladesh Rice Research Institute (BRRI) and Bangladesh Institute of Nuclear Agriculture (BINA) initiated research on climate resilient varieties. Since 2010, a number of climate tolerant varieties have been invented by the above- mentioned research organizations.

66. <http://www.sciencedirect.com/science/article/pii/S0921818113002191>

In Bangladesh, disaster risk reduction and climate change adaptation in some cases is now an integral part of national development strategy. New legal and institutional frameworks for disaster risk reduction and climate change adaptation have been established. Disaster and climate change sensitive sectoral development strategies, norms and standards (e.g. urban development, water management, natural resource management, and infrastructure) have also been adopted. Social safety net programs have been strengthened for building resilience to cope with disasters and anticipated climate impacts in Bangladesh. Cooperation and collaboration in disaster risk reduction and climate change adaptation have been strengthened at some level among government and non-government actors in the areas of land-use planning, city emergency management, early warning message dissemination, community based disaster preparedness, etc. Post-disaster needs assessments are undertaken in the aftermath of a disaster to accelerate resilient recovery (CDMP, 2013). The Ministry of Food and Disaster Management (MoFDM), as the ministry primarily responsible to serve the country in addressing disaster risk reduction, has implemented the Comprehensive Disaster Management Programme (CDMP) to address capacity building and mainstreaming as key areas of support toward making the country and its development resilient. In line with this, an initiative has been taken to develop mechanisms to mainstream DRR and CCA into development planning and processes. As part of this, a “Guide to Practice” has been drafted to facilitate the operation of the integration process into ministries, agencies and departments (MoFDM, 2009). The following activities have been identified by this process as immediate actions.

- Understanding disaster and climate risks;
- Contextualizing risks in relation to sectors and concerned agencies/departments;
- Exploring the range of disaster and climate risk reduction options in relation to mandated goals and targets, including enhanced synergy between climate change adaptation (CCA) and disaster risk reduction (DRR)
- Identifying priorities, needs, gaps, cross- and inter-sectoral linkages;
- Planning to address these priorities, needs, gaps, cross- and inter-sectoral concerns;
- Mobilizing resources: internal and external; and
- Reviewing and monitoring disaster and climate resilient activities, programmes and projects and feedback to mainstream processes.

B.1 Potential adaptation actions

Potential adaptation measures, regarding different sectors that affect human lives and livelihoods, such as water, agriculture, health, and infrastructure, have been formulated and taken from various documents including the Third National Communication and the Bangladesh Climate Change Strategy and Action Plan. These adaptation measures are further classified as engineering or non-engineering based on their nature and technicalities.

B.2 Cost of adaptation

Significant investments will be required to address climate impacts, including developing early warning systems for floods and cyclones, improved irrigation and water management, improved operation and maintenance and upgrading of coastal embankments and polders and upgrading of flood protection embankments/drainage systems. A comprehensive adaptation cost estimates for all related sectors is yet to be prepared in Bangladesh. The World Bank in 2010 estimated that by 2050, the investment costs of tropical cyclones and storm surges alone will be USD 5.5 billion and the annual recurrent cost will be USD

1.1 billion, whereas for inland monsoon flooding the investment cost will be \$2.7 billion and the annual recurrent cost will be USD 54 million⁶⁷. The cost of climate related diseases and conditions, like Diarrhoea, Kalazar, Filariasis, Dengue/Malaria, Chikun gunya and chronic obstructive pulmonary diseases, would cost around USD 4.01 billion for the 15-year period (2015-2030) which is equivalent to USD 272.1 million per annum. Bangladesh has already implemented some key adaptation activities based on urgent and immediate needs of the country. Implementation of identified adaptation measures is critical to increase the resilience of the country to climate change. In the submitted INDC it was estimated that Bangladesh will need USD 42 billion from 2015 to 2030 to implement the identified adaptation measures to address adverse impacts of climate change from tropical cyclones, monsoon flooding and climate related diseases. Bangladesh will seek to access monetary support from the Green Climate Fund (GCF), Adaptation Fund (AF), Least Developed Countries Fund (LDCF) and other relevant international financing windows to support the implementation of the major adaptation measures in the country.

67. See page 61 of the Economics of Adaptation to Climate Change Synthesis Report at <http://documents.worldbank.org/curated/en/646291468171244256/pdf/702670ESW0P10800EACCSynthesisReport.pdf>

Appendix 3: Activities for implementing the power sector mitigation action plan

Activity	Responsibility	Timeline	Indicative cost*
Mitigation-solar			
Explore potential for GCF to support utility-scale solar projects	Power Division/SREDA	Immediate	Minimal
Assessment of Government-owned and no-ownership land, to understand potential for utility-scale solar	Power Division and BPDB/SREDA	Immediate	Minimal
Programme of engagement of distribution licensees to continue to scale up rooftop solar PV	Power Division/ SREDA	Immediate	Minimal
Programme of engagement of factories in SEZs, to encourage uptake of rooftop solar	BPDB, DESCO, DPDC, BREB, WZPDCL, NWPDC	Immediate	Minimal
M&E study on the impacts of solar-PV irrigation pumps in areas that have been connected to the grid.	Power Division and BREB	Immediate	Moderate (USD 200k)
Carry out a study to explore potential multi-purpose land use schemes for solar PV	SREDA	Immediate	Moderate
Carry out a study to explore the use of distributed energy storage for commercial users	SREDA	By 2018	Moderate
Mitigation-wind			
Complete the onshore wind mapping study ASAP and publish results	Power Division	Immediate	Part of an ongoing study
Carry out a detailed wind power study on technical and non-technical issues	SREDA	By 2018	High, expected to be ICB in excess of USD 500,000.
Establish incentivised tariff mechanism to promote wind energy and investigate use of innovative competitive tendering processes (such as reverse auctions)	Power Division and SREDA	By 2018	High, expected to be ICB in excess of USD 1 million.

Activity	Responsibility	Timeline	Indicative cost*
<i>Carry out first round of competitive tendering for Wind Parks</i>	<i>Power Division</i>	<i>By 2019</i>	<i>Moderate, ICB proposed to support GoB in the procurement process</i>
<i>Complete study on Wind Parks</i>	<i>Power Division</i>	<i>By 2018</i>	<i>High, however, Parks already funded under recently signed MFF by GoB</i>
Mitigation-biomass			
<i>Disseminate findings from Gazipur and Thakurgaon rice husk power plant projects</i>	<i>SREDA</i>	<i>Immediate</i>	<i>Minimal</i>
<i>Pilot relevant utility scale waste-to-energy plant in a suitable municipal area</i>	<i>Power Division</i>	<i>By 2018</i>	<i>High</i>
Mitigation-biogas			
<i>Develop capacity building programme for partner organisations (NGOs)</i>	<i>SREDA</i>	<i>By 2018</i>	<i>Moderate</i>
<i>Develop slurry management training programmes</i>	<i>SREDA</i>	<i>By 2018</i>	<i>Moderate</i>
<i>Stakeholder engagement programme on biogas including stakeholder workshop</i>	<i>SREDA</i>	<i>By 2018</i>	<i>Minimal</i>
<i>Develop support program for local manufacturing including but not limited to access to finance options training and capacity building for staff, access to technologies, processes, etc.</i>	<i>SREDA</i>	<i>By 2018</i>	<i>Moderate</i>
Mitigation-fossil fuels			
<i>Secure international funding for remaining steam repowering potential</i>	<i>Power Division, BPDB</i>	<i>Immediate</i>	<i>Minimal</i>
<i>Establish procedures and processes for actively monitoring and reporting total emissions from coal based generation</i>	<i>MoEFCC, Power Division, CPGCBL</i>	<i>2019 or earlier</i>	<i>International Competitive tendering package anticipated, likely costs in excess of USD 400k</i>

Activity	Responsibility	Timeline	Indicative cost*
<i>Carry out a study to explore innovative technologies and options for operating, maintaining and retrofitting coal generation assets</i>	<i>Power Division and CPGCBL</i>	<i>2020 and beyond</i>	<i>Costs are likely to vary based on the amount of innovation being adopted/ piloted</i>
<i>Carry out study to more accurately assess the potential scope for centralised power plants</i>	<i>Power Division</i>	<i>Immediate</i>	<i>Medium, based on the likely requirement for ICB package.</i>
Adaptation			
<i>Conduct detailed vulnerability assessment of the power sector</i>	<i>Joint Power Division & MoEFCC</i>	<i>Immediate</i>	<i>Approx. BDT 10m</i>
<i>Power sector climate resilience stakeholder workshop</i>	<i>Joint Power Division & MoEFCC</i>	<i>Immediate</i>	<i>Approx. BDT 600,000</i>
<i>Write a report, based on the workshop's outputs, on approaches to improving climate resilience in the power sector.</i>	<i>Joint Power Division and MoEFCC</i>	<i>Immediate</i>	<i>Approx. 4 weeks staff time</i>
MRV			
<i>Detailed review of existing data for supporting power sector MRV</i>	<i>Power Division and SREDA</i>	<i>Immediate</i>	<i>Approx 3 weeks staff time, could be part of a technical assistance package</i>
<i>Review additional data needs for power sector MRV</i>	<i>Power Division and SREDA, supported by technical assistance</i>	<i>Immediate</i>	<i>Technical Assistance package, approx. 5m BDT</i>
<i>Internal Capacity development of key agencies like SREDA & Power Division mainly in the areas of technical, capacities to understand the specific measure implemented and to monitor and evaluate the performance of MRV</i>	<i>Power Division and SREDA, supported by Technical Assistances funds</i>	<i>Immediate</i>	<i>TBD</i>
<i>Drafting and agreement of data sharing MoUs between respective institutions</i>	<i>SREDA</i>	<i>Immediate</i>	<i>Some technical assistance support needed to assist understanding of required data</i>

Activity	Responsibility	Timeline	Indicative cost*
Governance			
<i>Draft detailed terms of reference for the Power NDC Working Group</i>	<i>SREDA</i>	<i>Immediate</i>	<i>Minimal</i>
<i>Write to proposed members of Power NDC Working Group, inviting them to join</i>	<i>SREDA, with support from MoEFCC</i>	<i>Immediate</i>	<i>Minimal</i>
<i>Internal Capacity development of key agencies like SR EDA & Power Division mainly in the areas of governance, effective coordination and policy formulation</i>	<i>Power Division & SREDA, supported by Technical Assistances funds</i>	<i>TBD</i>	<i>TBD</i>
<i>Arrange NDC power sector stakeholder engagement workshop, to discuss the sectoral plan and its implementation</i>	<i>Power Division</i>	<i>Immediate</i>	<i>Est. 250,000 BDT</i>
<i>NDC analytical support to Technical Committee as well as to all working group to understand the technical, financial and other aspects of projects to be undertaken in the power sector</i>	<i>Supported by Technical Assistance fund</i>	<i>TBD</i>	<i>TBD</i>

* Amounts in this column are indicative only and further work may be needed to refine them. 'TBD' indicates where further work is needed by the Government to assess costs.

Appendix 4: Activities for implementing the transport sector mitigation action plan

A table showing detailed activities, responsibilities and timelines.

<i>Activity</i>	<i>Responsibility</i>	<i>Timeline</i>	<i>Indicative cost*</i>
Mitigation			
<i>Comprehensive review and updating of mitigation and costs evidence base</i>	<i>RTHD, supported by technical assistance</i>	<i>By 2018</i>	<i>Approx. USD 0.3m</i>
Avoid measures			
<i>Feasibility study for Transit Oriented Development (TOD) at Major MRT & BRT Station</i>	<i>DTCA, RHD</i>	<i>By 2018</i>	<i>Approx. USD2.5m</i>
<i>Feasibility Study for Congestion Charging in Dhaka</i>	<i>RTHD</i>	<i>by 2018</i>	<i>Approx. USD 6.25m</i>
Shift measures			
<i>Actions from BR master plan</i>	<i>Ministry of Railways, Bangladesh Railway</i>	<i>By 2030</i>	<i>235 projects included in the Rail Master Plan costing USD 30 billion to be implemented during the period 2010 to 2030</i>
<i>Construction of 3 Transit line (MRT 2 &4 and BRT 7)</i>	<i>RTHD, DTCA, RHD</i>	<i>by 2030</i>	<i>USD 5742 m</i>
Improve measures			
<i>Replacement of old locomotives, fuel efficiency increase, track electrification, introduction of HSR etc</i>	<i>BR</i>	<i>By 2030</i>	<i>Procurement of new locomotives, coaches etc.</i>
<i>Build traffic modeling capacity in GoB</i>	<i>BRTA, DTCA, Bangladesh Police & City Corporations</i>	<i>By 2019</i>	<i>Approx. USD 0.25 m</i>
<i>Develop driver training workshops</i>	<i>BRTA, DTCA, BRTC, RHD</i>	<i>By 2020</i>	<i>Approx. USD 0.375million</i>

Activity	Responsibility	Timeline	Indicative cost*
<i>Develop implementation framework and action plan, and plan budget support</i>	<i>DTCA, BRTA, RHD</i>	<i>By 2018</i>	<i>Approx. USD 0.2 million</i>
<i>Scoping study on Green Freight</i>	<i>BRTA, RHD</i>	<i>By 2018</i>	<i>Approx. USD 0.05 million</i>
MRV			
<i>Detailed review of existing data for supporting transport sector MRV</i>	<i>RTHD, BRTA, RHD</i>	<i>By 2018</i>	<i>Approx. 3 weeks staff time, could be part of a technical assistance package</i>
<i>Review additional data needs for transport sector MRV</i>	<i>RTHD, supported by technical assistance</i>	<i>Immediate</i>	<i>Technical assistance package, approx. USD 0.2 million</i>
<i>Drafting and agreement of data sharing MoUs between respective institutions</i>	<i>RTHD, with support from Ministry of Railways, Ministry of Shipping and Ministry of Civil Aviation and Tourism</i>	<i>Immediate</i>	<i>Some technical assistance support needed to assist understanding of required data Governance</i>
Governance			
<i>Draft detailed terms of reference for the Transport NDC Working Group</i>	<i>RTHD</i>	<i>Immediate</i>	<i>Minimal</i>
<i>Write to proposed members of Transport NDC Working Group, inviting them to join</i>	<i>RTHD</i>	<i>Immediate</i>	<i>Minimal</i>
<i>Arrange transport stakeholder engagement workshop, to discuss the sectoral plan and its implementation</i>	<i>RTHD, with support from Ministry of Railways, Ministry of Shipping and Ministry of Civil Aviation and Tourism</i>	<i>Immediate</i>	<i>Approx. USD 0.1 m</i>

* Amounts in this column are indicative only and further work may be needed to refine them.

Appendix- 5 Activities for implementing the industry sector mitigation action plan

A table showing detailed activities, responsibilities and timelines.

<i>Activity</i>	<i>Responsibility</i>	<i>Timeline</i>	<i>Indicative cost*</i>
Mitigation			
<i>Energy Manager, Certified Energy Auditor and Accredited Energy Auditor certification with qualification and examination system under Energy Management Program</i>	<i>SREDA</i>	<i>By 2019</i>	<i>Most of the exam related cost will be borne by the participants. International donors will provide multi-year financial as well as capacity support to SREDA for the development of the Energy Auditor pool. The resource assessment is yet to be started.</i>
<i>Energy audit regulations</i>	<i>SREDA</i>	<i>Immediate</i>	<i>Supported by GIZ and UK Aid</i>
<i>Select targets methods of EE promotion (e.g. energy audits, building energy & environment rating, EE testing)</i>	<i>SREDA</i>	<i>By 2020</i>	<i>To be supported by UNDP, KEA and ADB under TA components</i>
<i>Select targets methods of EE promotion (e.g. energy audits, building energy & environment rating, EE testing)</i>	<i>SREDA</i>	<i>By 2022</i>	<i>-</i>
<i>Energy audits for government facilities</i>	<i>Independent accredited Energy Auditor</i>	<i>By 2019</i>	<i>Cost to be borne by the facilities</i>
<i>Energy audits for large designated energy consuming factories on mandatory basis</i>	<i>Completion of 113 identified designated facilities by the independent auditors</i>	<i>By 2020</i>	<i>Cost to be borne by the industrial facilities</i>
<i>Energy audits at the facilities of medium and small industrial facilities</i>	<i>On voluntary basis</i>	<i>2018 and onward</i>	<i>Cost to be borne by the industrial facilities</i>

<i>Activity</i>	<i>Responsibility</i>	<i>Timeline</i>	<i>Indicative cost*</i>
<i>Certification of green building</i>	<i>Trial implementation at the identified facilities</i>	<i>By 2020</i>	<i>Cost to be borne by the facilities</i>
<i>Accreditation of ISO14001/50001 in government organizations</i>	<i>Trial implementation at the identified facilities</i>	<i>By 2020</i>	<i>TBD</i>
<i>Review of concessional financing and consideration of additional incentive mechanisms and loan disbursements to</i> <ul style="list-style-type: none"> • <i>Flagship Projects</i> • <i>EE&C Policy Promotion</i> • <i>Loans</i> 	<i>SREDA</i>	<i>2016-2030</i>	<i>SREDA received JPY 11.988 billion under the Energy Efficiency and Conservation Promotion Financing Project (of which 1.37 billion BDT is disbursed to a local conglomerate for the implementation of EE measures at their industrial facilities.)</i>
<i>Develop energy consumption database for textiles and garments sectors</i>	<i>SREDA and Mol</i>	<i>By 2019</i>	<i>To be Supported by SREDA's own resources</i>
<i>Develop plans for the central data cell for collating information on industrial energy efficiency</i>	<i>Mol, working with SREDA (to ensure alignment with SREDA's energy consumption database)</i>	<i>By 2018</i>	<i>TBD</i>
<i>Tax Incentives</i>			
<i>Low Duties (2%) for all imported EE industrial machineries</i>	<i>SREDA and other relevant Government Organization</i>	<i>By 2030</i>	<i>TBD</i>
<i>Duty free for solar panels & materials, LED and raw materials</i>			
<i>Add energy efficient(EE) products to the list of "Renewable Energy (RE) Products" for tax benefits</i>			
<i>Submit proposals to NBR by mid-May</i>			
<i>Income tax reductions for EE product manufacturers</i>			

Activity	Responsibility	Timeline	Indicative cost*
<i>Monitoring of EE&C measures</i>	<i>SREDA and related agencies/utilities</i>	<i>2017-2030</i>	<i>To be supported by yearly budgetary allocation and external financing support</i>
Adaptation			
<i>Conduct detailed vulnerability assessment of the industry sector</i>	<i>Joint MoI & MoEFCC</i>	<i>By 2019</i>	<i>Approx. BDT 10m</i>
<i>Industrial climate resilience stakeholder workshop</i>	<i>Joint MoI and MoEFCC</i>	<i>Immediate</i>	<i>Approx. BDT 600,000</i>
<i>Write a report, based on the workshop's outputs, on approaches to improving climate resilience in the industry sector.</i>	<i>Joint MoI and MoEFCC</i>	<i>Immediate</i>	<i>Approx. 4 weeks staff time</i>
MRV			
<i>Detailed review of existing data for supporting industry sector MRV</i>	<i>MoI</i>	<i>Immediate</i>	<i>Approx. 3 weeks staff time, could be part of a technical assistance package</i>
<i>Review additional data needs for industry sector MRV</i>	<i>MoI, supported by technical assistance</i>	<i>Start by June 2018</i>	<i>Technical assistance package approx. 5m BDT</i>
<i>Internal Capacity development of key agencies like SREDA & MoI mainly in the areas of technical, capacities to understand the specific measure implemented and to monitor and evaluate the performance of MRV</i>	<i>MOI, SREDA supported by Technical Assistance funds</i>	<i>TBD</i>	<i>TBD</i>

Activity	Responsibility	Timeline	Indicative cost*
<i>Drafting and agreement of data sharing MoUs between respective institutions</i>	<i>Mol</i>	<i>Start by December 2018</i>	<i>Some technical assistance support needed to assist understanding of required data</i>
Governance			
<i>Draft detailed terms of reference for the Industry NDC Working Group</i>	<i>Mol</i>	<i>Immediate</i>	<i>Minimal</i>
<i>Write to proposed members of Industry NDC Working Group, inviting them to join</i>	<i>Mol, with support from MoEFCC</i>	<i>Immediate</i>	<i>Minimal</i>
<i>Internal Capacity development of key agencies like SREDA & Mol mainly in the areas of governance, effective coordination and policy formulation</i>	<i>Mol, SREDA supported by Technical Assistances funds</i>	<i>TBD</i>	<i>TBD</i>
<i>Arrange industry stakeholder engagement workshop, to discuss the sectoral plan and its implementation</i>	<i>Mol, with support from SREDA</i>	<i>Immediate</i>	<i>Est. 250,000 BDT</i>
<i>NDC analytical support to Technical Committee as well as to all working group to understand the technical, financial and other aspects of projects to be undertaken by the industries</i>	<i>Supported by Technical Assistance fund</i>	<i>Immediate</i>	<i>TBD</i>

* Amounts in this column are indicative only and further work may be needed to refine them. 'TBD' indicates where further work is needed to assess costs.

Appendix- 6 More detail on cross-cutting mitigation measures in industry

Cogeneration

Cogeneration, or Combined Heat & Power (CHP), offers a big opportunity for energy efficiency in Bangladesh, where captive power generation is very common in the industrial facilities due to the insufficiency of grid power supply. A stand-alone generator is typically used for meeting own power demand without any thermal energy recovery measures. Thus captive power generation is quite energy inefficient i.e. roughly around 34%, hence 66% of the energy is left as waste heat. By installing heat recovery systems to the engine exhaust and water jacket, steam and hot water can be produced to meet the energy required in the process area which can lead to an improved overall energy efficiency of up to 80~86%. While packaged CHP is an ideal choice for new installation, a waste heat recovery boiler (WHB) can also be easily fitted with an existing generator with an additional heat exchanger in the radiator water circuits for maximum energy recovery.

There is currently not more than around 20MW of cogeneration capacity installed in Bangladesh, in a relatively small number of Government and private owned industrial facilities. For example, the Bangladesh Sugar & Food Industries Corporation has already started cogeneration plants in two of its sugar mills.

Case study: Viyellatax Cogeneration Plant, Bangladesh⁶⁸

Viyellatax Limited is an apparel and textile manufacturer that has operations in Bangladesh. They developed a cogeneration system at their plant in 2009, linked to a steam generator to utilise thermal energy for higher efficiency and reduced carbon emissions. The thermal energy generated from the exhaust system is piped into the boiler to generate steam for the dyeing process.

Viyellatax has managed to significantly improve their production capacity and overall factory efficiency due to continuous and reliable power as well as reducing total reliance on oil fired boilers for steam generation.

Potential: Bangladesh has nearly 4000 MW of natural gas-based captive generation (auto-generation) in industrial facilities, the average efficiency of which is around 30%. The existence of this large captive generation capacity presents an opportunity for setting up CHP plants. If cogeneration can be successfully promoted, then the low efficiency of engine-based generators will not be an issue. As per standard practice and the current level of technology progression, 600 kg of process steam can be produced from the exhaust of 1 MW of captive generation plant, which means there is an overall potential of roughly 2400 tons per hour (TPH) of steam generation in the industrial sector in Bangladesh.

Cost: The cost for a standard 3 TPH waste heat recovery boiler from a reputed manufacture with full range of EPC support is roughly around 1,70,000 USD. It has high GHG reduction potential and the aggregated benefits are manifold. It can complement national fuel security as well as ensure operational sustainability for the industrial owner by equipping them with on-site energy generation from waste heat.

Practical next steps: This measure is applicable where waste exhaust of captive generators is available and there is obvious demand for steam. A good number of internationally reputed EPCs are present in the market to support industrial facilities to implement this type of initiatives. Moreover, a supported NAMA under a programmatic framework can play an essential role to upscale this opportunity.

68. <https://www.clarke-energy.com/2016/viyellatax-limited/>

Waste heat recovery

Waste heat recovery is the collection and re-use of heat arising from any process that would otherwise be lost. In the context of the industry sector, this could be for uses such as pre-heating combustion air for boilers, ovens, furnaces, hot water generation, drying. Heat recovery can help to reduce the overall energy consumption of the process itself, or provide useful heat for other purposes⁶⁹. In the case of Bangladesh, this is applicable to a number of sectors, but in particular textiles and food processing facilities.

There are a large number of textiles processing mills in Bangladesh, from weaving to spinning, dyeing and fabric production, all running at different production capacities. Among these textile mills, only a very small number have been installed with any integrated CCHP (combined cooling, heat and power) utility provision for internal energy consumption. In many cases, electricity, heat and cooling load are being catered by standalone options in the respective units. Spinning, being a major part in the textile industry where separate fibres are spun together to make stronger and continuous yarn, requires maintenance of stable relative humidity and suitable temperature conditions within the prescribed tolerance limits at all steps of the textile processing process. In most of the spinning facilities, human comfort is still not considered a high priority and running with conventional electricity-driven air conditioning system for humidity control. Some of the facilities are equipped with electric chillers to provide space cooling provision in a way to control the temperature within human comfort level. Moreover, the electric chiller is a proven option because of its easy installation and maintenance and the technology is conveniently available in the host country.

This waste heat recovery measure involves implementation of different types of waste heat recovery units for heat absorption from high temperature engine exhaust gas and low temperature jacket water. The waste heat recovered can be for production of thermal energy in the form of steam and hot water for running different types of chillers i.e. steam driven and hot water fed as well. Thus, the heat recovery is optimized by installing waste heat recovery boilers and chillers units operating in different ranges. Chilled water is fed to respective factories production unit for space cooling and ensures comfort.

Absorption chillers consist of an absorber by a solution in the absorber & a generator pump. The refrigerant vapour, lithium bromide (LiBr) from the evaporator, is absorbed by a solution in the absorber. This solution is then pumped to the generator where the refrigerant is re-vaporized using hot water or steam as heat source. The refrigerant-depleted solution is then returned to the absorber. The rich refrigerant solution will then pass through the evaporator where refrigerant evaporates by exchanging heat return chilled water and refrigerate vapour goes to the absorber.

Waste heat recovery through exhaust of the gas engines and engine jacket water will result in reduction of the thermal impact of atmospheric release of high temperature exhaust gases and also savings in the fuel consumption which would otherwise be required to meet the energy requirement for chilled water production from the conventional cooling system.

Potential (from exhaust of captive generators): There is nearly 2500 MW of potential waste heat recovery from the captive generation installed in the Bangladeshi textiles sector. These exhaust gases from the gas engines have high heat content. The measure involves the recovery of the heat from these high temperature exhaust gases in the heat recovery units. This recovered heat is then utilized for production of steam to feed vapour absorption chillers which otherwise would be done by burning of fossil fuel.

69. <https://www.carbonrust.com/resources/guides/energy-efficiency/heat-recovery/>

Hence, the flue gases, that otherwise would have been let off to the atmosphere at very high temperature, are now let off at a much lower temperature, thereby preventing heat dispersion in the atmosphere. The measure also results in reduction of GHG emissions into the atmosphere that otherwise would have been there due to combustion of fossil fuels.

Potential (from engine jacket water heat recovery): During power generation, heat is produced in the power generating sets resulting in the heating of engines. Cooling water is used in the engine jacket for cooling the engines. This jacket water then gets heated. The project activity involves the heat recovery from this jacket water. This recovered heat is then tapped in form of hot water and fed to hot water chillers.

Implementation of the technology replaces burning of fossil fuel to provide thermal energy to the absorption chillers. Thus the project activity results in the reduction of the GHG emissions. Waste heat recovery activity reduces the environmental impact of emitting hot exhaust in the form of high temperature gas and hot water. Moreover, the overall project activity has a potential for energy savings to a greater extent by implementing energy efficient measures. Thus the technology applied is safe and environmentally sound. This measure increases energy efficiency of existing power generation facilities through utilization of exhaust heat for providing cooling energy through production of steam and hot water. The single utility consists a Combined Cooling, Heat and Power (CCHP - tri-generation) by replacing electrical chillers or that is existing or would have been built in absence of this initiative. CCHP systems with waste heat recovery-based vapour absorption chillers cater to both the cooling and power requirements of the consuming facilities.

Challenges: Cooling from vapour absorption is an evolving potential in the industrial sector of Bangladesh but due to the following factors it is not yet become an economical choice for most textile entrepreneurs. To implement this kind of alternative measure, investment plays a significant role in decision making. First of all initial investment of vapour absorption and hot water chillers is much higher than electric chillers. To invest in such a new project, industry owners need funding either from retained profit or equity or from commercial banks or any other public institutions. In many cases, there is a shortfall prevalent in the technical capacity of financial institutions to finance this type of project. They cannot assess the credit worthiness of industries and the risks and opportunities of investments in such projects. Sometimes risk associated with new technology is overestimated because new technology is uncertain. Banks charge high interest and expect reasonable repayment which cannot be met and that makes capital too expensive. Project owners and entrepreneurs are reluctant to borrow bank loans for this new technology with high rates of interest. Also most of the project owners and entrepreneurs do not want to bear any upfront cost of investment for the introduction of new technology if there is no financial guarantee available.

Installation of vapour absorption chillers and hot water chillers can be a good means of cooling or conditioning when there is waste heat available from generator exhaust or from other source to run the chiller. Though this choice has enormous potential, use of waste heat to run utilities is not yet fully established in the country. Captive generation is largely adopted by factories in Bangladesh for ensuring their own power demand because of quality and availability of grid power supply and the low cost of generation because of indigenous gas supply. Industries in Bangladesh regularly enjoy highly subsidized gas supply so that they can run captive generators for 24 hours. Heat can be recovered from generator exhaust or from jacket water which is used for cooling purposes. But only a very few industries have taken the initiative to utilize such measures to meet their additional energy demand. Diffusion of new technology in industries is quite difficult in the country because of lack of awareness and a traditional

mind-set of industry owners and entrepreneurs. Limited sources of trustworthy information and opportunities to learn about new technology are major impediments for implementing any kind of new technology in the country. Moreover, there is also lack of proper infrastructure and policy support to facilitate capacity building about advanced technology in the country. That's why industry owners and entrepreneurs are hesitant about the new technology.

Cost: The cost for one TPH of such unit from reputed manufactures, with full range of EPC support, is around 70,000 USD. This measure has high GHG reduction potential and the aggregated benefits are manifold. It can complement national fuel security as well as for the industrial owner by equipping them with on-site energy generation from waste heat.

Condensate recovery

Condensate recovery is a process to reuse the water and sensible heat contained in discharged condensate from industrial processes. Recovering condensate instead of throwing it away can lead to significant energy savings. Condensate can be reused in many different ways, for example⁷⁰:

- As heated feed water, by sending hot condensate back to the boiler's deaerator
- As pre-heat, for any applicable heating system
- As steam, by reusing flash steam
- As hot water, for cleaning equipment or other cleaning application

Efficient chillers

Energy efficient centrifugal chillers, that have a Coefficient of Performance of more than 6, can play an important role in saving energy in Bangladesh's strategically important and growing textile sector. There are no significant installation or maintenance-related difficulties associated with this technology and it can repay the initial investment within a relatively short period of time. Under its Joint Crediting Mechanism, the Japanese Government is providing a significant incentive for installing efficient chillers in factories in Bangladesh.

Efficient boilers

Natural gas fired boilers and furnaces are extensively used in industries and steel & re-rolling mills and are usually operated at around 70% efficiency compared to 85% efficiency for the international norm. Efficiency improvement of boilers and furnaces is therefore seen as an attractive and cost-effective option⁷¹.

Efficient motors

More efficient motors can provide a relative small, but still useful, efficiency saving. The sectoral benchmarks being developed by SREDA should help to drive industry towards the purchase of more efficient motors over time. In addition, bigger gains are possible from retrofitting more efficient motors coupled with a speed drive, and this could be particularly relevant in the cement, jute and fertiliser sectors. Further more significant reductions can be gained through ensuring appropriate installation of the motors, which is something that should be picked up through the energy audits.

Data on costs and mitigation potential of efficient motors is still somewhat scarce. It is therefore suggested that a study be carried out to collect more data, to help industrial stakeholders better understand the likely cost effectiveness of such measures.

70. <http://www.tlv.com/global/UK/steam-theory/introduction-to-condensate-recovery.html>

71. <http://ep-bd.com/online/details.php?cid=32&id=18707>

Appendix- 7 Bangladesh's Intended Nationally Determined Contributions

1. National context

Bangladesh is a highly climate vulnerable country whose emissions are less than 0.35% of global emissions¹. Without ambitious action to limit greenhouse gases internationally, the future costs of adapting to climate change will be much higher than they are today. If the world fails to take ambitious action, the costs to Bangladesh of climate change could amount to an annual loss of 2% of GDP by 2050 and 9.4% of GDP by 2100². Bangladesh therefore wants to play its part in the global collective action to reduce future emissions as part of a robust and ambitious international agreement.

Consequently, Bangladesh is adopting a two-fold strategy against climate change. The main focus of Bangladesh's activities is on increasing our resilience to the impacts of climate change – which are already affecting the livelihoods of much of our population and will continue to do so in the future. For example, extreme temperatures, erratic rainfall, floods, drought, tropical cyclones, rising sea levels, tidal surges, salinity intrusion and ocean acidification are causing serious negative impacts on the lives and livelihoods of millions of people in Bangladesh, and are gradually offsetting the remarkable socio- economic development gained over the past 30 years, as well as jeopardising future economic growth. However at the same time, Bangladesh is also working to achieve lower- carbon as well as more resilient development. With this in mind, this INDC aims to put forth mitigation actions that Bangladesh can take to tackle its growing emissions and to play its role in global efforts to limit temperature rise to two degrees or preferably 1.5 degrees above pre-industrial levels.

With respect to Bangladesh's contribution to global efforts to counter climate change, this INDC sets out a number of mitigation actions that will help limit the country's GHG emissions. These mitigation actions will play a key role in realising the move to a low-carbon, climate-resilient economy and to becoming a middle-income country by 2021 whilst ensuring that it will not cross the average per capita emissions of the developing world. The INDC includes both unconditional and conditional emissions reduction goals for the power, transport, and industry sectors, alongside further mitigation actions in other sectors, which Bangladesh intends to carry out. Bangladesh intends to implement its conditional emissions reduction goal subject to appropriate international support in the form of finance, investment, technology development and transfer, and capacity building. The foundation of this INDC is Bangladesh's existing strategies and plans, in particular the Bangladesh Climate Change Strategy and Action Plan (BCCSAP), Renewable Energy Policy 2008, the Energy Efficiency and Conservation Master Plan (E&CC Master Plan), the forthcoming National Adaptation Plan, the National Sustainable Development Strategy, the Perspective Plan (Vision 2021) and the Sixth (and forthcoming seventh) Five Year Plan, the National Disaster Management Plan and the Disaster Management Act. In addition, it incorporates the outcome of further analysis and consultation to enhance our existing plans, and to analyse future GHG emissions trends and mitigation and adaptation options.

The INDC of Bangladesh consists of the following elements:

➤ **Mitigation contribution:**

- An unconditional contribution to reduce GHG emissions by 5% from Business as Usual (BAU) levels by 2030 in the power, transport and industry sectors, based on existing resources.
- A conditional 15% reduction in GHG emissions from BAU levels by 2030 in the power, transport, and industry sectors, subject to appropriate international support in the form of finance, investment, technology development and transfer, and capacity building.

1. Climate Analysis Indicators Tool (CAIT) Version 2.0. (Washington, DC: World Resources Institute, 2014)". World Resources Institute

2. <http://www.adb.org/news/bangladesh-could-see-climate-change-losses-reach-over-9-gdp-report>

- A number of further mitigation actions in other sectors which it intends to achieve subject to the provision of additional international resources.
- Adaptation component:
 - An outline of what Bangladesh has already done on adaptation and what the next steps are, including the long-term vision for adaptation in Bangladesh and synergies with mitigation measures.
- INDC implementation:
 - Proposals for governance and coordination of INDC implementation and an outline of key next steps.
- Support for INDC implementation:
 - A qualitative description of Bangladesh's support needs and an outline of plans to further quantify this, along with some examples of indicative costs of taking action on mitigation and adaptation.

Bangladesh reserves the right to revise its intended national target and contribution at any point of time and considers its INDC to be a living document that should be integrated with changed/modified national development goals and targets.

2. Mitigation

2.1. “Business as usual” emissions

As part of the process of preparing this INDC, Bangladesh has updated its projections of future greenhouse gas emissions including the development of a “Business As Usual” (BAU) scenario and analysis of mitigation potential in three key sectors. Emissions in the “Land use, land-use change and forestry” (LULUCF) sector were not modelled due to difficulties in obtaining the necessary data. Further details of the analysis will be published on the Ministry of Environment and Forests' website.

2.2. Mitigation contribution

Bangladesh's mitigation contribution covers the power, transport and industry sectors. Under a BAU scenario, GHG emissions in Bangladesh in these sectors are expected to represent 69% of total emissions by 2030 (excluding LULUCF), an increase of 264% by 2030, from 64 MtCO₂e in 2011 to 234 MtCO₂e in 2030.

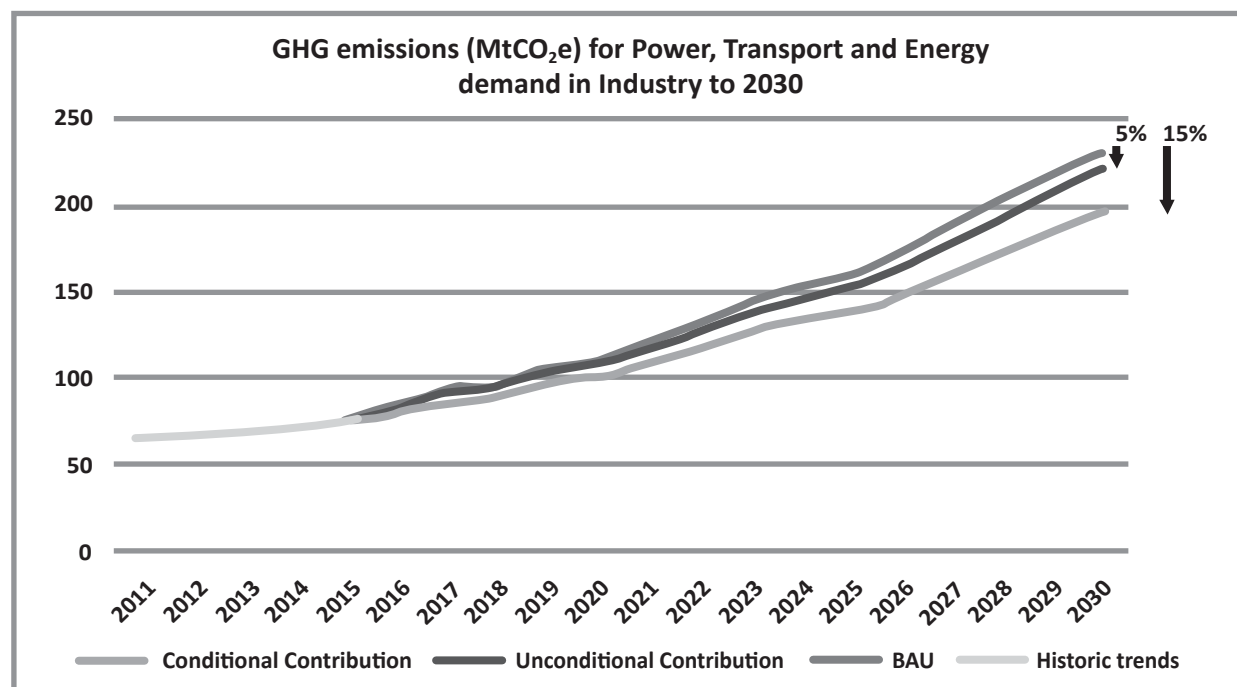
The contribution Bangladesh is willing to make is set out below.

Table 1: Intended Nationally Determined Contributions – Mitigation

Unconditional contribution	Contribution assuming no additional international support	Bangladesh will reduce its GHG emissions in the power, transport, and industry sectors by 12 MtCO ₂ e by 2030 or 5% below BAU emissions for those sectors.
Conditional contribution	Contribution assuming additional international support	Bangladesh will reduce its GHG emissions in the power, transport, and industry sectors by 36 MtCO ₂ e by 2030 or 15% below BAU emissions for those sectors.

These contributions are illustrated graphically below.

Figure 1: Projection of GHG emissions (MtCO₂e) on power, transport and industry sectors from 2011 to 2030



The reduction will occur as illustrated in following Table 2.

Table 2: Projected emissions reductions in the power, transport and industry (energy) by 2030

Sector	Baseyear (2011) (MtCO ₂ e)	BAU scenario (2030) (MtCO ₂ e)	BAU change from 2011 to 2030	Unconditional contribution scenario (2030) (MtCO ₂ e)	Change Vs BAU	Conditional contribution scenario (2030) (MtCO ₂ e)	Change Vs BAU
Power	21	91	336%	86	-5%	75	-18%
Transport	17	37	118%	33	-9%	28	-24%
Industry (energy)	26	106	300%	102	-4%	95	-10%
TOTAL	64	234	264%	222	-5%	198	-15%

This contribution is based on analysis carried out throughout 2015 using the best available data. However data quality and availability is an issue in Bangladesh. If new and more robust data comes to light in the future, or if assumptions change (e.g. projections of population or economic growth) the Government will update its analysis accordingly. This will be coordinated with the next update of the BCCSAP and also embedded within the National Communication and Biennial Update Report reporting cycle.

2.3. Mitigation actions

This section sets out some of the mitigation actions that the Government of Bangladesh is currently implementing and examples of the kinds of measures that could be implemented in the future to meet the contributions set out in section 2.2 above.

2.3.1. Mitigation objectives

Bangladesh's strategy on mitigation is set out in the BCCSAP. This sets out 7 programmes on mitigation:

Table 3: Mitigation programmes from the BCCSAP

Programme	Objective
Improved energy efficiency in production and consumption of energy	Ensure energy secure and low-carbon development of the economy
Gas exploration and reservoir management	Enhance energy security and ensure low-emission development
Development of coal mines and coal-fired power station(s)	Maximising coal output and managing coal fired power stations in a carbon-neutral way
Renewable energy development	Maximising the use of renewable energy sources to lower GHG emission and ensuring energy security
Lower emissions from agricultural land	Raise productivity of agricultural land and lower emissions of methane
Management of urban waste	Ensure liveable cities while lowering GHG (methane) emissions
Afforestation and reforestation programme	Provide support to scale up afforestation and reforestation

2.3.2. Existing mitigation actions

Bangladesh already has a number of activities and targets that are driving action to reduce GHG emissions, and that will help it meet the unconditional contribution set out in section 2.2, including:

- A target to reduce energy intensity (per GDP) by 20% by 2030 compared to 2013 levels (E&CC Master Plan)
- An Energy Management Programme, including establishment of Energy Management Systems and energy audits for industry by accredited energy auditors
- An Energy Efficiency labelling programme to promote sales of high efficiency products in the market
- Energy Efficiency measures for buildings, such as heat insulation and cooling measures, and a revised code on energy efficiency of new buildings
- The Solar Homes Programme, providing off-grid electricity access to rural areas
- A target to deliver 5% of energy from renewable sources by 2015, and 10% by 2020 (2008 Renewable Energy Policy)
- More than 1.5 million Improved Cook Stoves (ICS) and 4.0 million Solar Home Systems have already been distributed across the country
- Improving kiln efficiency in the brick making industry, composting of organic waste and waste biomass-based thermal energy generation

- Construction of Combined Cycle Power Plant (CCPP) by the Government of Bangladesh and utilities companies
- Under the Solar roof-top program around 14 MW of solar has been installed on the vacant roof-tops of Government and private buildings
- The country has set aggressive target to scale up the potentials of Solar Irrigation Pumps, Solar mini and nano grids to address the energy access issue of off-grid population

2.3.3. Additional mitigation actions in power, industry and transport

Bangladesh will also need to implement additional mitigation actions in order to meet the conditional contribution set out in section 2.2. Examples of these are set out in Table 4. More analysis will be taken in future to consider these options in more detail, based on the availability of funding support and internal capability, including as part of a proposed INDC implementation roadmap (see section 4), before decisions are taken.

Table 4: Possible mitigation actions to deliver the conditional contribution

Sector	Description	Objectives of the activity by 2030
Power	<ul style="list-style-type: none"> • Ensure all new coal generation uses super-critical technology • Increased penetration of wind power • Implement grid-connected solar plant to diversify the existing electricity generation mix 	<ul style="list-style-type: none"> • 100% of new coal based power plants use super-critical technology by 2030 • 400 MW of wind generating capacity by 2030 • 1000 MW of utility-scale solar power plant
Transport	<ul style="list-style-type: none"> • Modal shift from road to rail, delivered through a range of measures, including underground metro systems and bus rapid transit systems in urban areas. Co-benefits will include reduced congestion, improved air quality and improved traffic safety. • Reduced congestion and improved running of traffic. This will be achieved by a number of measures, including building of expressways to relieve congestion and public transport measures. 	<ul style="list-style-type: none"> • To achieve a shift in passenger traffic from road to rail of up to around 20% by 2030 compared to the business as usual. • 15% improvement in the efficiency of vehicles due to more efficient running.
Industry (energy-related)	<ul style="list-style-type: none"> • Carry out energy audits to incentivise the uptake of energy efficiency and conservation measures in the main industrial sectors based on the Bangladesh Energy Efficiency and Conservation 	<ul style="list-style-type: none"> • 10% energy consumption reduction in the industry sector compared to the business as usual

2.3.4. Additional mitigation actions in other sectors

As explained above, sectors other than power, transport, and industry were not included in the quantified contributions as a robust data-set is not as readily available for these other sectors, making quantification of mitigation potential more challenging. Yet, Bangladesh will carry out more work in future, under the umbrella of the BCCSAP, to improve analysis in other sectors. And Bangladesh will also continue to consider mitigation actions in these sectors, despite their contribution currently not being quantified in the INDC. Examples of potential measures in other sectors are set out below:

Table 5: Possible conditional action-based contributions

Sector	Description	Objectives of the activity by 2030
Households	<ul style="list-style-type: none"> • Put in place policy mechanisms to incentivise the uptake of improved (more efficient) gas cookstoves • Support the replacement of biomass with LPG for cooking purposes • Promoting policies to induce greater level of energy efficiency and conservation in the household sector based on the Bangladesh Energy Efficiency and Conservation Masterplan 	<ul style="list-style-type: none"> • 70% market share of improved biomass cookstoves, reaching 20 million households in 2030 • 40% market share of improved gas cookstoves • 10% market switch from biomass to LPG for cooking compared to the business as usual
Commercial buildings	<ul style="list-style-type: none"> • Promote policies to induce greater level of energy efficiency and conservation in the commercial sector based on the Bangladesh Energy Efficiency and Conservation Master plan • Incentivise rainwater harvesting in commercial buildings as a form of water and energy conservation 	<ul style="list-style-type: none"> • 25% reduction of overall energy consumption of the commercial sector compared to the business as usual
Agriculture (non-energy related)	<ul style="list-style-type: none"> • Increase mechanisation in agriculture leading to a reduction in numbers of draft cattle (and therefore lower methane emissions) • Increase the share of organic manure in the used fertilizer mix • Scale up rice cultivation using alternate wetting and drying irrigation 	<ul style="list-style-type: none"> • 50% reduction in draft animals compared to the business as usual • 35% increase in organic fertiliser share compared to the business as usual • 20% of all rice cultivation uses alternate wetting and drying irrigation
Waste	<ul style="list-style-type: none"> • Increase composting of organic waste • Promote landfill gas capture and power generation 	<ul style="list-style-type: none"> • 50% of the managed waste fraction is diverted from landfill to composting • 70% of landfill gas captured and used for electricity generation
Land use, land use change and forestry	<ul style="list-style-type: none"> • Continuation of coastal mangrove plantation • Reforestation and afforestation in the reserved forests • Plantation in the island areas of Bangladesh • Continuation of Social and Homestead forestry 	<ul style="list-style-type: none"> • Not quantified.

2.4. Information to facilitate clarity, transparency and understanding

This section provides more detail on the contributions set out in section 2.2 and the analysis that was carried out to inform them.

Table 6: Information to facilitate clarity, transparency and understanding

Time frames and/or periods for implementation	
Timeframe for implementation	The timeframe for implementation of the INDC is 2020 - 2030.
Scope and coverage	
Scope of gases included in the contribution	Carbon dioxide (CO ₂), methane (CH ₄), nitrous oxide (N ₂ O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and Sulphur Hexafluoride (SF ₆).
Sectors covered by the contribution	The contribution covers the power sector, and energy use in the transport and industry sectors. Other sectors are not included in the quantified contribution, but are included as action-based conditional contributions.
Geographies covered by the contribution	The contribution covers all of Bangladesh.
Assumptions and methodological approaches	
Methodology for estimating current and future emissions	The IPCC Revised 1996 Guidelines for National Greenhouse Gas Inventories and the Good Practise Guidance and Uncertainty Management in National Greenhouse Gas Inventories were used to calculate current and future GHG emissions. GHG projections were developed to be consistent with Bangladesh's aim of becoming a middle-income country by 2021. The exact approach to estimating GHG emissions was tailored for each sector according to the availability of data. For example, GHG emissions from road transport were calculated in a relatively disaggregated manner, by combining data on numbers of vehicles, distances travelled and the fuel efficiencies of the vehicles. Similarly, GHG emissions from electricity use in households were calculated in a detailed bottom-up manner, using data on projected numbers of electrical appliances and their efficiencies. On the other hand, GHG emissions from industry were calculated using aggregated energy demand data per industrial sub-sector and forecasts of future industrial output. Future emissions were modelled using the LEAP model, with emissions being calculated from the relevant activity data and emissions factors.
Global warming potentials	The carbon dioxide equivalent has been calculated using the 100 year global warming potentials in accordance with the Revised IPCC 1996 Guidelines.
Approach for land-based emissions	Data was not available to allow for detailed analysis of future GHG emissions and mitigation potential in the LULUCF sector. Further work will be needed to quantify this accurately (see section 4 on INDC implementation).
Synergies and co - benefits	<p>The shortlist of mitigation options analysed for the INDC was created from a longer list by applying certain criteria, one of which was co-benefits. All the measures are expected to therefore have some co-benefits. These include improved air quality (e.g. from increased renewables or reduction in traffic congestion), improved road safety (from modal shift to public transport and reduced traffic congestion), economic benefits from developing green jobs, cost savings to families (e.g. from lower running costs of cars and from energy efficient appliances) and improved access to energy (e.g. from localised biogas production).</p> <p>For more information on mitigation-adaptation synergies, see section 3.</p>
Net contribution of International Market Based Mechanism	Bangladesh does not rule out the use of international market- based mechanisms in line with agreed modalities and accounting rules.

2.5. Fair and ambitious goal

Bangladesh is a Least Developed Country (LDC) whose emissions are less than 0.35% of global emissions. However, Bangladesh recognises that in order to meet the 2 degrees objective all countries will need to undertake mitigation in line with the IPCC conclusion that meeting 2 degrees requires global reductions to reduce by 40 to 70% global anthropogenic GHG emissions reductions by 2050 compared to 2010. Bangladesh's approach is driven by the long-term goal announced by its Prime Minister that its per capita GHG emissions will not exceed the average for developing countries. Therefore, Bangladesh's approach focuses on putting itself on a pathway which will avoid an increase of emissions per capita beyond this level, while pursuing national development goals.

Despite its current status as a LDC and its currently small share of past and current global GHGs, Bangladesh is still putting forward actions which will allow the country to embark on a low carbon development pathway, keeping in mind the global climate change agenda. This INDC represents the first time that Bangladesh has made an international undertaking to take action on mitigation and therefore fulfils the requirements of the Lima Call for Climate Action to go beyond existing efforts. The actions needed to deliver on these commitments will require international support in the form of finance, technology transfer and capacity building. Bangladesh will also provide a relevant contribution with regards to national financial resources, staff time and strong integration of development and mitigation activities.

In selecting the actions set out above, Bangladesh has prioritised those which fit with the growth priorities set out in our national development plans. In addition, Bangladesh has captured the synergies between mitigation and adaptation, not only by prioritising those adaptation activities with significant mitigation co-benefits, but also by seeking to minimise the carbon footprint of adaptation portfolio as a whole. The INDC contains a mix of measures that have already been taken forward under its own resources, thus demonstrating that Bangladesh is not content to wait for international support to take action on climate change.

3. Adaptation

3.1 Country situation on vulnerability

Bangladesh, one of the world's most disaster-prone climate vulnerable countries, has faced dozens of major disasters over its short history as a nation. Located on the Bay of Bengal, Bangladesh is particularly susceptible to seasonal cyclones, acting as a funnel for heavy precipitation from the Indian Ocean and creating extreme weather events. The country sits on the flood plain of several major rivers, which drain from the mountainous regions of the Himalayas, making seasonal flooding another hazard often coinciding with the cyclone season. Current research and studies suggest that flood, tropical cyclones, storm surge and drought are likely to be more frequent and severe in the years to come. The Climate Change Vulnerability Index (CCVI-2011) calculated the vulnerability of 170 countries to the impacts of climate change over the next 30 years³, which reveals that Bangladesh is the most vulnerable country to climate change.

Climate change adaptation is a key priority and the country has already undertaken initiatives to mainstream adaptation into national development such as in the water, health, forestry, agriculture and more prominently in the infrastructure sectors. Bangladesh is already experiencing a host of climate impacts, including floods, storm surges, drought and river bank erosion. For example, floods in 2007 inundated 32,000 sq. km, leading to over 85,000 houses being destroyed and almost 1 million damaged, with approximately 1.2 million acres of crops destroyed or partially damaged, 649 deaths and estimated damage over \$1 billion. Climate change will drastically hamper economic growth of the country. For

3. <http://maplecroft.com/about/news/ccvi.html>

instance, the Asian Development Bank estimated that Bangladesh may experience a 2% GDP annual loss by 2050 because of climate change.

3.2 Adaptation goal

The primary goal for adaptation is to protect the population, enhance their adaptive capacity and livelihood options, and to protect the overall development of the country in its stride for economic progress and wellbeing of the people.

3.3 Adaptation action – past and present

Over the last three decades, the Government of Bangladesh has invested over \$10 billion (at constant 2007 prices) to make the country more climate resilient and less vulnerable to natural disasters. Flood management embankments, coastal polders and cyclone shelters have been built, and important lessons learnt on how to implement such projects successfully in the dynamic hydrological conditions of Bangladesh and with active participation of communities.

To enhance climate change adaptation activities in all key policies and sectors, Bangladesh has recently established two innovative funds: the Bangladesh Climate Change Trust Fund (BCCTF) from the Government's own budget and the Bangladesh Climate Change Resilient Fund (BCCRF) with the support of development partners. Bangladesh submitted the National Adaptation Programme of Action (NAPA) in 2005 (revised in 2009) and prepared a climate change action plan (the Bangladesh Climate Change Strategy and Action Plan in 2009).

3.4 Expectations for future – near term plans and action

Considering the vulnerabilities, the government has identified the following areas of interventions to address adverse impacts of climate change:

Key Areas to address adverse impacts of climate change	
1	Food security, livelihood and health protection (incl. water security)
2	Comprehensive disaster management
3	Coastal Zone Management including Salinity Intrusion control
4	Flood Control and Erosion protection
5	Building Climate Resilient Infrastructure
6	Increased Rural Electrification
7	Enhanced Urban Resilience
8	Ecosystem based adaptation (including forestry co-management)
9	Community based conservation of wetlands and coastal areas
10	Policy and Institutional Capacity Building

Based on the above-mentioned areas the following broad adaptation actions are prioritized for the country:

Adaptation Priorities for Bangladesh	
I.	Improved Early warning system for tropical cyclone, flood, flash flood and drought
II.	Disaster preparedness and construction of flood and cyclone shelters
III.	Tropical cyclones and storm surge protection
IV.	Inland monsoon flood-proofing and protection
V.	Climate resilient infrastructure and communication
VI.	Climate resilient housing
VII.	Improvement of Urban resilience through improvement of drainage system to address urban flooding
VIII.	River training and dredging (including excavation of water bodies, canals and drains)
IX.	Stress tolerant (salinity, drought and flood) variety improvement and cultivation (including livestock and fisheries)
X.	Research and knowledge management
XI.	Adaptation on local-level perspectives etc.
XII.	Adaptation to climate change impacts on health
XIII.	Biodiversity and ecosystem conservation
XIV.	Capacity Building at Individual and institutional level to plan and implement adaptation programmes and projects in the country

Bangladesh has already developed considerable infrastructure and capability to address these climate change-induced vulnerabilities through disaster risk management and climate change adaptation. In order to accelerate the present domestic initiatives to adapt to climate change and secure lives and livelihoods of people, the Government has allocated nearly \$ 400 million to Bangladesh Climate Change Trust Fund (BCCTF). As of June 2015 BCCTF has funded over 236 projects of which 41 have already been implemented. The projects undertaken so far from BCCTF include:

- Construction of embankments and river bank protective works
- Building cyclone resilient houses, excavation /re-excavation of canals
- Construction of water control infrastructures including regulators/slucice gates
- Waste management and drainage infrastructure
- Introduction and dissemination of stress tolerant crop varieties and seeds, afforestation
- Installation of solar panels.

Please see details on the country's achievement in the field of climate change adaptation in Annex 1. A significant number of development programmes are implemented under the revenue budget, and the allocation for BCCTF also comes from the revenue budget (FY-2013/14), so the total allocation to development activities amounts to about 32 percent of the national budget. An updated BCCTF project list is provided on the Fund's website⁴.

4. <http://www.bcct.gov.bd/images/180814/Updated%20Project%20List%202017.11.pdf>

A good number of climate change adaptation projects have been further developed for implementation by different ministries and departments like Local Government Engineering Department (LGED), Water Development Board, Bangladesh Inland Water Transport Authority (BIWTA), Ministry of Disaster Management, Road and Transport Highways Division, Ministry of Road Transport and Bridges. Please see the detailed project list in Annex 1.

Furthermore, Bangladesh has prepared a roadmap towards formulating a comprehensive National Adaptation plan (NAP) with a view to reducing vulnerability to the impacts of climate change by building adaptive capacity and resilience. The NAP is expected to facilitate the integration of climate change adaptation into relevant new and existing policies, programmes and activities in a coherent manner, in particular development planning processes and strategies, within all relevant sectors and at different levels, as appropriate.

Bangladesh is considered one of the leading countries in managing disasters, and many good lessons and practices gathered over the years are being replicated in the context of CCA.

3.5 Barriers and needs

Bangladesh acknowledges that climate change action requires a holistic approach and further acknowledges that many activities will deliver both adaptation and mitigation benefits. For example, Bangladesh's national afforestation programme has led to significant afforestation in newly accreted lands along the coast in the Bay of Bengal as well as reforestation in the adjacent denuded hills. About 195,000 hectares of mangrove plantations have been raised so far and these new plantations are also playing an important role in carbon sequestration. More analysis needs to be carried out on future GHG emissions and mitigation options for the LULUCF sector and when this is done, further consideration will be given to mitigation-adaptation synergies in this sector.

Needless to mention, domestic/national initiatives to address climate change vulnerabilities from our own resources are far from inadequate compared to what is required to address vulnerabilities of 160 million of the national population. Resources are required from international mechanisms to ensure climate resilient development of the country. This will assist in developing a comprehensive programme for adaptation and the NAP will form the core element of this programme.

Bangladesh acknowledges that monitoring and evaluation of adaptation policies and programmes is crucial to ensure that resources are well utilized to increase the overall resilience of our people. The objective is to mainstream adaptation initiatives in a National Monitoring, Reporting and Verification (MRV) system that is being planned.

4. INDC development and implementation

This INDC has been prepared through consultation and dialogue with the Government's Advisory and Technical Committees, which include a range of stakeholders including line ministries, Planning Commission, technical departments, professionals, experts, and the private sector.

With obvious reason the INDC implementation will be carried forward under the framework of updated and meaningful implementation of the Bangladesh Climate Change Strategy and Action Plan (BCCSAP) and other key policies/plans. The BCCSAP is a ten-year programme running from 2009 to 2018, to build the capacity and resilience of the country to meet the challenge of climate change. An INDC implementation roadmap will be produced in 2016. This will review the current situation with respect to implementation of the BCCSAP, identify gaps and support needs, review barriers to implementation and present proposals for INDC implementation next steps.

Specific activities to be carried out in the development of the INDC implementation roadmap include:

- List potential mitigation interventions that could be studied in more detail and developed into NAMAs, along with recommendations on possible delivery levers (e.g. incentives, standards, fiscal levers etc).
- Carry out a review of Bangladesh's current climate finance landscape, support needs and the international funding landscape, along with an assessment of climate finance readiness and gaps. Produce recommendations on an appropriate climate finance strategy for Bangladesh.
- Carry out a gap analysis of existing data sharing and reporting structures and processes and make initial recommendations on the appropriate form and structure of a national MRV system.
- Integration of the Climate Fiscal Framework (CFF) in the national planning and budgeting process to determine and disburse suitable yearly allocation for the implementation of mitigations and adaptation projects/programmes in this stipulated time-frame.
- Carry out a gap analysis of existing institutional framework and recommend institutional strengthening for effective access of international climate finances including Green Climate Fund
- Make recommendations on appropriate institutional structures for INDC implementation and coordination.
- Set out a clear roadmap and timetable for actions across the key elements of INDC implementation, grouping into short, medium and long-term actions.

INDC implementation will be taken forward by existing governance arrangements under the BCCSAP, with coordination being managed by the climate change secretariat in the Ministry of Environment and Forests, reporting to the Advisory Committee and the National Environment Committee (chaired by the Prime Minister). Specific implementation activities will be carried out by the appropriate line ministries and agencies with fiscal support under the fiscal framework of the Government. A comprehensive and robust INDC implementation framework will be developed in line with the existing CFF and other climate change related bodies.

5. Support for INDC implementation

Significant resources will be needed to support the implementation of Bangladesh's INDC, including finance, technology transfer and capacity building support. This section gives examples of the kinds of costs facing Bangladesh, both for adaptation and mitigation, and a brief summary of the existing institutional frameworks on climate finance.

5.1. Adaptation costs

Being amongst the countries worst affected by climate change, much of the required resource will be focused on adaptation and improving climate resilience. The BCCSAP sets out the type of investments needed to address climate impacts, early warning systems, improved irrigation and water management, improved operation and maintenance and upgrading of coastal embankments and polders and upgrading of flood protection embankments/drainage systems⁵.

It was estimated by the World Bank⁶ in 2010 that by 2050, adaptation costs of tropical cyclones and storm surges will be \$5516⁷ million and the annual recurrent cost will be \$112 million, whereas for inland monsoon flooding the cost will be \$2671 million and the annual recurrent cost will be \$54 million. Just taking these two sectors into consideration, the cost is estimated to be around \$6.59 billion by 2030.

5. See box 7 of the BCCSAP

6. World Bank. 2010. Main Report. Washington DC: World Bank.

<http://documents.worldbank.org/curated/en/2010/01/16420806/bangladesh-economic-adaptation-climate-change-vol-1-2-main-report>

7. Signifies USD throughout the document

Bangladesh has already implemented some key adaptation activities as urgent and immediate needs of the country. Implementation of identified adaptation measures are very critical to increase the resilience of the country to climate change. It was estimated that Bangladesh will need to invest \$40 billion from 2015 to 2030 in order to implement identified adaptation measures (detail in section 3) to address adverse impacts of climate change. This figure includes the actions included in the NAPA, BCCSAP as well as new adaptation needs for the period 2015-2030 based on the current NAP Roadmap and the 7th Five Year Plan. Some examples of specific adaptation-related costs are set out below:

Table 7: Estimated costs of key adaptation measures

Adaptation measure	Estimated investment required (billion USD, 2015-2030)
Food security and livelihood and health protection (incl. water security)	8
Comprehensive disaster management	10
Salinity intrusion and coastal protection	3
River flood and erosion protection	6
Building climate resilient infrastructure	5
Rural electrification	3
Urban resilience	3
Ecosystem based adaptation (incl. forestry co-management)	2.5
Community based conservation of wetlands and coastal areas	1
Policy and institutional capacity building	0.5

5.2. Mitigation costs

Further work will be needed to assess the scale and scope of investment needs for mitigation activities (see section 4 on INDC implementation). But examples of the kinds of investment required (2011-2030) to implement key mitigation measures are set out below:

Table 8: Estimated costs of key mitigation measures

Mitigation measure	Estimated investment required (billion USD, 2011-2030)	
Switching to 100% super-critical coal power generation	16.50	
Developing utility-scale solar energy	1.30	
Scaling up wind energy	.60	
Repowering steam turbine with CCGT	.63	
Expanding the Solar Homes Programme	1.20	
Other solar	Solar Irrigations Pumps	.60
	Solar Mini-grids	.25
	Solar Nano-grids	.27
	Pico-solar	.10
Scaling up biomass production from sugar	.20	
Building an Elevated Express Highways in Dhaka for decongestion of the main urban traffic arteries	2.65	
Dhaka mass rapid transit system	2.70	

This is expected to ensure better synergy among financing intermediaries to leverage investments that are greater than the sum of their parts. Effective access to international climate finances is critical for implementation of the Bangladesh INDC to address adverse impacts of climate change for sustaining economic growth and thereby aiding to achieve middle-income country status by 2021.

Annex1 – Adaptation projects and achievements

List of adaptation projects

LGED:

Haor Infrastructure and livelihood Improvement Project (HILIP) including Climate Adaptation and Livelihood Protection (CALIP) – <http://www.lged.gov.bd/ProjectHome.aspx?projectID=274>

Emergency 2007 Cyclone Recovery and Restoration Project (ECRRP), LGED Part – <http://www.lged.gov.bd/ProjectHome.aspx?projectID=33>

Bangladesh Water Development Board (BWDB):

http://www.bwdb.gov.bd/index.php?option=com_content&view=article&id=133&Itemid=120

Bangladesh Inland Water Transport Authority (BIWTA):

http://www.biwta.gov.bd/website/?page_id=9

Road and Transport Highways Division, Ministry of Road Transport and Bridges:

The list of projects is divided into three sections.

- Foreign funded projects: http://www.rthd.gov.bd/foreign_project.php
- Mega Projects: <http://www.rthd.gov.bd/elibrary.php>
- Fast track projects: http://www.rthd.gov.bd/fast_track_project.php

Bangladesh Climate Change Trust:

<http://www.bcct.gov.bd/images/180814/Updated%20Project%20List%2017.11.pdf>

