Power and Energy

Sector Strategy Paper (SSP)

Programming Division, Planning Commission
Ministry of Planning
Government of the People's Republic of Bangladesh

March 2018

A H M Mustafa Kamal, FCA, MP
Minister, Ministry of Planning
and
Vice-Chairman, Bangladesh Planning Commission
Government of the People's Republic of Bangladesh

Message

The Government of Bangladesh has been implementing the 7th Five Year Plan (7FYP) to achieve the goals and targets envisioned in "Vision 2021", and our achievements are quite visible in most of the socio-economic indictors including Gross Domestic Product (GDP) growth rate. However, challenges remain to be addressed. Critically, public investment in all sectors needs to be better managed for maximising value for money and providing an enabling environment for private sector investment. Our Government fully recognises its importance and has made a commitment in the 7FYP to implement Public Investment Management (PIM) reforms.

In this context, I am pleased to learn that Programming Division of Bangladesh Planning Commission is going to launch a set of new PIM tools which will eventually improve the current PIM system in Bangladesh. I expect that the proper usage of these tools will strengthen strategic linkages among national plans, public investment, and budgeting, thereby achieving the national goals and targets in a more efficient, effective, and timely manner. Furthermore, I am glad to know that these new PIM tools have been thoroughly tested and validated in two pilot sectors- i) Power & Energy, and ii) Local Government & Rural Development. In due course, these will be rolled out to other Sectors and Ministries, Divisions and Agencies.

I would like to take the opportunity to congratulate the team of Government officials and experts of the "Strengthening Public Investment Management System (SPIMS)" project, supported by Japan International Cooperation Agency (JICA), who have successfully developed these PIM tools as part of PIM reform. Finally, I would like to express my heartfelt appreciation for the Government of Japan in their financial and technical support as well as friendship extended towards Bangladesh since our independence.

(A H M Mustafa Kamal, FCA, MP)

M. A. Mannan, MP
State Minister
Ministry of Finance and Ministry of Planning
Government of the People's Republic of Bangladesh

Message

It is my pleasure to put forward a set of new Public Investment Management (PIM) tools to my colleagues at the Planning Commission, Ministry of Planning, Ministry of Finance, and the Ministries, Divisions and Agencies (MDAs) under the Power & Energy Sector and the Local Government & Rural Development Sector.

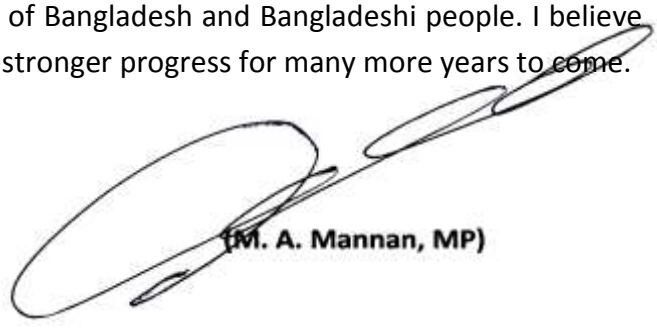
The new PIM tools comprise the i) Ministry Assessment Format (MAF), ii) Sector Appraisal Format (SAF), iii) Sector Strategy Paper (SSP), and iii) Multi-Year Public Investment Programme (MYPIP). I congratulate all public officials and experts who contributed to developing these tools through close collaboration and hard work under the Strengthening Public Investment Management System (SPIMS) Project. My special thanks go to the Programming Division of the Planning Commission for their excellent leadership and the initiative to engage a broad range of stakeholders in the process of developing these tools.

As State Minister in charge of the Ministry of Finance and Ministry of Planning, I have a few remarks to make regarding the new PIM tools.

First, the new PIM tools will contribute significantly to the implementation of two major governance reform initiatives – the Public Financial Management (PFM) Reform Strategy led by the Ministry of Finance, and the PIM Reforms led by Planning Commission, Ministry of Planning. Both reforms will require close collaboration between the two central ministries that are tasked to manage the national budget of the Government. I am very pleased that the new PIM tools have been developed through close collaboration between them.

Second, I am also delighted that the MDAs in the two pilot sectors have played an instrumental role throughout the Project. I would like to thank all the officers who participated in various seminars, workshops and consultation meetings and provided extremely useful feedback and comments to make the PIM tools relevant and effective in their day-to-day work at their respective assignments.

Last, but not least, I would like to thank the Japan International Cooperation Agency (JICA) for their technical and financial support for the project, and the Government of Japan for continued partnership and friendship with the Government of Bangladesh and Bangladeshi people. I believe and do hope that our partnership will make even stronger progress for many more years to come.



(M. A. Mannan, MP)

Md. Ziaul Islam
Member, Programming Division
&
Secretary, Planning Division
Ministry of Planning
Government of the People's Republic of Bangladesh

Foreword

The Strengthening Public Investment Management System (SPIMS) project is seeking to improve Public Investment Management (PIM) capacity with strengthened linkages between public investment projects and national development policies and fiscal frameworks. The Project is co-financed by the Japan International Cooperation Agency (JICA). The Project is being implemented by the Programming Division of the Planning Commission, supported by a JICA Expert Team (JET). Crucially, four key PIM tools have been developed under this project, namely the i) Ministry Assessment Format (MAF), ii) Sector Appraisal Format (SAF), iii) Sector Strategy Paper (SSP), and iv) Multi-Year Public Investment Programme (MYPIP).

The SSP will provide a comprehensive outlook of sectoral goals, performance, opportunities, and challenges, and above all, identify policies and strategies that support the 14 sectors of the Five Year Plans (FYPs). The SSP is a planning tool intended to support the translation of Sustainable Development Goals (SDGs), national goals and priorities outlined in the 7FYP into Sector objectives and strategies. Crucially, SSPs are a strategic link between the national level planning (FYPs) and planning and budgeting at the level of Ministries/Divisions /Agencies (MDAs), supporting the 'funnelling' of development objectives from national to sectoral and subsequently to Ministerial/MDAs levels. SSPs will provide greater detail and structure to sector-level objectives and strategies, thus aiding project design, appraisal, and approval. The SSP will be complemented by the MYPIP which provides an estimate for the upcoming budget year and two-year projection of the development budget.

As such, the Programming Division has taken the lead to prepare SSPs and MYPIPs for the two pilot sectors under the SPIMS Project. The SSP and the MYPIP are complementary and mutually reinforcing. These SSPs and MYPIPs have been prepared through a collaborative drafting process involving, inter alia, the Sector Divisions, General Economics Division (GED) and the Programming Division of the Planning Commission, Implementation Monitoring and Evaluation Division (IMED), Finance Division of the Ministry of Finance, and relevant MDAs. The drafts have been developed in consistency with the 7FYP and other policy documents related to these two Sectors.

For achieving the desired benefits of the new PIM tools it is necessary to start practicing them in the two pilot sectors. It is also the hope of the SPIMS project that other sectors will take the lead on preparing their own SSPs and MYPIPs. With this end in view, the SSPs were presented before the National Coordination Committee (NCC) of the SPIMS Project chaired by the Hon'ble Minister for Planning.

The NCC approved the SSPs developed by the SPIMS project for adoption and use within the pilot sectors. I strongly believe that use of the SSPs will facilitate and improve the existing process of project selection in line with the strategic directions of the 7FYP. This will bring about qualitative change in the whole process of project preparation, appraisal, approval, and implementation and also to achieve the Goals of 7FYP.

(Md. Ziaul Islam)

Md. Syeedul Haque
Chief, Programming Division
&
Project Director, SPIMS Project
Planning Commission, Ministry of Planning
Government of the People's Republic of Bangladesh

Acknowledgements

A new Public Investment Management (PIM) tool titled the "Sector Strategy Paper (SSP)" has been developed by the "Strengthening Public Investment Management System (SPIMS) Project" of the Programming Division, Planning Commission. SPIMS is managed by the Programming Division of the Planning Commission and the Japan International Cooperation Agency (JICA) Expert Team (JET) provided technical support. The purpose of the SPIMS project is to deliver structural improvements in PIM capacity, with strengthened linkages between public investment projects, national development policies, and fiscal frameworks.

The Programming Division gratefully recognizes the financial support of the Government of Japan and technical assistance of JICA in the implementation of the SPIMS project. The concerned officials of the JICA Bangladesh Office were actively involved in the implementation of the project activities for which they deserve special appreciation and thanks.

The members of the Sector Working Groups (SWGs) in the two pilot sectors of i) Power & Energy and ii) Local Government & Rural Development provided very useful contribution, guidance and inputs in the process of developing the PIM tools. The SPIMS project benefited immensely from the expert opinions of the members of the SWGs. We recognize their contributions with thanks and gratitude. We would also like to thank all the officials of the pilot Ministries/Divisions, Sector Divisions and GED of Planning Commission, IMED, ERD and Finance Division as well as those of the relevant agencies who cooperated with the SPIMS team in meeting and helping them with information and data.

We are extremely grateful to the respected Members of the Agriculture, Water Resources and Rural Institutions Division, Physical Infrastructure Division and Industry and Energy Division of the Planning Commission for kindly organising and chairing consultation meetings on the new PIM tools developed by the SPIMS Project and providing very useful suggestions for improving these documents.

The Member, Programming Division and Secretary, Planning Division lent invaluable support through his vast experience and able guidance as the Chair of the Project Steering Committee (PSC) in carrying forward the project activities. His unequivocal support was the greatest source of our inspiration. We are grateful to him.

The Hon'ble State Minister for the Ministry of Finance and the Ministry of Planning deserves thanks for his advice and guidance in the implementation of the SPIMS project.

We are also indebted to the Hon'ble Minister for Planning for approving the new PIM tools with the valuable instruction for utilising/practicing these tools by the Pilot Ministries/Divisions, Agencies and related Sector Divisions of Planning Commission.

Finally, we owe our thanks to all the members of the Project Implementation Unit (PIU), JET team and the local consultants for their dedication and hard work for the project. Without their unswerving endeavours and knowledge of best practice of PIM in other countries it would not have been possible to develop the new PIM tools.

The Programming Division looks forward to the cooperation of all concerned and their similar involvement in the next steps for using the new PIM tools as well as roll out of these tools to other sectors, Ministries/Divisions and Agencies, towards achieving the ultimate purpose and goal of the project.

(Md. Syeedul Haque)

POWER AND ENERGY SECTOR STRATEGY PAPER (PESSP)

Strengthening Public Investment Management System (SPIMS) Project

March 2018

TABLE OF CONTENTS

ABBREVIATIONS AND ACRONYMS

6FYP	6th Five Year Plan
7FYP	7th Five Year Plan
ADP	Annual Development Programme
BERC	Bangladesh Energy Regulatory Commission
BPDB	Bangladesh Power Development Board
BREB	Bangladesh Rural Electrification Board
DESCO	Dhaka Electricity Supply Company
DRF	Development Results Framework
DP	Development Partner
DPDC	Dhaka Power Distribution Corporation
DSM	Demand Side Management
EEC	Energy Efficiency and Conservation
EMRD	Energy and Mineral Resources Division
ERD	Economic Relations Division
FSRU	Floating Storage and Regasification Unit
FY	Financial Year
FYP	Five Year Plan
GED	General Economics Division
GoB	Government of Bangladesh
IAEA	International Atomic Energy Agency
IPP	Independent Power Producer
JICA	Japan International Co-operation Agency
KPC	Kuwait Petroleum Corporation
KWh	Kilowatt Hour
Km	Kilometre
ktoe	Kilo Tonne of Oil Equivalent
MDA	Ministry, Division, and Agency
mmcfd	Million Cubic Feet Per Day
MoPEMR	Ministry of Power, Energy, and Mineral Resources
MoST	Ministry of Science and Technology
MTBF	Medium Term Budgetary Framework
MTSBP	Medium Term Strategy and Business Plan

MW	Megawatt
MYPIP	Multi-Year Public Investment Programme
NLDC	National Load Dispatch Centre
O&M	Operation and Maintenance
P&E	Power and Energy
PA	Project Aid
PC	Planning Commission
PESSP	Power and Energy Sector Strategy Paper
PP	Power Plant
PPP	Public Private Partnership
PSMP	Power System Master Plan
SPIMS	Strengthening Public Investment Management System (JICA Project)
SREDA	Sustainable and Renewable Energy Development Authority
SRF	Sector Results Framework
SSP	Sector Strategy Paper
T&D	Transmission and Distribution
TCF	Trillion Cubic Feet
Tk.	Taka
USC	Ultra Super Critical
WZPDC	Western Zone Power Development Corporation

EXECUTIVE SUMMARY

Sector Definition

This SSP adopts an institutional definition of the Power and Energy sector, namely that the sector encompasses all the areas covered by the Ministry of Power, Energy and Mineral Resources (MPEMR) and that of its two main Divisions – Power Division and the Energy and Mineral Resources Division (EMRD).

That being said, this Power and Energy SSP recognises the critical role of the private sector in power development, including obtaining better value for money, on time delivery, performance assurance and access to financing, including through the mechanism of Public Private Partnerships (PPPs). International experience has demonstrated that government policies have a significant impact on attracting private sector participation in the power and energy sector, and Bangladesh is no different in this regard. The GoB has a crucial role to play in creating a climate which makes investment in energy and power infrastructure development attractive, thus supporting the strategic goal of "affordable, reliable, sustainable and modern energy for all" in Bangladesh through the development of conventional and non-conventional energy infrastructure, with both public and private sector participation.

Sector Situation

The power and energy sector in Bangladesh made impressive progress in the 6th Five Year Plan (6FYP) period from FY2010 to FY2015. Both key performance indicators (KPI) of this sector -- (1) per capita consumption of electricity, and (2) access to electricity as percentage of population -- surpassed their targets by 3 and 11 per cent, respectively, in FY2015.

The Government of Bangladesh (GoB), however, recognises that there remain many challenges arising from the implementation of the 6FYP as outlined in the 7th Five Year Plan (7FYP), the need to meet Sustainable Development Goal (SDG) targets, and potential opportunities arising from emerging trends.

Energy sub-sector

- Formulating a long-term strategy about how the growing needs of primary fuel will be met in the next 25 years and achieving Vision 2041.
- Exploring domestic gas resources, both onshore and offshore, to address the growing shortage of natural gas.
- Diversifying energy supply through (1) energy imports, both LNG and coal and supporting infrastructure, (2) energy conservation measures and Demand Side Management (DSM), and (3) renewable energy sources, biogas, and Improved Cooking Stoves (ICS).

Power sub-sector

- Curbing increasing electricity cost and improving financial viability of the power sub-sector, through fuel diversification, economic dispatch and improving energy efficiency.
- Enhancing reliability and network quality of power supply to meet rapidly increasing power demand and higher quality of power supply.
- Increasing capacity for power transmission and distribution to keep pace with the increasing generation capacity.
- Improving power sector efficiency by (1) reducing technical and non-technical losses, and (2) improved operation and maintenance (O&M) of power plants.

Cross-cutting issues

- Improving energy (gas) and power tariff setting mechanism to cover the 'true' cost of energy and power supply and reduce the burden of power subsidies on the national budget.
- Pursuing DSM in both energy and power sub-sectors, through regulatory reforms.

Sector Theory of Change

Building on the achievements, the 7th Five Year Plan (7FYP) sets forth the Sector Goal (outcome statement) for the power and energy sector:

> "***Ensure sustainability in production, consumption and use of power, energy and mineral resources***."

The 7FYP identifies the Key Performance Indicators (KPIs) and their targets over FY2016-FY2020 presented in the following Table. This is also aligned with the SDGs.

Key Performance Indicator (KPI)	Baseline (FY2015)	Target (2016)	Target (2017)	Target (2018)	Target (2019)	Target (2020)
Electricity installed generation capacity (MW)	13,540	14,943	16,399	19,249	20,649	23,000
Access to electricity (% of households)	72%	80%	85%	90%	94%	96%
Per capita generation of electricity (kWh)	371	398	425	454	483	514
Share of renewable energy to the total electricity generation (%) (including hydro)	3.6	5	6	7	8	10

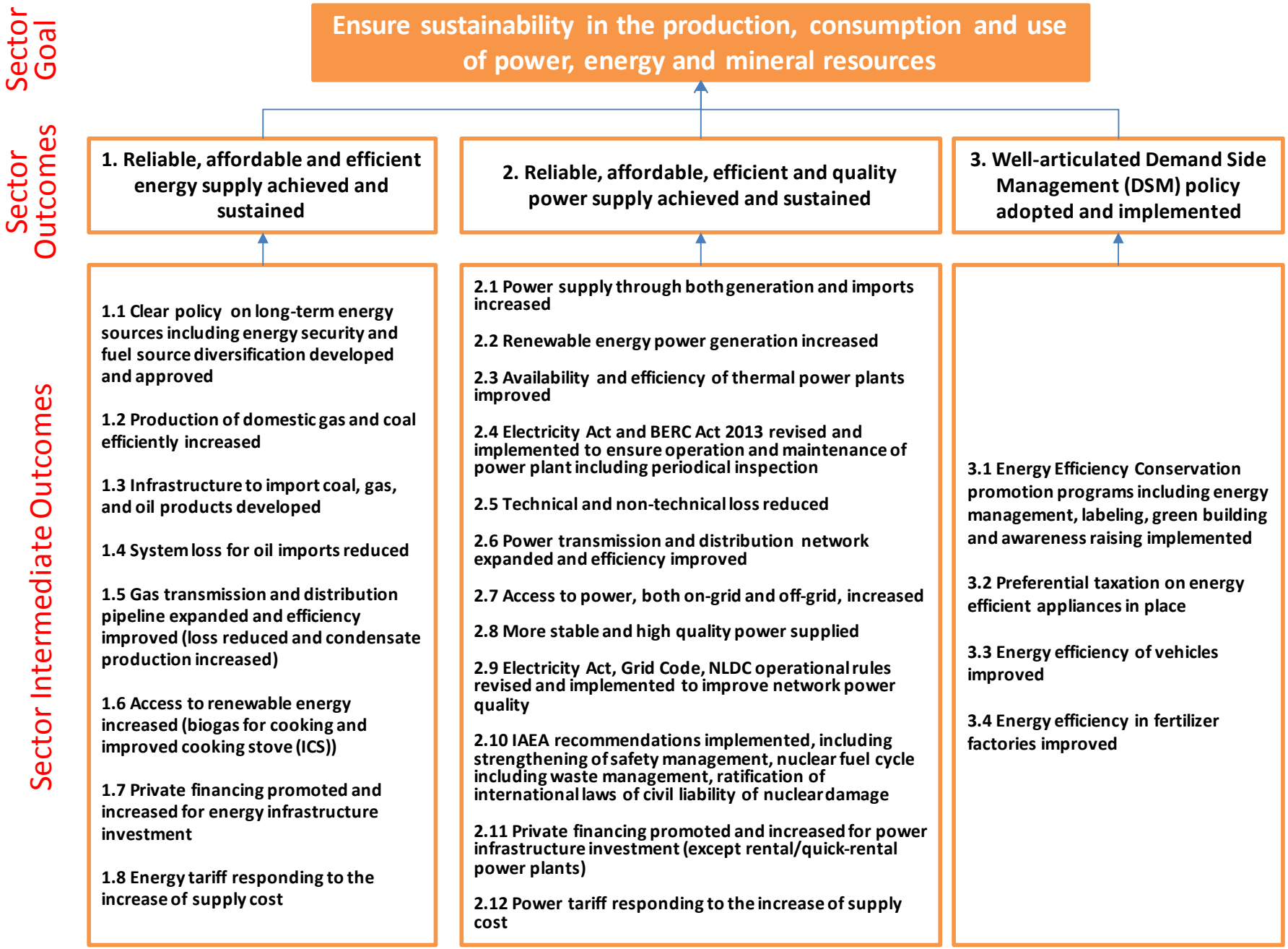
Source: 7FYP, p.155

The GoB will achieve the Sector Goal through the Theory of Change in the power and energy sector presented in the figure overleaf. Achieving three Sector Outcomes below will collectively attain the Sector Goal.

- ***Sector Outcome 1***: Reliable, affordable, and efficient energy supply achieved and sustained;
- ***Sector Outcome 2***: Reliable, affordable, efficient, and quality power supply achieved and sustained; and
- ***Sector Outcome 3***: Well-articulated Demand Side Management (DSM) policy adopted and implemented.

All interventions in the power and energy sector will contribute to the realisation of one or more Sector Intermediate Outcomes in the Sector Theory of Change. The achievement of those Sector Intermediate Outcomes will help deliver one of the three Sector Outcomes, thereby achieving the overarching Sector Goal.

To this end, concerned MDAs in the power and energy sector will identify and formulate investment projects and technical assistance projects to achieve one or more Sector Intermediate Outcomes, whereas the Planning Commission will appraise relevance of project proposals against the Sector Intermediate Outcomes.


Sector Goal
Ensure sustainability in the production, consumption and use of power, energy and mineral resources
Sector Outcomes
1. Reliable, affordable and efficient energy supply achieved and sustained
2. Reliable, affordable, efficient and quality power supply achieved and sustained
3. Well-articulated Demand Side Management (DSM) policy adopted and implemented
Sector Intermediate Outcomes
1.1 Clear policy on long-term energy sources including energy security and fuel source diversification developed and approved
1.2 Production of domestic gas and coal efficiently increased
1.3 Infrastructure to import coal, gas, and oil products developed
1.4 System loss for oil imports reduced
1.5 Gas transmission and distribution pipeline expanded and efficiency improved (loss reduced and condensate production increased)
1.6 Access to renewable energy increased (biogas for cooking and improved cooking stove (ICS))
1.7 Private financing promoted and increased for energy infrastructure investment
1.8 Energy tariff responding to the increase of supply cost
2.1 Power supply through both generation and imports increased
2.2 Renewable energy power generation increased
2.3 Availability and efficiency of thermal power plants improved
2.4 Electricity Act and BERC Act 2013 revised and implemented to ensure operation and maintenance of power plant including periodical inspection
2.5 Technical and non-technical loss reduced
2.6 Power transmission and distribution network expanded and efficiency improved
2.7 Access to power, both on-grid and off-grid, increased
2.8 More stable and high quality power supplied
2.9 Electricity Act, Grid Code, NLDC operational rules revised and implemented to improve network power quality
2.10 IAEA recommendations implemented, including strengthening of safety management, nuclear fuel cycle including waste management, ratification of international laws of civil liability of nuclear damage
2.11 Private financing promoted and increased for power infrastructure investment (except rental/quick-rental power plants)
2.12 Power tariff responding to the increase of supply cost
3.1 Energy Efficiency Conservation promotion programs including energy management, labeling, green building and awareness raising implemented
3.2 Preferential taxation on energy efficient appliances in place
3.3 Energy efficiency of vehicles improved
3.4 Energy efficiency in fertilizer factories improved

Implementation Strategy

The GoB will implement legal, regulatory, and institutional reforms in the 7FYP period that are required to achieve the sector objectives outlined in the sector Theory of Change.

Legal and regulatory issues

- Develop regulations on safety and security standards for nuclear power plants.
- Develop laws and regulations for the improvement of power quality.
- Develop regulations on periodical maintenance of power plants.
- Develop rules and systems for Demand Side Management (DSM).

Institutional issues

- Adopt a comprehensive National Energy Policy.
- Amend the Renewable Energy Policy.
- Adopt Power System Master Plan 2016 (PSMP2016).
- Develop institutional capacity and legal framework of National Load Dispatch Centre (NLDC).
- Strengthen Bangladesh Energy Regulatory Commission (BERC).
- Strengthen Sustainable and Renewable Energy Development Authority (SREDA).
- Approve draft Bangladesh Atomic Energy Regulations Act 2011.
- Strengthen procurement capacity within relevant MDAs.

Financing issues. Financing of the power and energy sector is a major challenge to achieve the Sector Goal. The 7FYP projection estimates a large funding shortfall in this sector over most of the 7FYP period. According to the estimation of 'fiscal space' (i.e. the sector budget ceiling minus forward baseline estimates) using the Multi-Year Public Investment Programme (MYPIP), the fiscal space of the power and energy sector is negative in FY2017-18 and FY2018-19, and only becomes positive in FY2019-20.

This points to the need for the GoB to expand fiscal space by exploring other sources of financing. Other potential sources of financing may include, but are not limited to: (1) increasing self-finance by autonomous bodies under the Ministry of Power, Energy, and Mineral Resources (MoPEMR); (2) increasing PPP arrangements; (3) adjusting electricity tariff policies; (4) enhancing efficiency of the power and energy sector; and (5) sector-specific foreign assistance. The adoption of new projects in this sector will require a careful fiscal space analysis to ensure that the budgetary implications of new projects for current and future years is accurately estimated and a set of remedial measures to expand fiscal space are well developed.

Sector coordination issues. The MoPEMR will take the lead role in the coordination of the power and energy sector. Other key institutions include the Industry and Energy Division, GED and Programming Division of the Planning Commission as well as IMED, Finance Division, ERD, Ministry of Science and Technology, Ministry of Foreign Affairs, Ministry of Road Transport and Bridges, and Ministry of Industries. The Energy Sector Working Group under the Local Consultative Group (LCG) mechanism will be a venue for dialogue and coordination between the GoB and Development Partners (DPs).

Sector Monitoring and Evaluation

The GoB will conduct monitoring and evaluation (M&E) using the Sector Results Framework presented in Chapter 5. The SRF, which consists of a Sector Results Matrix (SRM) and a Sector Results Monitoring Matrix (SRMM), will allow the GoB to conduct sector-level M&E at three levels – Sector Goal, Sector Outcomes, and Sector Intermediate Outcomes. This will complement the higher-level M&E through the Development Results Framework (DRF) in the 7FYP. The SRF in Chapter 5 covers the 7th FYP period from 2016 to 2020, and Annex III presents the long-term SRF from 2020 to 2040, addressing the need of long-term planning for infrastructure projects in the power and energy sector.

1 INTRODUCTION

1.1 Background

This Background section covers both: i) the methodology by which the Power and Energy Sector Strategy Paper (PESSP) has been produced, as well as ii) an overview of the SSP as a key planning tool. This PESSP has been produced through a collaborative exercise jointly led by the Programming Division and the Industry and Energy Division of the Planning Commission, in close collaboration with Power Division, Energy and Mineral Resources Division and other key stakeholders, notably General Economics Division (GED) of the Planning Commission, Implementation Monitoring and Evaluation Division (IMED) and Economic Relations Division (ERD).

The stakeholders from the following institutions were active participants in the SSP Formulation Workshop for the Power and Energy Sector from 3 – 5 March 2017: Industry and Energy Division of the Planning Commission, Power Division, Energy and Mineral Resources Division, Bangladesh Power Development Board (BPDB), Bangladesh Rural Electrification Board (BREB), Programming Division, ERD and Japan International Cooperation Agency (JICA). During the workshop, three key chapters of the PESSP were jointly formulated, namely Situation Analysis (Chapter 2), Sector Objectives (Chapter 3), and Sector Results Framework (Chapter 5). The remaining chapters were drafted by the JICA Expert Team (JET) in close consultation with SSP Formulation Workshop participants, who provided valuable inputs, feedback, and comments throughout the process.

The Sector Strategy Paper (SSP) is a planning tool intended to help translate national goals and priorities outlined in the 7th Five Year Plan (7FYP) into sector strategies and objectives. The 7FYP sets out national goals across 14 thematic sectors and has a high-level Development Results Framework (DRF). The SSP complements this by providing greater detail and structure to sector-level objectives and a basis on which these can be monitored and evaluated.

SSPs are designed to complement and be consistent with both the 7FYP and other strategic and policy documents. Their value-added lies in the way in which they focus on existing priorities in a concise, accessible, and logical manner. This PESSP draws heavily from, *inter alia*, Chapter 5 of the 7FYP, the Power Sector Master Plan (PSMP) 2016, Medium Term Budgetary Frameworks (MTBFs), Power Division Medium-Term Strategy and Business Plan (MTSBP), Annual Performance Agreements (APAs), and numerous other strategies and policy documents present within the sector. A list of the full documentation consulted is provided in Annex II.

1.2 Purpose

This PESSP is designed to offer benefits in six main areas:

- **Project identification**: by providing clear guidance to Ministries, Divisions, and Agencies (MDAs) and Statutory Bodies[1] engaged in the identification of projects to ensure that projects are aligned with sector goals and outcomes from the earliest stage;
- **Project formulation:** by providing clear guidance to MDAs and Statutory Bodies engaged in the formulation of projects to ensure that projects deliver sector goals and outcomes required to achieve 7FYP objectives;
- **Project appraisal:** by providing a means though which both Ministries/Divisions, Statutory Bodies, and Sector Divisions of the Planning Commission (PC) can assess and appraise project proposals against their relevance to the 7FYP;
- **FYP monitoring:** by elaborating a Sector Results Framework (SRF) that provides GED with more detailed information on sector-level performance to complement the higher-level DRF;
- **FYP financing:** by providing information on sector-level resource needs, including the cost of the current and planned investment portfolio, that is valuable to Finance Division, GED, and Programming Division; and
- **Aid co-ordination:** by providing a clear overview of current priorities within the power and energy sector from which Development Partners (DPs) – under the tutelage of the ERD – can identify prospective projects and programmes for funding.

It will also have broader relevance as a concise source of information on the power and energy sector for stakeholders both within the Government of Bangladesh (GoB) as well as outside (e.g. within the private sector and think-tanks/research institutes).

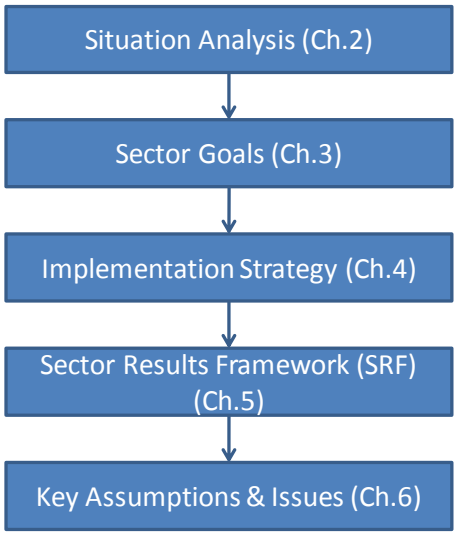
The PESSP should also be seen in the context of other GoB-led reform initiatives, notably attempts to strengthen the results-orientation of the 7FYP, including mapping the SDGs onto key 7FYP actions led by GED; efforts to improve the quality of project design and appraisal and to adopt a Multi-Year Public Investment Programme (MYPIP) both led by Programming Division; and ongoing budget management reforms led by Finance Division. It is important to note that care has been taken to align the structure of the PESSP with the structure of the Sector Action Plans (SAP) proposed by GED, to ensure consistency with each other and minimise duplication and overlap in sector level strategic planning efforts.

[1] Statutory Bodies such as the Planning Commission, Anti-Corruption Commission, Election Commission, and Public Service Commission do not fall under the category of 'Ministries, Divisions, and Agencies' (MDA) and should be considered separately.

1.3 Structure

The SSP is designed to be a concise, synthetic document and is therefore structured as in **Figure 1-1** below.

Figure 1-1 Structure of SSP



Chapter 2 provides a synthesis of situation analyses of sector performance. This chapter highlights the progress made to date, outlines the SDGs toward which Bangladesh is working, and identifies the main challenges and opportunities facing the sector. It also looks at the sector from a long-term perspective until 2041.

Chapter 3 elaborates the sector goals and objectives for the coming five years (7FYP period). The Chapter begins by focusing on the power and energy sector objective contained in the Development Results Framework (DRF) of the 7FYP. Then, it elaborates how this sector goal will be achieved through the Sector Theory of Change that outlines the key sector outcomes and intermediate outcomes through which the overarching Sector Goal will be achieved.

Chapter 4 highlights the key implementation strategies required to achieve the sector outcomes and intermediate outcomes. This covers the main areas of reform which need to be undertaken in the 7FYP period: 1) legal and regulatory; 2) institutional (including sector coordination mechanisms); 3) human resource capacity; and 5) financing, including expanding potential financing options for the sector.

Chapter 5 presents a Power and Energy Sector Results Framework (SRF) for the 7FYP period. This consists of two matrices, the Sector Results Matrix (SRM) and the Sector Results Monitoring Matrix (SRMM). The SRM includes indicators for each element of the Sector Theory of Change (namely the Sector Goal, Sector Outcomes, and Intermediate Outcomes), and specifies the lead institutions responsible for collecting data for each respective indicator. The SRMM then specifies the baseline for each indicator as well as intermediate and final targets to measure progress against key sector indicators. The SRMM also captures the ratio of ADP disbursement to FYP allocation at the level of intermediate outcomes, which provides a quick summary of sector performance.

Chapter 6 elaborates key assumptions and risks, as well as key risk mitigation strategies where possible.

Chapter 7 presents the Annexes. A full Multi-Year Public Investment Programme (MYPIP) for the power and energy sector is then provided in Annex I. This annex provides a list of all ongoing and approved projects in the power and energy sector that appear up to the Revised Annual Development Programme (RADP) FY2016-2017 issued at the end of March 2017. Annex II contains a Bibliography of all documents consulted. Finally, Annex III presents the Long-Term Sector Results Framework from 2020 to 2040 to address the need of long-term planning for infrastructure projects in the power and energy sector.

2 SITUATION ANALYSIS

2.1 Progress under the 6FYP

This section provides a situation analysis of the power and energy sector focussing on the sector performance during the 6FYP period (July 2010 – June 2015) and covering the specific areas of energy supply, power generation, transmission and distribution, institutional issues and fiscal performance.

Energy Sub-Sector

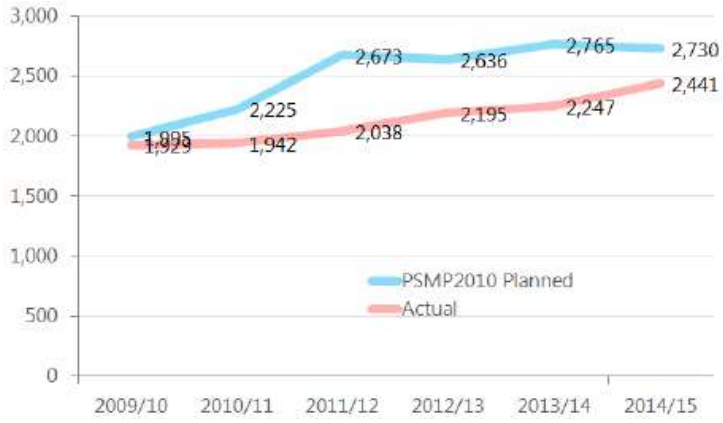
The energy sub-sector consists of gas, coal, oil, and renewable energy sources (e.g., biogas). The focus of sub-sector performance during the 6FYP period was on the two primary fuels that Bangladesh possesses, i.e., natural gas and coal.

Gas Exploration, Development and Fuel Diversification

In relation to natural gas, considerable progress was made during the 6FYP, in which average gas production surpassed 2,770 million cubic feet per day (mmcfd) in June 2015, a significant increase from 1,744 mmcfd in January 2009. By contrast, less progress was made in coal. Only one (Barapukuria) of five identified coal fields produced coal during the 6FYP period.

Despite considerable progress made in gas production, the 6FYP's target of boosting the proportion of domestic gas and coal production did not materialise. **Figure 2-1** shows the gap between the planned and actual natural gas production in the recent past. It reveals that the actual supply from 2009 to 2015 was lower than what was planned in Power System Master Plan 2010 (PSMP2010). The Power System Master Plan 2016 (PSMP2016) pointed out that the main factor of this gap is due to the production projection methodology and the gas reserve data used for the projection. Due to the shortage of gas supply, the share of gas in power generation fell from 84% in FY2010 to 63% in FY2015[2]. This contributed to an increase in the share of liquid fuel from 8% to 29%, a costlier source of power generation.

Figure 2-1 Gap between Planned and Actual Gas Production between 2010 to 2015

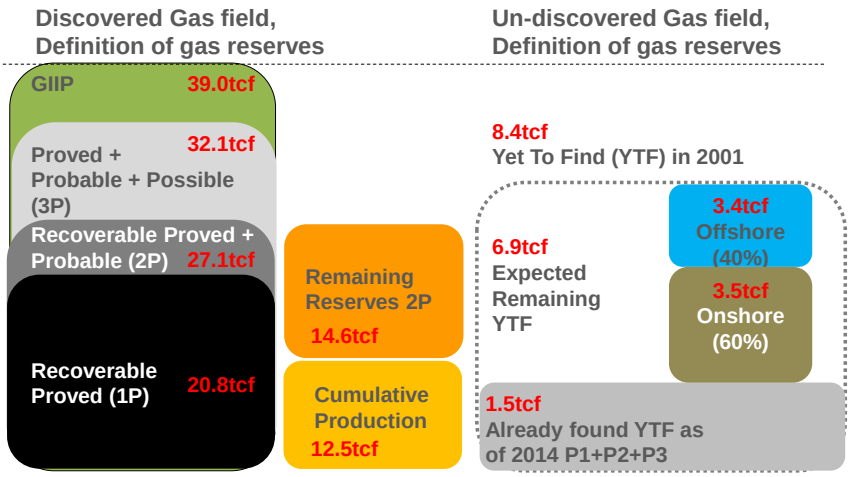


Source: PSMP2016

[2] 7FYP, p.18.

More importantly, the remaining gas reserve in Bangladesh is limited as presented in **Figure 2-2**. Although Bangladesh still has more than 14 Trillion Cubic Feet (TCF) as of 2015, the R/P (reserves to production ratio) is less than 10, one of the lowest ratios in the world.

Figure 2-2 Gas Initially In Place (GIIP) and Yet to Find (YTF) as of 2015



Source: PSMP2016

This points to an urgent need to address a fuel diversification challenge and restore financial sustainability of the power sub-sector. Besides the import of primary fuels such as coal, LNG and other petroleum products, the GoB will need to encourage the use of renewable energy sources as well as biomass-fuelled Improved Cooking Stoves (ICS) in the 7FYP period.

Gas Transmission and Distribution

Besides gas production, the supporting infrastructure of gas supply was considerably improved. For instance, 767km of high-pressure gas transmission pipelines was constructed between January 2009 and June 2015, and three compressor stations at Muchai, Ashuganj and Elenga were installed, and the first two become operational during the 6FYP period.

Key Developments over the 6FYP Period:

While the domestic gas production was steadily increased, the actual production was always lower than the planned, and the potential demand was not met. Gas transmission and distribution infrastructure were also improved.

Power Sub-Sector

The 7FYP highlights the "strong and well-rounded reform Programme" to increase the supply of electricity that was adopted over the 6FYP period. This Programme involved substantial investment, sector reforms, and regional trade.

Overall, power generation, transmission and distribution as well as the overall institutional framework were considerably improved in the 6FYP period. **Table 2-1** below presents two key indicators and targets in the 6FYP Development Results Framework: (1) per capita consumption of electricity; and (2)

access to electricity. Contrary to a common perception that those targets were highly ambitious, per capita electricity consumption surpassed the target by 3% between FY2010-2015, and access to electricity comfortably exceeded the target by 11%.

Table 2-1 Performance towards the 6FYP P&E Sector Objectives

Indicator	Baseline (FY 2010)	Target (FY 2015)	Actual (FY 2015)	Difference (Actual vs. Target, %)
Per capita generation of electricity	220 KWh	360 KWh	371 KWh	+3%
Access to electricity (% of population)	48%	71%	72%	+1%

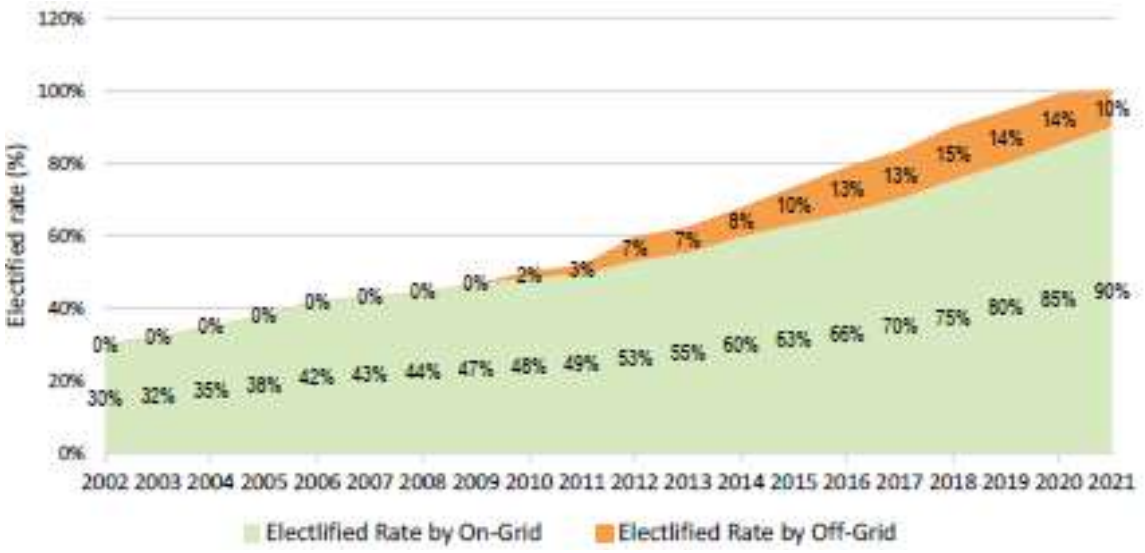
Source: 7FYP; authors' calculations.

Generation

The 6FYP had a target of total installed generation capacity of 15,457 MW by 2015. Whilst actual performance fell short of this target, it is still impressive that installed grid-based power generation capacity expanded to 13,540 MW (including captive power) by FY2015. On a per capita basis, electricity generation rose from 220 KWh per capita in 2010 to 371 KWh per capita in 2015, exceeding the 2015 target of 360 KWh per capita. Progress was also made in engaging with energy trade. In line with the 6FYP target, some 500MW of power was added to the national grid based on purchases from India.

Significant progress continues to be made in expanding off-grid generation, contributing to the impressive growth in access to electricity of nearly 80% as of 2016 as shown in **Figure 2-3**. In addition, more attention was paid to renewable energy generation, particularly solar, during the 6FYP period.

Figure 2-3 Progress of Electrification Rate (actual and projection)



Source: PSMP2016

Transmission and Distribution

The success with the expansion of generation capacity along with expansion of transmission and distribution networks helped achieve considerable progress for the power sector over the period 2010-2015.

The 6FYP aimed to increase efficiency of energy use and reduce system loss. The transmission and distribution (T&D) loss, an indicator of system loss, reduced from 16% in 2010 to 13% in 2015, below the target loss of 14%.

Key Developments over the 6FYP Period:

Several major power generation projects were initiated in the 6FYP period including the Matarbari Coal Fired Power Project (2 600MW) and the Ashugonj 450 MW plant and the Rooppur Nuclear Power Plant.*

Dozens of power transmission and distribution projects were also initiated over the 6FYP period including several transmission projects designed to improve regional interconnectivity with India and Nepal.

Fiscal Performance

Table 2-2 below presents fiscal performance of the power and energy sector over the 6FYP period. Three key observations can be made. Firstly, there was significant growth in both allocations and actual expenditure over the five-year period. The ADP allocation rose by 88% from FY2011 to FY2015 and ADP expenditure rose by 47%. Secondly, the actual ADP allocation diverged from the initial 6FYP allocation over the five-year period. Although they were about the same level in FY2011, the actual ADP allocation declined to only 73% of the initial ADP allocation by FY2015. Finally, after initially exceeding the ADP allocation in FY2011 (reallocations through the RADP process), the ADP expenditure fell to 88% of the ADP allocation in FY2015.

Table 2-2 Fiscal Performance of the Power and Energy Sector (FY2012-FY2015; Billion Taka)

	FY2012			FY2013			FY2014			FY2015		
	Allocation		ADP	Allocation		ADP	Allocation		ADP	Allocation		ADP
	ADP	6FYP	Expenditure	ADP	6FYP	Expenditure	ADP	6FYP	Expenditure	ADP	6FYP	Expenditure
Power Division	71.9	70.7	71.6	85.6	85.6	88.5	79.3	109	78.3	92.7	134.6	83.3
Energy and Mineral Resources Division	7.3	15.5	7.5	16.1	17.2	16	19	20.1	18.4	22.2	22.9	18.1
Total	**79.2**	**86.2**	**79.1**	**101.7**	**102.8**	**104.5**	**98.3**	**129.1**	**96.7**	**114.9**	**157.5**	**101.4**

Source: 7FYP

Other Issues

Financial viability of the power sector further diminished in the 6FYP period, largely because of a significant increase in the marginal cost of electricity. The 6FYP aimed to eliminate Tk. 12 billion of subsidies to the sector by FY2015. On the contrary, the subsidies ballooned to Tk. 61 billion by FY2015. This unfavourable performance resulted from higher cost of production that had required budget support for the power sector, even though average electricity prices were raised several times during the 6FYP period.

2.2 Sustainable Development Goals (SDGs)

In 2015 the United Nations adopted the Sustainable Development Goals (SDGs) as new development targets to be achieved by 2030. The SDGs are based on the Millennium Development Goals (MDGs), but intend to cover more comprehensive agendas and a wider group of stakeholders. First, MDGs were targeted only at "developing countries," whereas the SDGs also encompass "developed countries". Second, the 17 SDGs focus on a broad range of global issues with sustainable development as the cross-sectoral theme. Finally, the SDGs call for international efforts to address some global issues that were not included in the MDGs. The case in point is the power and energy sector that has specific references in the SDGs, but none in MDGs.

Out of 17 SDGs, the following four goals have strong connection with the power and energy sector development:

Goal 7 (Affordable and clean energy): Ensure access to affordable, reliable, sustainable, and modern energy for all;

Goal 9 (Industry, innovation, infrastructure): Build resilient infrastructure, promote sustainable industrialization, and foster innovation;

Goal 12 (Ensure sustainable consumption and production patterns); and

Goal 13 (Climate action): Take urgent action to combat climate change and its impacts.

Under the respective Goals, several targets are set forth to be achieved by 2030[3]:

Goal 7 (Affordable and clean energy) Targets:

1) Ensure universal access to affordable, reliable, and modern energy services.
2) Increase substantially the share of renewable energy in the global energy mix.
3) Double the global rate of improvement in energy efficiency.
4) Enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology.
5) Expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing states, and land-locked developing countries, in accordance with their respective programs of support.

[3] United Nations. 2015. Transforming Our World – the 2030 Agenda for Sustainable Development.

Please refer to Annex I for a detailed description of Goals 9, 12 and 13.

Translating the GoB's commitment to the SDGs into action, the GED developed a document entitled: 'Mapping of Ministries and Divisions by SDGs' Targets.' This document outlines a broad set of actions to achieve the SDG targets in the 7FYP period, and specifies lead and associated Ministries and Divisions in the sector that are responsible for those actions. Power Division and the Energy and Mineral Resources Division (EMRD) will take the leading role in achieving the SDG targets of the power and energy sector, whereas the other institutional actors in the following are deemed essential for achieving the SDGs in the sector:

- Ministry of Science and Technology (MoST) -- Issues related to nuclear power generation;
- Ministry of Foreign Affairs (MoFA) -- Issues related to energy and power imports;
- Sustainable & Renewable Energy Authority (SREDA) -- Issues related to the dissemination of information, especially Demand Side Management (DSM) and energy conservation measures; and
- Economic Relations Division (ERD) of the Ministry of Finance -- Issues related to the enhancement of international cooperation to facilitate access to clean energy research and technology.

These institutional coordination issues are discussed in detail in Chapter 4 on Implementation Strategies where an institutional map of the power and energy sector is presented and specific coordination mechanisms are outlined.

2.3 7th Five Year Plan (July 2015 – June 2020) for Power and Energy Sector

7FYP Development Results Framework

The Development Results Framework (DRF) of the 7FYP sets forth the following outcome statement for the power, energy, and mineral resources sector:

> ***Ensure sustainability in production, consumption and use of energy and mineral resources.***

Under this statement, the DRF also identifies four key performance indicators for the sector as summarised in **Table 2-3**.

Table 2-3 7FYP DRF Indicators for the Power and Energy Sector

Key Performance Indicator (KPI)	Baseline (Year)	Target (2016)	Target (2017)	Target (2018)	Target (2019)	Target (2020)
Electricity installed generation capacity (MW)	13,540 (FY 2015)	14,943	16,399	19,249	20,649	23,000
Access to electricity (% of households)	72 (FY 2015)	80%	85%	90%	94%	96%

Key Performance Indicator (KPI)	Baseline (Year)	Target (2016)	Target (2017)	Target (2018)	Target (2019)	Target (2020)
Per capita generation of electricity (kWh)	371 (FY 2015)	398	425	454	483	514
Share of renewable energy to the total electricity generation (%) (including hydro)	3.6 (FY 2015)	5	6	7	8	10

Source: 7FYP (p.155)

The 7FYP further elaborates a set of priorities for the power and energy sector over the 2016-2020 period, which are aligned with the goal of energy security set forth in the Perspective Plan 2010 – 2021. These are presented below.

Energy Sub-Sector

The key energy priorities over the 7FYP period are summarised as follows.

- The development of a Gas Allocation Policy to address critical gas supply issues.
- The development of a Domestic Gas Exploration Policy to exploit the potential of untapped domestic gas resources, which cost less than LNG imports.
- Improving the efficiency of domestic coal utilisation to ensure that high quality domestic coal is channelled to higher value-added processes.
- Increasing energy imports, including diversifying gas suppliers, natural gas import strategy incorporating the current increase of spot trade, as well as identifying potential coal suppliers.
- Encouraging Demand Side Management (DSM) and energy conservation.
- Encouraging the increase of renewable energy sources, including biomass-based Improved Cooking Stoves (ICS).
- Developing an appropriate energy subsidy and pricing policy for increased fiscal sustainability and the promotion of efficient energy use.

Power Sub-Sector

The key power generation priorities over the 7FYP period are summarised as follows.

- Increasing the installed generation capacity to 23,000 MW by 2020.
- Reducing the cost of electricity generation by restricting the reliance on high-cost rental power plants and more attention to the choice of fuel (favouring gas and coal over fuel oil and diesel).
- Greater emphasis on operation and maintenance (O&M) to maximise the power generation yield from installed capacity and ensure system reliability.
- Greater reliance on Independent Power Producers (IPPs) to meet the financing gap.
- Increasing the share of renewable power generation, particularly from solar and wind power.
- Increased use of power trade with neighbouring countries (particularly India and Nepal), with 600MW to be obtained through this source by the end of the 7FYP.

The key power transmission and distribution priorities over the 7FYP period are as follows:

- Further reducing transmission and distribution (T&D) losses from 13 per cent in FY2015 to 12 per cent by FY2020.
- Construction of around 8,000km of new transmission lines and 120,000km of distribution lines;
- An additional 90,000km of distribution lines and other investments by the Bangladesh Rural Electrification Board (BREB) aimed at increasing the number of consumer connections by 7 million;
- Specific T&D targets for BPDB, Dhaka Power Distribution Company (DPDC), Dhaka Electricity Supply Company (DESCO), and West Zone Power Distribution Company (WZPDC).

Demand Side Management (DSM)

The pricing strategy of 7FYP is to eliminate all operational deficits and subsequently to generate a surplus so that the sector can finance 10-15 per cent of its annual investment through its own resources. A proper pricing strategy, including proper metering (e.g. pre-paid meters for gas and power), will set a strong incentive to use primary energy (especially natural gas) and electricity more efficiently, and hence contribute to the broader demand side management (DSM) that will support energy conservation policies.

2.4 Challenges and Opportunities

This section presents a synthesis of the main challenges and opportunities in the energy and power sub-sectors. It focuses on the main challenges arising from the implementation of the 6FYP as outlined in the 7FYP, the need to meet SDG targets outlined above, and potential opportunities arising from emerging trends.

Energy Sub-Sector

Formulating a long-term strategy on energy sub-sector. A key challenge in primary energy is the absence of a long-term, strategic view about how the growing needs of primary fuel will be met in the next 10 – 20 years as seen in **Figure 2.1** and **Table 2.3**. The GoB needs to finalise and adopt the pending National Energy Policy, and adopt the energy strategy outlined in the Power Sector Master Plan (PSMP) 2016. The PSMP 2016 outlines the following energy demand projection and supply targets by 2041 in **Table 2-4** below.

Table 2-4 Long-term Targets of Energy Sub-Sector

Indicators	Current (2015)	Projection/Target (2041)
Total Primary Energy Demand (ktoe)	27,549	98,071
Energy Intensity (toe/million taka)	3.42	2.56
Gas		
Domestic Gas Production[4] (mmcfd)	2,500	2,000
Import LNG (mmcfd)	0	4,000
Coal		
Domestic Coal (million tons/year)	0.7	11
Import Coal (million tons/year)	0	60
Oil		
Import Oil (million tons/year)	5	30

Source: PSMP2016

The following figures show a striking increase of energy consumption growth (

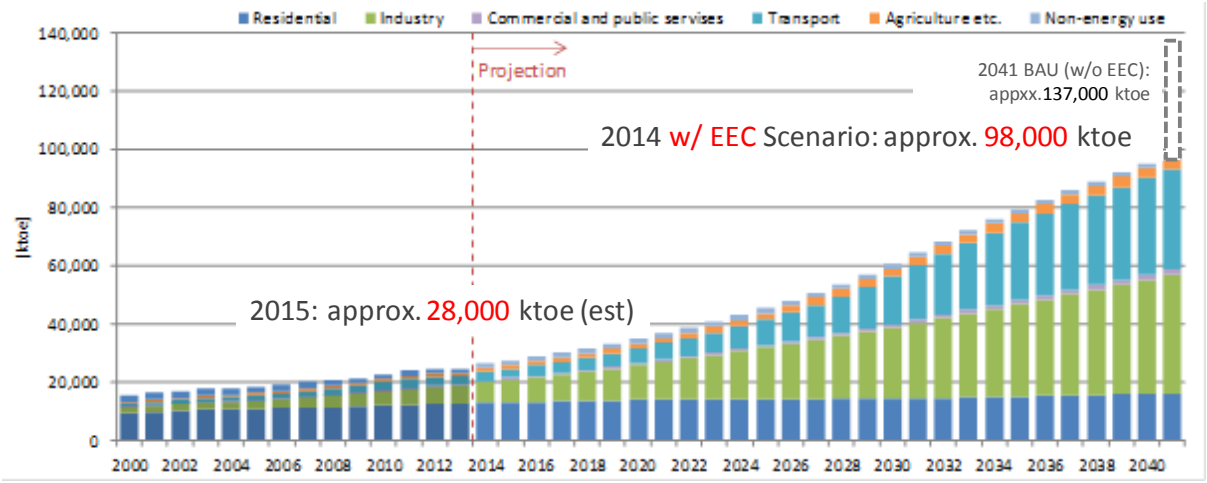
[4] Domestic gas production includes the exploration and development of yet-to-be-found resources, both on-shore and off-shore.

Figure 2-4), and the energy diversification needs to meet such demand growth (**Figure 2-5**).[5] It is projected that energy consumption in 2041 would be 3.5 times more than that at the current level. It should be noted that such energy consumption and demand projection are based on the assumptions that (1) the energy efficiency and conservation (EEC) is holistically implemented from primary energy supply to electric power generation and consumption, and (2) the energy intensity is improved over the long-run.[6] If Bangladesh cannot achieve the EEC for whatever reasons, it is projected that its energy requirement would be nearly 5 times more than at current levels. Approaching the new era of a Bangladesh economy that would be dependent on imported fuel, more energy requirement would immediately imply the outflow of national wealth in the near future.

[5] In this document, the term "energy consumption" is distinguished from "energy demand", where the former means the energy required by various sectors including power generation, while the latter means the synonym of "energy supply" as seen in the Total Primary Energy Supply (TPES) of IEA energy balance statistics. Therefore, "energy supply (or demand)" is the sum of "energy consumption" and the total loss in the energy and power systems.

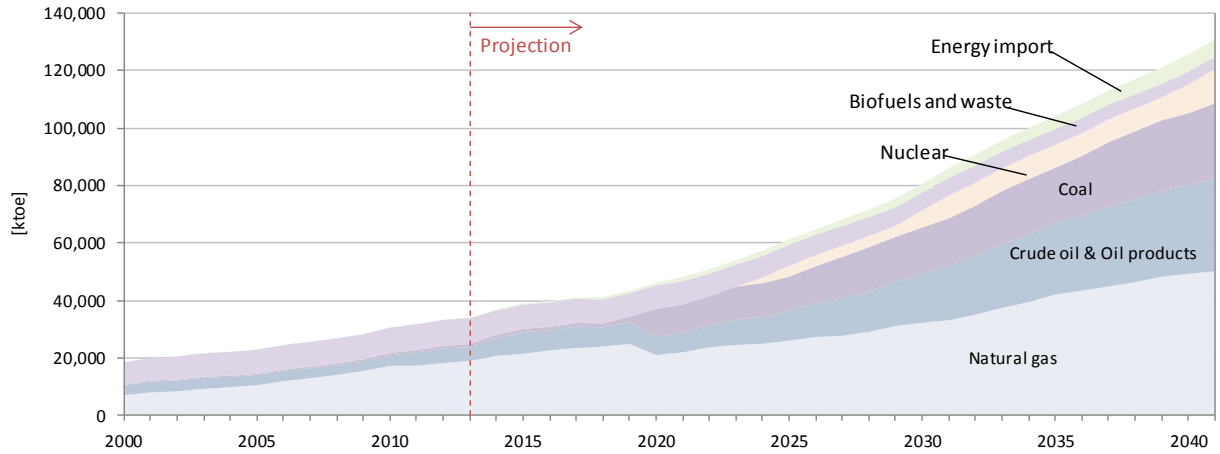
[6] Energy intensity is defined as the energy consumed per economic activity. Generally it is defined as the amount of energy (ktoe) per GDP (or sectorial value-added). It should be noted, however, that energy intensity is not determined by solely by energy efficiency, but also by various factors such as economic structure, industry base, affordability and accessibility to energy.

Figure 2-4 Final Energy Consumption Projection with EEC Scenario (2015-2041)



Source: Modified based on PSMP2016

Figure 2-5 Total Primary Energy Supply Projection (2015-2041)



Source: PSMP2016

Bangladesh is therefore facing a major challenge, i.e., the need to transition from dependence on cheap, abundant domestic natural gas to expensive import of primary energies such as natural gas, oil and coal, in all sectors. However, this may be considered as a potentially significant opportunity to transform Bangladesh to a more energy efficient economy as well.[7]

[7] It is worthwhile to mention that the projected TPES in the 2040s, approximately 130,000 ktoe in Figure 2-5, happens to be the same level to the projected total primary energy final consumption under BAU scenario (i.e. without EEC programme implementation) in the same period in Figure 2-4. This indicates that in Bangladesh, the energy and power supply loss incorporating the impact of the future energy intensity improvement (e.g. fertilizer plants and gas-fired thermal power plants efficiency improvement, and system loss reduction in power transmission and distribution lines) would happen to be the same level of EEC saving potential.

Exploring domestic natural gas resources. Facing up to the challenge of growing shortage of natural gas, Bangladesh needs to potentially explore a considerable amount of unexplored and undiscovered gas resources, both onshore and offshore.

Petrobangla and its subsidiaries will take the lead in exploring onshore resources with the Gas Development Fund (GDF) where 15% of gas tariff is utilised for upstream exploration and development. A key opportunity for onshore and offshore exploration of undiscovered resources is Production Sharing Contracts (PSCs) with reputed International Oil Companies (IOCs). The IOCs will be selected based on a competitive-bidding process, because direct contract is not suitable for ensuring effectiveness of contract and transparency of the selection process of IOCs.

Promoting natural gas efficient use. Another key opportunity is to use "merit-based gas allocation" with the adoption of Gas Allocation Policy, in which scarce gas resources are allocated for more energy efficient users. Adoption of this policy will save much volume of natural gas that is currently provided to inefficient state-owned, gas-fired power plants and fertilizer factories. The gas saving under this policy is estimated to amount to 92 BCF/year that could fuel 2,300 MW state-of-the-art, gas-combined-cycle power plants.

Diversifying energy supply. There is an urgent need to address energy supply diversification to restore financial sustainability of the power and energy sector. A recent decline in international oil prices has provided a relief in energy supply. Yet, the trends of future oil prices remain uncertain. Besides increasing domestic gas, considerable emphasis will be given to at least four other energy sources: (1) energy imports, both LNG and coal, and their supporting infrastructure; (2) energy conservation measures[8] and Demand Side Management (DSM); (3) renewable energy sources[9] such as biogas and solid biomass-based Improved Cooking Stoves (ICS); and (4) utilization of high quality coal from Barapukuria for higher value-added processes such as corking coal or export with the development of Domestic Coal Utilization Policy .

A major challenge in expanding energy imports is to implement large-scale public investment for port facilities and related infrastructure to import coal and LNG. Renewable energy sources are crucial first to encourage development of environmentally-friendly, low-carbon energies, and second to improve energy access for rural people.

Power Sub-Sector

Despite a major progress in the 6FYP period, some key challenges remain to be addressed in the power sub-sector.

Curbing an increasing electricity cost and improving financial viability. The marginal cost of electricity increased considerably because most of the power plants added to the national grid use liquid fuel-based sources. These plants incur much higher power generation costs than other power

[8] In line with Bangladesh's Energy Efficiency and Conservation Master Plan up to 2030 (Power Division, MPEMR)

[9] In line with Bangladesh's Renewable Energy Policy 2008 (Power Division, MPEMR)

plants using gas and coal. In addition, inefficient use of gas at some power plants calls for additional (or recoverable) generation capacity and regulatory reforms discussed earlier.

Enhancing reliability and network quality of power supply. The nationwide blackout[10] experienced in November 2014 resulted from the failure of a single high voltage transmission line connecting Kushtia with West Bengal in India. This points to the need to enhance reliability of power supply to meet rapidly increasing demand for power. Enhancing network quality is also required to maintain quality of industrial products in domestic and international markets. The network quality is also a prerequisite for safe operation of nuclear power plant (NPP) since it requires highly stable network quality with the frequency within 50±0.5 Hz. The issue of network quality must be addressed through enhancing infrastructure and strengthening institutions and organisations.

Increasing capacity for power transmission and distribution. Besides increasing power generation, increasing capacity for transmission and distribution is crucial to keep pace with the increase in power generation and solve bottlenecks in the system which prevent residences and businesses from receiving electricity. Additional generation capacity will be ineffective without increased transmission and distribution capacity. An analysis suggests that many of the rolling "brownouts" which occur during summer months may be due to transmission and distribution bottlenecks, not necessarily capacity constraints of power generation.[11]

Improving power sector efficiency. Over the 6FYP period the power sector successfully achieved substantive reduction in transmission and distribution losses. Building on the achievement, effort will be made to further improve power sector efficiency. First, there is scope for further reducing technical and non-technical losses in power transmission and distribution. Second, there is large potential to improve efficiency of thermal power plants, including ensuring appropriate operation and maintenance (O&M) of these power plants through appropriate regulation.

Renewable Energy. Though Bangladesh is the world's fastest growing country in terms of dissemination of small Photovoltaic (PV) systems for households (SHS), it still faces many challenges in introducing utility-scale (large scale) renewable energies. First, Bangladesh has scarce land available, especially for large scale solar PV (as it has low energy density and requires large space). Second, Bangladesh's renewable energy potential is yet to be fully realised, especially in wind and biomass (municipal waste). As a result, Bangladesh's current renewable energy portfolio unevenly concentrates on small/off-grid solar PV, and projects and pipelines of other renewable energy sources are relatively small. Third, Bangladesh needs further technical standards and regulations for grid-connected renewable generation, especially solar and wind (as their outputs are variable and can cause network disturbance). While Bangladesh has already approved the first private-owned grid-connected large scale PV project and developed the feed-in-tariff, detailed technical standards and regulations especially for the grid-connecting technologies are yet to be achieved.

[10] Blackout referred as a period of darkness caused by a power system failure, specifically in a wider area or even nation-wide. A specific example is the one happened in November 2014 in Bangladesh. Such "blackout" is differentiated from "power outage" in the Bangladesh context.

[11] Power Division. 2015. Power Division Medium Term Strategy and Budget Plan: 2016-2020. It should be noted that 'brownout' could be also caused by fuel shortages and older plants operating at reduced capacity.

Power Trade. To address power network reliability and quality improvement, and at the same time to explore the potential of renewable energy, power trade with neighbouring countries would be one of the solutions. Indeed, additional power imports will be sought through grid lines from India (this process is underway). Potential power trading agreements will also be sought with countries like Bhutan, Nepal and Myanmar to exploit their hydropower potential. In addition, the potential for regional cooperation in gas exploration is a further opportunity to be explored. The PSMP 2016 (Section 8.7) mentions the potential for cross-border LNG trade, specifically the development of a cross-border gas transmission pipeline from a Floating Storage and Regasification Unit (FSRU) in the state of West Bengal, India to a to-be-built gas combined cycle power plant in Khulna, Bangladesh.

Cross-cutting issues

Besides the specific sub-sector challenges and opportunities identified above, there are key cross-cutting issues which apply to both power and energy.

Improving energy and power tariff setting mechanism. Improving energy and power tariff setting mechanism is crucial to ensure that consumers pay the 'true' cost of energy and power supply, and reduce the burden of energy and power subsidies on the national budget. Currently Bangladesh Power Development Board (BPDB) receives significant budgetary support from the GoB to fill the financial gap between the generation cost which BPDB pays to power generators and bulk supply tariff that BPDP charges to users. Both national gas and oil tariffs will be exposed to international market price fluctuation and exchange rate risks. Significant risks of the subsidy regime to the national coffer could become reality. Adjusting tariff policy will help ensure that the rates for energy and electricity cover reasonable operating costs of energy and power utilities.

Optimising choice for power generation. While tariff setting is mainly an issue for the Bangladesh Energy Regulation Commission (BERC), the choice of fuel for generation critically affects supply costs and consequently the amount of budget support by MoF for the sector. In addition, demand side management (DSM) will help manage electricity loads and curtail peak demand of 4,000MW, which would reduce peak capacity use and translate into cost savings for investment in new capacity. SREDA will be critical for the implementation of DSM.

Impact on society and the environment. The importance of reliable energy and power supply for Bangladesh's development cannot be denied. However, its impact on both society and the environment remains a point of contention, especially in relation to coal-based power plants and the development of nuclear energy. Besides key issues around land acquisition and the impact of resettlement on communities, there are also significant environmental concerns around the negative impact of coal-fired power plants as well as the management and disposal of spent fuel and other nuclear waste.

3 POWER AND ENERGY SECTOR OBJECTIVES – Theory of Change

3.1 Scope of the Power and Energy Sector

Before we examine the Sector Objectives in detail, it is important to reiterate the scope of the Power and Energy sector as defined in this SSP. This SSP adopts an institutional definition of the Power and Energy sector, namely that the sector encompasses all the areas covered by the Ministry of Power, Energy and Mineral Resources (MPEMR) and that of its two main Divisions – Power Division and the Energy and Mineral Resources Division (EMRD).

That being said, this Power and Energy SSP recognises the critical role of the private sector in power development, including obtaining better value for money, on time delivery, performance assurance and access to financing, including through the mechanism of PPPs. International experience has demonstrated that government policies have a significant impact on attracting private sector participation in the power and energy sector, and Bangladesh is no different in this regard. The GoB has a crucial role to play in creating a climate which makes investment in energy and power infrastructure development attractive, thus supporting the strategic goal of "affordable, reliable, sustainable and modern energy for all" in Bangladesh through the development of conventional and non-conventional energy infrastructure, with both public and private sector participation. The role of the private sector is further discussed in Sections 3.4 (Strategies to Achieve 7FYP Targets) and 3.5 (Financing Strategy).

3.2 Sector Theory of Change

The priorities in the 7FYP, Power Sector Master Plan (PSMP) 2016, and other key strategies and policies were discussed at the SSP Formulation Workshop for the Power and Energy Sector from 3 – 5 March 2017.[12] The workshop was conducted in a highly active and participating manner. The participants conducted situation analysis, discussed sector objectives, and developed a sector-level Theory of Change presented in **Figure 3-1.**

The Power and Energy Sector Theory of Change has been developed in line with the targets outlined in the FYP DRF (discussed in Section 2.3 above) as well as the current performance of the sector in relation to the KPIs outlined in the 7FYP DRF. Based on updated information from Power Division (collected in September 2017) presented in the Table below, it is emerging that the power and energy sector is not currently meeting its KPI targets as set forth in the 7FYP, with the exception of per capita generation of electricity, which currently stands at 433kWh, exceeding the target of 425kWh set in the 7FYP.

[12] Participants of this workshop were drawn from the Industry and Energy Division of the Planning Commission, Power Division, Energy and Mineral Resources Division, Bangladesh Power Development Board (BPDB), Bangladesh Rural Electrification Board (BREB), Programming Division, ERD and JICA. For the list of key documents, see the Bibliography.

Key Performance Indicator (KPI)	Baseline (FY2015)	Target (2017)	Actual (June 2017)
Electricity installed generation capacity (MW)	13,540	16,399	15,821
Access to electricity (% of households)	72%	85%	80%
Per capita generation of electricity (kWh)	371	425	433
Share of renewable energy to the total electricity generation (%) (including hydro)	3.6	6	1.7

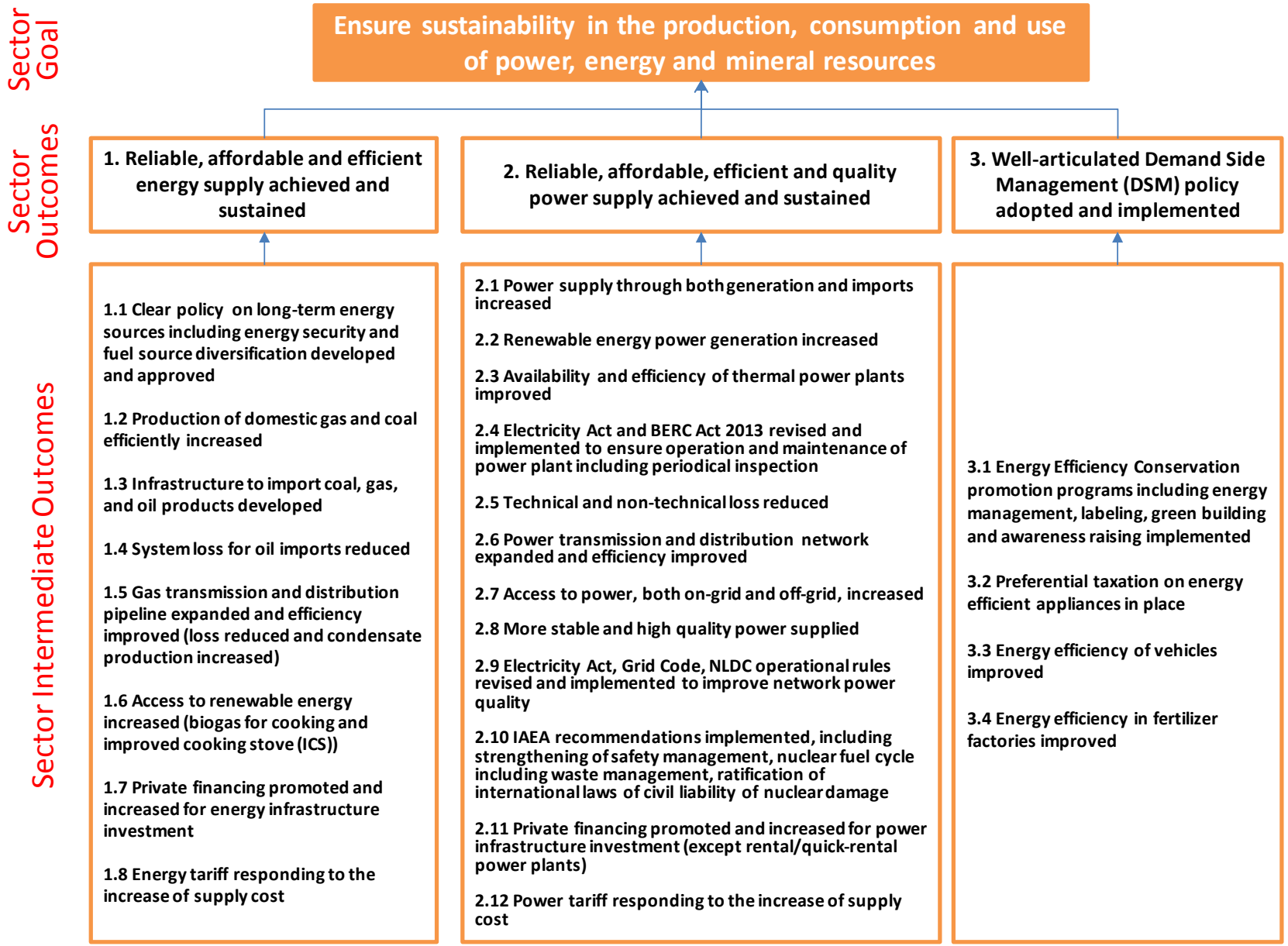
This creates an additional imperative which underlies the importance of achieving the Sector Goal, Outcomes and Intermediate Outcomes discussed below, especially in the areas of electricity installed generation capacity, access to electricity and share of renewable energy generation.

The Theory of Change provides a logically structured framework for the design, formulation, appraisal, and approval of projects in the power and energy sector. All interventions in this sector should contribute to the realisation of one or more Sector Intermediate Outcome, which if achieved, will help deliver one of three Sector Outcomes required to achieve the overall Sector Goal. The assumptions for achieving each of the Sector Outcomes are described in more detail in Chapter 6 on 'Assumptions and Risks'. A set of relevant risk mitigation measures to reduce the likelihood of the risk occurring and/or reduce the impact of the risk should it occur are outlined in more detail.

The bibliography presents the list of main documents used for the collaborative and participatory formulation of the Theory of Change during the SSP Formulation Workshop over 3-5 March 2017. Those documents include: (1) Chapter 5 Power and Energy Development Strategy of the 7FYP; (2) Power Sector Master Plan (PSMP) 2016 (final draft); (3) Power Division Medium Term Strategy and Business Plan (MTSBP) (final draft); (4) FY 2016-17 Ministry Budget Frameworks (MBF) for Power Division and EMRD; and (5) FY 2016 -17 Annual Performance Agreements (APA) for Power Division and EMRD.

Since the PSMP 2016 has a much longer time duration (until 2041) than PE SSP (until 2020), the Theory of Change of the power and energy sector focuses on the objectives that would be realised within the five-year duration of the PE SSP, or where significant actions will be required in the 7FYP period.

Figure 3-1 Power and Energy Sector Theory of Change



3.3 **Narrative Descriptions of the Theory of Change**

The Theory of Change for the power and energy sector holds that pursuing three Sector Outcomes will collectively achieve the Sector Goal in the DRF of 7FYP, namely, 'Ensure sustainability in the production, consumption and use of power, energy and mineral resources.' Those three Sector Outcomes are:

> **Sector Outcome 1**: Reliable, affordable, and efficient energy supply achieved and sustained;
>
> **Sector Outcome 2**: Reliable, affordable, efficient, and quality power supply achieved and sustained; and
>
> **Sector Outcome 3**: Well-articulated Demand Side Measures (DSM) policy adopted and implemented.

Sector Outcomes 1, 2 and 3 above are both *necessary* and *sufficient* for the Sector Goal to be realised, assuming that broader contextual factors remain constant. Those factors might be, for example, that Bangladesh continues to achieve more than 7% GDP growth year-on-year, and that domestic peace prevails[13]. When all these outcomes materialize and contextual factors remain the same, energy and power are expected to be produced, delivered and consumed in a sustainable and efficient manner, and contribute to realizing economic and social development, poverty reduction, and improvement of people's quality of life. To bring about this change, Sector Outcomes 1, 2 and 3 should be implemented in parallel, namely, energy and power supply expansion should come along with rationalisation of energy and power tariffs and successful implementation of DSM.

In the following, Intermediate Outcomes under respective Sector Outcomes are explained in great details.

Sector Outcome 1: Reliable, affordable, and efficient energy supply achieved and sustained

Intermediate Outcomes

1.1 Clear policy on long-term energy sources including energy security and fuel source diversification developed and approved

Bangladesh's energy consumption is projected to become 3.5 times higher in the next 25 years than now if the current level of robust economic growth is maintained and energy efficiency and conservation (EEC) is implemented as planned (see

[13] Here, it is important to note that these factors are mutually reinforcing, that is, sustainability in the production, consumption and use of power, energy and mineral resources also contributes to Bangladesh achieving more than 7% GDP growth year-on-year, and the prevailing domestic peace.

Figure 2-4).

To meet the rapid growth of energy demand in Bangladesh, there is a need to articulate a clear energy policy that ensures sustainable production and usage of energy at reasonable cost in the long term. This policy should ensure energy security in Bangladesh, address fuel diversification through an appropriate fuel mix of power plants and the realization of the potential of renewable energy and mega-watt (synonym of energy efficiency and conservation at supply and demand sides), broaden people's access to modern energy services, and thereby facilitating economic growth, poverty reduction, and improvement of quality of life.

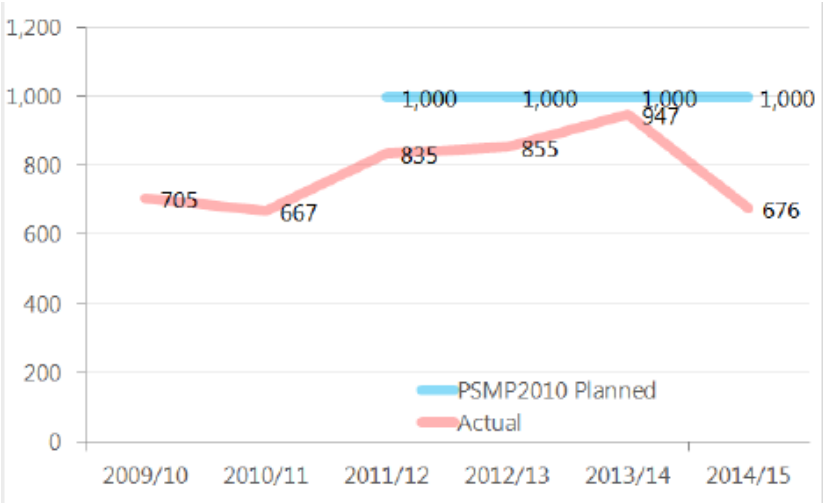
1.2 Increased efficient production of domestic gas and coal

Bangladesh has still a good amount of remaining gas resources (see Figure 2-2). However, more advanced technological skills and financial backup will be required to manage exploration of the remaining oil and gas resources in the increasingly difficult and risky areas.

To minimize the exploration risks and maximize the recovery of resources, Bangladesh needs to consider a partnership with internationally known IOCs, through attractive PSC, both for onshore and offshore exploration. Unsatisfactory performance of the recent exploration and production implies that Petrobangla requires more financial resources, state-of-the-art skills for well exploration and development, and experiences in on-shore resources. It is therefore recommended that Petrobangla would engage in strategic partnership with internationally renowned IOCs and utilize their technologies for both off-shore and on-shore resources. The PSMP 2016 can be a good reference source, since it offers specific approaches for strategic partnerships with IOCs, and for the improvement of PSC.

Compared with domestic gas exploration and production, domestic coal production from Barapukuria poses a challenge to Bangladesh. It is true that actual domestic coal production is lower than the plan (see **Figure 3-2**). However, since the main factor behind this gap was simply a delay in the installation of new on-site equipment, the expansion of the production is expected to be realized soon to the required production level (a million tons per year). A larger challenge than that of Barapukuria production is the development and operationalization of other potential coal fields especially under the open-cast mining method that is now recognized as infeasible. There is a need to address this challenge in the 7FYP period.

Figure 3-2 Domestic Coal Production (Unit: thousand tons per year)

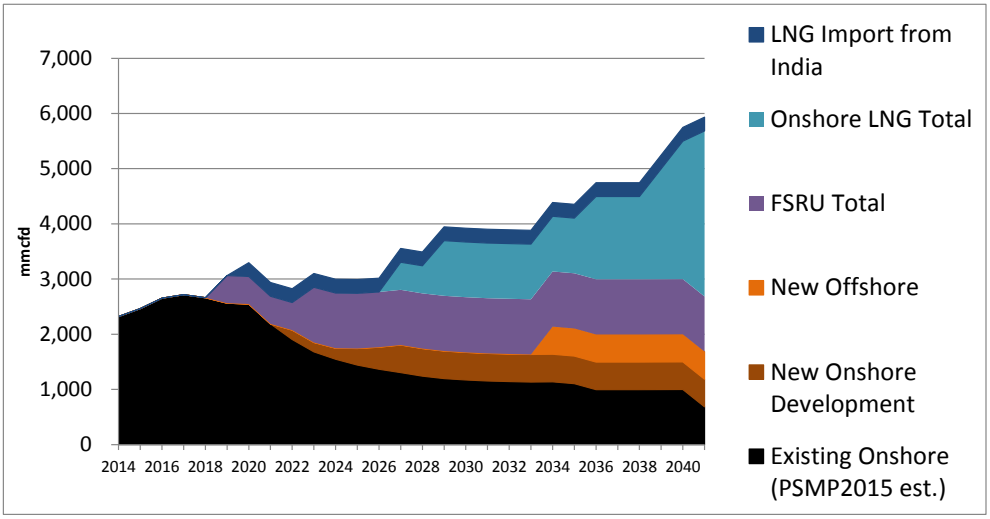


Source: PSMP2016

1.3 Infrastructure to import coal, gas, and oil products developed

As discussed earlier, Bangladesh still has natural gas exploration and development potential. However, this will be far from sufficient to meet the rapidly growing demand for energy in the future. **Figure 3-3** shows the clear trend of import LNG to support the gas demand of Bangladesh. It should be noted that the successful exploration and development of 'Yet to Find' (YTF) resources are assumed here. If this assumption does not hold in the future, however, Bangladesh will be required to import more gas resources, develop more infrastructures for imports, and financial resources as a result.

Figure 3-3 Gas Supply Scenario up to 2041

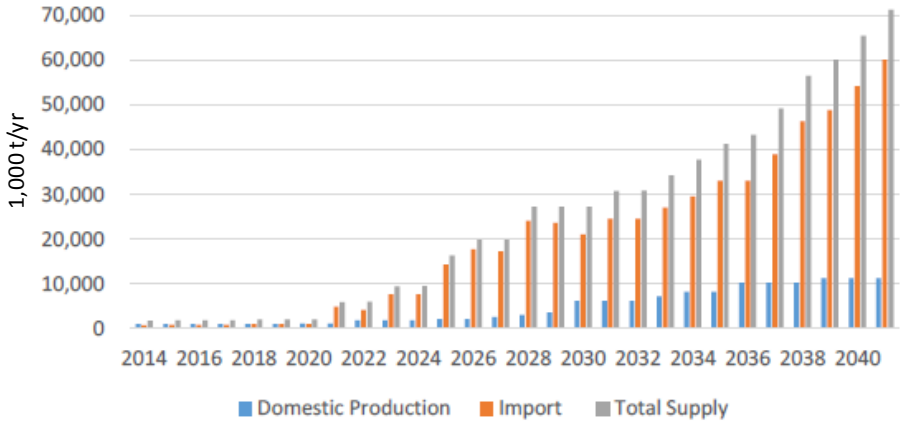


Source: PSMP2016

Similarly, import of coal and oil will also grow rapidly, as shown in **Figure 3-4** and **Figure 3-5** respectively, to respond to the growing demand for energy. Import coal will support power

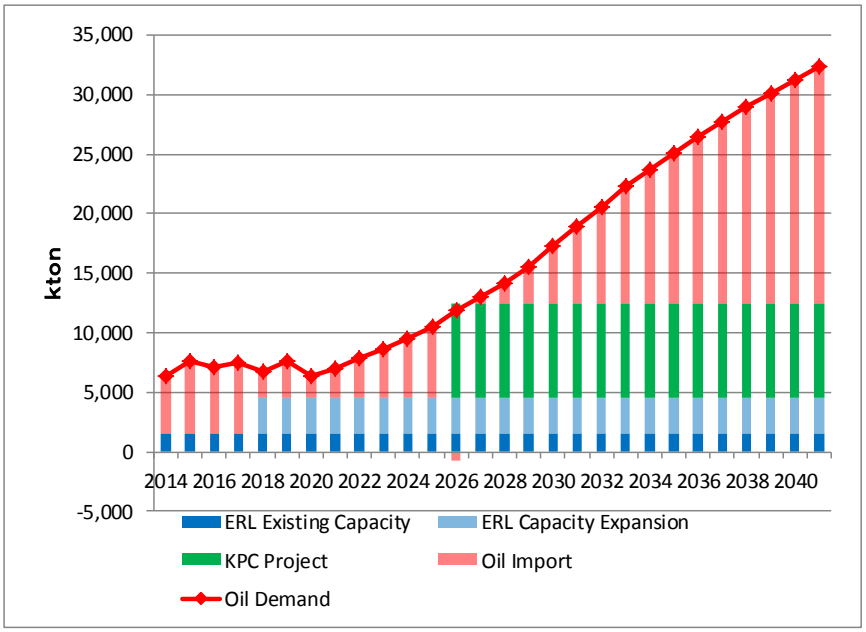
generation, and as seen in the **Figure 2-5** and **Figure 3-5**, oil demand will become 6 times higher in 2041 than in 2016 especially through the growing use of automobiles.[14]

Figure 3-4 Coal Supply Projection



Source: PSMP2016

Figure 3-5 Oil Supply Projection



Source: PSMP2016

The rapidly growing import of LNG and coal points to the urgent need of a deep sea port to be developed. Both coal carrier (collier) and LNG tanker (Q-Flex class) require the depth of 14-15m for waterways and turning basin.[15] Hence, the development of a deep sea port is a highly urgent task that *must be* completed before the start of LNG and coal imports.

It should be emphasized that capital-intensive mega projects call for a well-developed business plan and appropriate cost-benefit analysis. For example, a refinery development project such as the Kuwait

[14] PSMP2016, Figure 10-4 "Oil Demand Projection for Non-Power Sectors, 2014 to 2041"
[15] PSMP2016, Table 8-12 "Specification of LNG Harbour for Receiving Q-Flex Class LNG Tanker"

Petroleum Corporation (KPC) project will require careful cost benefit analysis because, under the recent oil market situation where oil price has been stagnantly low, it is not certain whether owning a costly refinery is a better option than developing the storage and distribution capacity of oil products.[16]

1.4 System loss for oil imports reduced

Shallow draft along the coast of Chittagong has prohibited a direct access of larger-sized tankers, and thus caused a higher shipping cost of crude oil to refinery as lightering operation is required to deliver crude oil. Bangladesh plans to build a single point mooring (SPM) system off-shore Matarbari Island to address this problem. The technical specification of the system is described in PSMP2016 Section 10.1.3 on Oil import supply – future projects.

[16] Detailed discussion on this point can be found in PSMP2016, Section 10.3 Refinery Development – World Trend and Implication to Bangladesh.

1.5 Gas transmission and distribution pipeline expanded and efficiency improved (loss reduced and condensate production increased)

When the supply and demand of expensive imported LNG grows, the stricter control and monitoring of gas inflow and outflow will be required to control and reduce "lost profit opportunities", minimize the system loss and leakage from the system, and improve the efficiency at domestic gas fields.

Particularly, the current fixed gas tariff for the domestic (resident) sector regardless of the amount of use is known for the inefficient use. The GoB has taken an initiative to replace this tariff with the gas pre-paid meter. With previously installed pilot projects (13,100 meters) and extended coverage in Dhaka and Chittagong areas (in total 260,000 meters), it is expected to reduce the gas usage by more than 7.3 million m^3 (or 0.3 BCF).[17]

1.6 Access to renewable energy increased (biogas for cooking and improved cooking stove (ICS))

Currently only 8% of the entire population in Bangladesh has access to grid gas. The grid gas users are highly concentrated in the Dhaka area, namely, 1.7 million out of 2.4 million contracts of grid gas in Bangladesh, or 70% of the national grid gas connections, are within the Dhaka area. According to the BBS statistics in 2014, more than 94% of rural population in Bangladesh uses traditional solid biomass for cooking. Therefore, social and environmental impacts will be enormous if the solid biomass users gain access to modern and cleaner energy for cooking.

One of the drastic social impacts is the liberation from the respiratory diseases caused by the incomplete combustion of solid biomass.[18] The WHO claims that indoor air pollution is the second major cause of illness in low income countries, next to the poor access to safe water and incomplete sanitary environment. Bangladesh Department of Environment estimates 30 million for the replacement need of indoor cooker in the rural areas in the next 5 years.[19]

Although LPG is a cleaner energy solution and can be used in off-gas pipeline areas, it is too expensive to afford for average rural households in Bangladesh. For instance, an average size of household with 4-5 persons requires two LPG cylinders (12kg) per month, which costs 2,100-2,600 Taka per month on average. While we recognise that many relatively wealthier rural households have switched from using firewood to using LPG, LPG remains an unviable solution for the 'energy poor' in rural Bangladesh. 'Energy poor' is defined as a household with an energy expense of more than 10% of monthly income. In the same vein, subsidies for LPG are not a long-term, sustainable solution.

By contrast, improved cooking stove (ICS) and biogas produced from a biogas digester are reasonable and low-carbon energy solutions. According to a recent estimate, ICS unit price ranges from 800-1000

[17] For other gas transmission and distribution infrastructure, see PSMP2016 Chapter 7.

[18] According to the World Health Organization (WHO), solid biomass incomplete combustion by using inefficient traditional cook stove produces toxic substances, so called "black carbons", such as mono dioxide and particle matters, and these substances cause respiratory diseases. Many of the victims are women and children, because they cook inside the house or are more exposed to the toxic substances owing to their low height

[19] According to the Bangladesh Department of Environment, April 2016.

Taka, and biogas digester construction cost is approximately the same as on-year LPG purchase cost.[20,21]

The above actions will directly contribute to the SDG Goal 7 "Ensure access to affordable, reliable, sustainable and modern energy for all."

1.7 Private financing promoted and increased for energy infrastructure investment

Investment in energy infrastructure is well known as capital intensive at the front-end, especially for deep sea ports. Public investment financed by GoB or development partners alone are not sufficient to finance the required amount of investment in energy infrastructure. This points to the critical need to facilitate public-private financing to achieve required infrastructure investment.

Table 3-1 summarizes the information about estimated investment cost in the energy sector. The figures in this table should be read with caution because these are only a preliminary estimation. In addition, actual investment costs can be much higher than those in this table because price escalation (inflation) and contingency are excluded from those figures.

Table 3-1 Estimated Investment Cost in Energy Sector (Constant Price)

Item	Source	Estimated Cost (billion BDT) [1] 2016 constant price)
Primary Energy Import Facility		
Deep Sea Port		400 +++ (As of June 2017, JICA-supported study in progress)
Gas		
1) Domestic Gas Development (remaining 2P)	PSMP2016 Table 7-10 "Total Investment Costs for Gas Development"	*40*
2) Land-based LNG receiving terminal (initial 3 tanks)	ditto	70
3) FSRU (initial 500mmcfd)		14
Coal		
Coal Transhipment Terminal (phase 1 and 2)		110
Oil		

[20] The Global Alliance for Clean Cookstoves, Working Paper No. 22 "Promotion of Improved Cookstove in Rural Bangladesh," May 2011.
[21] PSMP2016 Section 13.4.6 Biogas as cooking fuel.

Item	Source	Estimated Cost (billion BDT) [1] 2016 constant price)
SPM	Oil & Gas Journal, October 18, 2016.	50
ERL Expansion	Oil & Gas Journal, October 18, 2016	136
KPC Project	PSMP2016 Section 10.1.3 Oil import supply – future projects	480 or higher
Subtotal of Primary Energy Import		1300 or higher
Energy Access		
ICS for 30 million households	"Promotion of Improved Cookstove in Rural Bangladesh"	29
Biogas digester (conventional type) for 110,000 plants	PSMP2015 Section 13.4.6 Biogas as cooking fuel	13
Subtotal [2]		13 ~ 29
Total		1.1~1.2 trillion BDT

Notes: (1) USD/BDT Exchange rate: 1 BDT = 0.01247 USD (as of June 2017): (2) To improve the energy access especially in rural areas, either ICS or biogas digester (or mix of each) can be implemented. Therefore, this subtotal indicates the higher side of the required investment amount.

While recognising the critical need for increased private financing for energy infrastructure investment, this SSP also acknowledges that there are challenges in this regard which need to be overcome. In particular, the organisational transformation of Petrobangla is required to increase its attractiveness to private sector investors. These issues are further discussed in Section 3.4 which looks at implementation strategies to deliver key sector outcomes and intermediate outcomes.

1.8 Energy tariff responding to the increase of supply cost

It is high time for Bangladesh to face the challenge of raising energy tariff for gas, coal and oil products to meet financing requirements for expensive imported fuel and investment in energy infrastructure. In the case of natural gas, for example, Bangladesh historically enjoyed the cheap domestically produced natural gas at USD2.34/MMBTU (FY2014).[22] When the LNG import starts, however, gas price will surge to the international (Asia) market prices around 10.6USD/MMBTU. [23] In addition, Bangladeshi society needs to bear the astronomic investment cost in the coming decades (see Table 3-1 Estimated Investment Cost in Energy Sector (Constant Price)).

[22] Gas purchase price from IOC is USD 2.48/MMBTU (FY2014).
[23] PSMP2016, 8.6.2 LNG market.

Although energy tariffs should inevitably be raised, the fiscal burden on the national coffer and negative impact on the national economy (or negative growth) should be minimized. To address this issue, PSMP2016 proposes that the slow, steady and continuous raise of energy tariffs should be undertaken at the rate of 19.3% in nominal BDT until 2041. This scenario is expected to realize financial sustainability in the energy sector and minimize the negative impact on economic development (see PSMP2016, Chapter 21).

Sector Outcome 2: Reliable, affordable, efficient and quality power supply achieved and sustained

The following intermediate outcomes must be in place to achieve Sector Outcome 2 (Reliable, affordable, efficient, and quality power supply achieved and sustained).

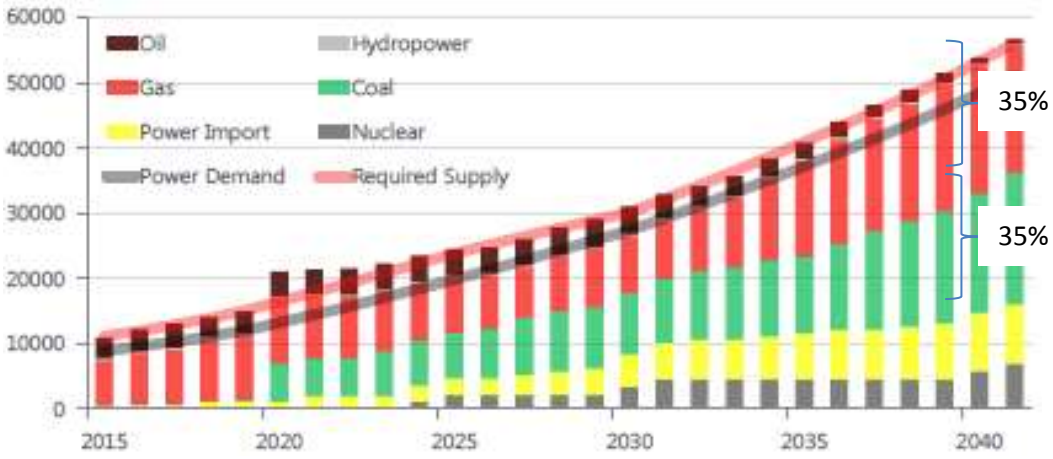
Intermediate Outcomes

2.1 Power supply through both generation and imports increased

PSMP2016 sought an optimal balance of power generation development to attain the optimum balance of cost, environmental and social impact, and energy security.[24]

Figure 3-6 presents the long-term power generation plan, which was based on intensive discussion of BDPB System Planning and factoring in other key parameters such as import fuel availability and assumed completion of import fuel facilities. In this plan, Bangladesh would have more than 50,000 MW at the end of 2040s, whereas expensive oil-based rental and quick-rental power plants would be decreased gradually and become marginal after the coal-based power plants become operational in the early 2020s.

Figure 3-6 Long-term Power Generation Development Plan (2017-2041)



Source: PSMP2016

In this long-term plan, the share of natural gas and coal fired power generation would become the same 35% respectively. The share of the latter would be substantially lowered than what was originally

[24] According to International Energy Agency (IEA), energy security is defined as "the uninterrupted availability of energy sources at an affordable price." In PSMP2016, energy security is translated into "risk of sudden shortage in energy supply" and "risk of GDP loss".

proposed in the previous PSMP2010 in which the gas and coal were 25 % and 50%, respectively.[25] This change resulted from two factors -- the downward trend of natural gas price and the growing concern over climate change impacts that are symbolized in the 2015 Paris Agreement.[26]

In addition, power imports from neighbouring countries was closely studied in parallel with the PSMP2016 and the study result is incorporated in the above power development plan. The power development plan is also fully consistent with other related policy documents such as Bangladesh's Strategy for the Infrastructure Sector[27] as well as the current Import Policy Order 2015 – 2018. Since the South Asia region is rich in hydropower potential, most of power generation for the power import are based on hydropower generation.

2.2 Renewable energy power generation increased

Renewable energy power generation consists of a part of power generation, and could be included in Intermediate Outcome 2.1. However, GoB is very keen on increasing renewable energy power generation, since this contributes to multi purposes – climate change mitigation, energy access, and energy security. Hence, GoB is determined to promote renewable energy power generation as its policy, 10% of total power from renewable sources by 2020. As of February 2017, Bangladesh generates merely 450 MW (less than 3%, including Kaptai 230MW hydro) from the installed renewable energy capacity of 15,500 MW.

Whilst more than 4 million SHS have been installed to date, it should be noted that Bangladesh has limited land availability for utility-scale solar PV power and its contribution to global trends of renewable energy policy should not be expected. However, Bangladesh's aspiration to utilize hydropower potential could be considered as renewable energy and hydropower imports could be expanded to 5,000MW by 2040. With other forms of renewable energy generation, including both on-grid and off-grid, total renewable energy would be raised to 9,000MW against its installed capacity of 53,000 MW, or 16% of total energy generation by 2040s.

2.3 Availability and efficiency of thermal power plants improved

While power generation development has been one of the highest priority for Bangladesh, the energy efficiency improvement of thermal power generation has not attracted much attention as it deserves.

It is unfortunate that publicly-owned thermal power plants have not been free from political interruption and scheduled inspection and maintenance has been neglected. As a result, those publicly-owned thermal power plants suffer from under-utilized capacity, lower than expected thermal efficiency, and resulted in only average 30% of expected output. Moreover, inefficient power plant operation will immediately become unprofitable if international fuel prices increase. It is estimated that, if these power plants improve thermal efficiency to the international standards,

[25] In PSMP2010, it was assumed to utilize domestic coal and import coal.

[26] Following the US and Europe, Asian utility companies become more aware of the risk of long-term LNG contract, and non-conventional LNG traders have started to supply destination free cargos on a spot basis, through swapping operation or purchasing from spot market. With such more flexibility and dynamism, LNG price in Asia expects downward trend.

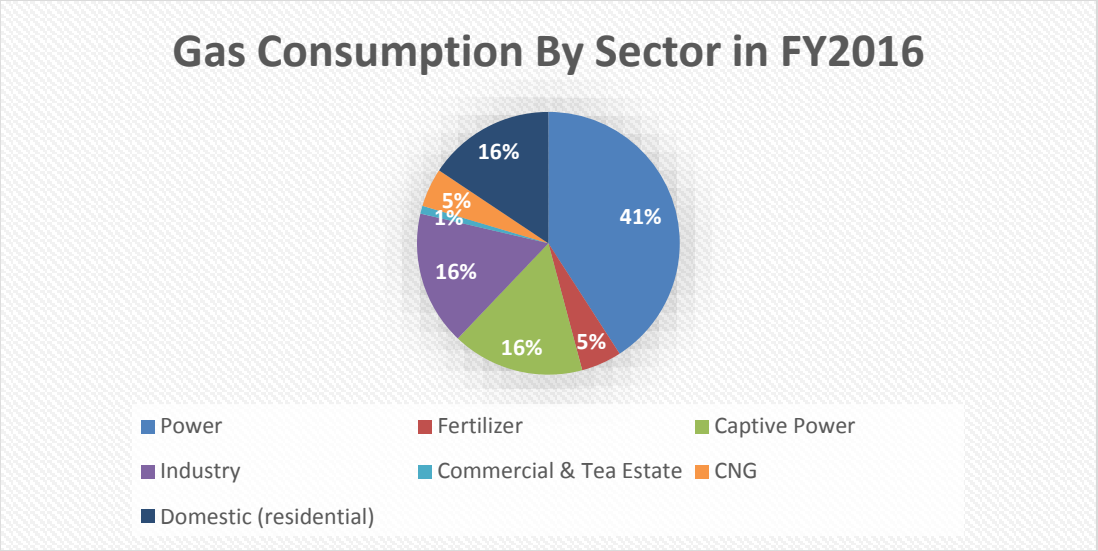
[27] Prepared as a Background Paper for the 7FYP, 12 January, 2015.

approximately 52 BCF can be saved per year, worth the fuel for 1300MW combined cycle power plants (Figure 3-7).

Among various approaches, repowering of existing simple cycle gas turbines to the state-of-the-art combined cycle power plants will contribute to both efficiency improvement and increase in output with least-cost compared with other feasible options (e.g., a newly built combined cycle gas power plant in the same location or coal Ultra Super Critical (USC) with import coal). Therefore, repowering of existing gas power plants should be given higher priority in public investment.

At the same time, periodic maintenance of public thermal power plants is a critical action to prevent deterioration of plant efficiency overtime. In the next section, the required institutional framework is discussed.

Figure 3-7 Gas Consumption by Sector in FY2016



Source: Petrobangla (2017)

2.4 Electricity Act and BERC Act 2013 revised and implemented to ensure operation and maintenance of power plant, including periodical inspection

The main cause of underperformance in public thermal power plants is that lower priority is given to proper maintenance in comparison with the expansion of power system infrastructure. As a result, public thermal power plants suffer from political intervention and low maintenance practices.

The GoB has already introduced the Electricity Maintenance and Development Fund (EMDF) to address this issue. However, PSMP2016 points out appropriate funding and maintenance practices supported by an established legal framework for publicly owned power plants would be required to reduce the reach of political influence, conduct scheduled maintenance as technically required, and improve their availability and efficiency.

2.5 Technical and non-technical loss reduced

In terms of transmission system loss (technical loss), Bangladesh has already achieved an international good practice of around 2.0%. However, the average distribution system loss of publicly

(BPDB)-owned distribution areas stagnates at around 11% despite its historically downward trend over the last two decades. Two corporatized distribution companies in Dhaka areas have managed their system loss at some 8%.

2.6 Power transmission and distribution network expanded

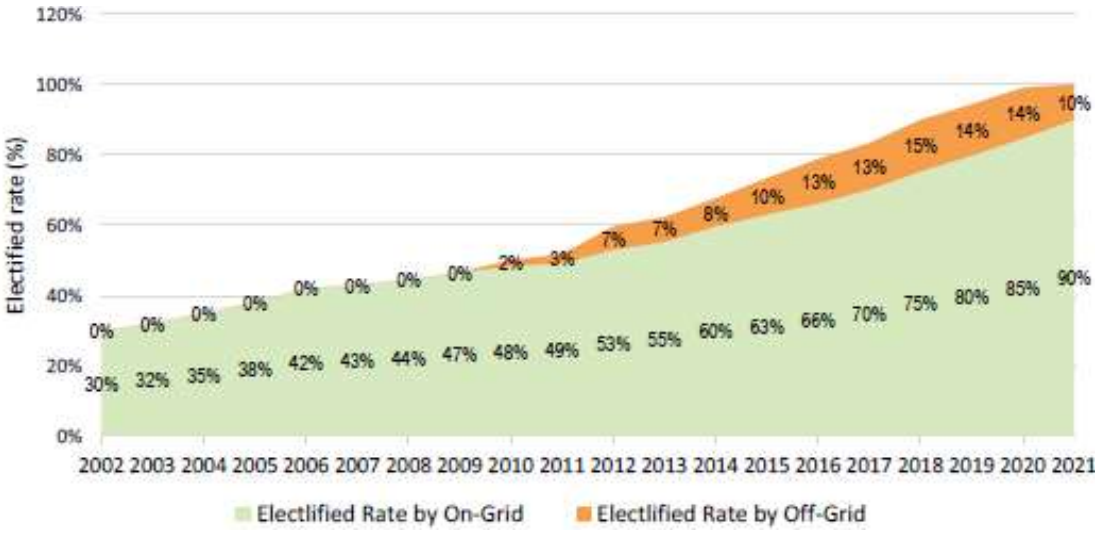
As Intermediate Outcome 2.1 outlines, Bangladesh is expecting to expand its installed generation capacity more than 4 times in the next 20 years. To achieve this, supply chain of electricity (transmission and distribution) to the end user needs to be expanded as well.

PSMP2016 recommends special design consideration for some facilities, including 756kV transmission lines and substations, and the 400kV circuits from Rooppur nuclear power station (PSMP2016, Section 15.5).

2.7 Access to power, both on-grid and off-grid, increased

GoB aspires to provide electricity to all citizens by 2021. According to the situational analysis and current progress, GoB has already achieved 77% of the access to the electricity, and it is not impossible to achieve this goal (see Figure 3-8).

Figure 3-8 Projection of Access to Electricity (On-grid + Off-grid SHS)



Source: PSMP2016

While this target is technically achievable, coordination between on-grid and off-grid approaches should be improved to achieve the “last one mile” electrification. On-grid electrification of the last one-mile area remain 140,000km (BREB has so far developed 300,000km) and tends to be less technically or financially viable than the existing grids. This means that government subsidy and/or off-grid solution would need to be considered as alternative means to achieve the goal.

2.8 More stable and high-quality power supplied

Bangladesh’s economic development will require transformation of the industrial structure from the current low value-added to higher value-added industries. This will inevitably require better quality

of power supply with better stability of frequency that is essential for high value-added industrial products (PSMP2016, Section 16.2.2).

When power supply capacity is insufficient or the system operator (=NLDC in Bangladesh) does not have power generation units under its full control, it is not capable of managing the power output and the power frequency adjustment is less prioritized than load following (or load shedding). Consequently, Bangladesh experiences quite large frequency fluctuations (plus/minus more than 1.0 Hz/second or 2.0% frequency change). This is in fact the deviation of the Bangladesh Grid Code stipulating that the system frequency be controlled within 50Hz±1.0Hz under normal conditions.

Furthermore, stable frequency is an important pre-requisite for continuous operation of synchronous power generators, including a nuclear power plant that normally requires power stability within plus/minus 0.5 Hz.

To improve this situation, a two-step approach may be considered: 1) more responsive generators are integrated into the enhanced NLDC system operation; and 2) stronger authority is given to NLDC to execute its order. First, several large units of coal-fired and gas-fired generation will become on-line in the early 2020s, and the generation capacity will have wider reserve margin for frequency control (in this sense, Intermediate Outcome 2.9 is dependent on Intermediate Outcome 2.1). Such additional margin (power plants) should be equipped with frequency control functionality, such as governor and additional equipment such as SCADA, Load Frequency Control (LFC), or Automatic Frequency Control (AFC) if they are expected to function as frequency adjuster.[28]

Second, the power plants that contribute to frequency control through governor-free operation and ancillary services should be appropriately compensated or incentivized to recover their investment (e.g., equipment) and variable costs (e.g., low availability of plant). In Bangladesh, a simulation suggests that the governor-free operation needs to be approximately 5% of total installed capacity to achieve plus/minus 0.5Hz by 2024 under normal conditions (see PSMP2016 Ch.16 for details).

2.9 Electricity Act, Grid Code, NLDC operational rules revised and implemented to improve network power quality

To achieve frequency control, there is a need to integrate power plants into the NLDC system operation, clarify and enforce legal obligations and penalties, and provide appropriate financial incentive to comply with the legal obligations. PSMP2016 points out that Bangladesh's current Electricity Act and Grid Code stipulate neither the power plant's obligations such as supply capacity and reserve margin, nor the penalty against non-compliance of these obligations.

Regarding the NLDC's authority over system operation, PSMP2016 revealed that NLDC does not have authority to order power plants to engage in output adjustment, develop a day-ahead plan, or scheduled outage. The BPDB is given the authority to develop these plants, but NLDC is not involved in this process. Furthermore, in the process of power sector unbundling, no rule or authority of NLDC

[28] It should be noted that coal-based power plants are principally base load, hence not appropriate for frequency control. Those who have fast start-up and flexible output capacity, such as simple cycle gas turbine will be good candidates as reserve marine. In Bangladesh, roughly 50% of the newly built coal-based power capacity is expected to contribute to the frequency control.

has been established for demand-supply control. Therefore, there is a clear need to amend the current act and code to establish more responsive system operation.

2.10 IAEA recommendations implemented, including strengthening of safety management, nuclear fuel cycle including waste management, ratification of international laws of civil liability of nuclear damage

As experienced in Japan, nuclear power plants could cause tragic situation to the public if proper safety nets are not properly in place. Especially the compensation system and emergency preparedness system in case of severe accident are essential, and they should be established or enhanced as soon as possible. In fact, Japan did not ratify the Convention on civil liability for nuclear damage, which makes it difficult for TEPCO to address promptly the compensation issue.

Nuclear power plant's safety management and nuclear fuel cycle including waste management are also important operational issues. The details of these issues and recommendations are described in IAEA reports.

2.11 Private financing promoted and increased for power infrastructure investment (except rental/quick-rental power plants)

The investment need for the energy sector discussed in Intermediate Outcome 1.7 is also applicable for the power sector. Furthermore, the power sector requires active private participation to overcome the limitation of public investment or foreign assistance by development partners.

Table 3-2 Estimated Investment Cost in Power Sector (Constant Price)

Item	Source	Estimated Cost (billion BDT [1] 2016 constant price)
Power generation		
Gas	PSMP2016	Approx. 1,270
Coal	PSMP2016	Approx. 2,500
Oil	PSMP2016	Approx. 12
Nuclear	PSMP2016	Approx. 2,600
Hydro	PSMP2016	Approx. 18
Power Trade	PSMP2016	N/A
Other on-grid renewable	World Bank SREP Final Report (October 2015) Table 3-9	Approx. 194
Subtotal		6,554 or higher

Item	Source	Estimated Cost (billion BDT [1] 2016 constant price)
Power Plant Reliability and Efficiency Improvement		
Repowering simple cycle gas turbine to combined gas turbine		N/A
Maintenance for public-owned thermal power plants		N/A
Subtotal		N/A
Transmission and Distribution		
765kV transmission lines	PSMP2016 Table 15-16~20	Approx. 110
400kV transmission lines	PSMP2016 Table 15-16~20	Approx. 196
230 kV transmission lines	PSMP2016 Table 15-16~20	Approx. 19
132 kV transmission lines	N/A	N/A
Transmission Substations	PSMP2016 Table 15-17~26	Approx. 393
Distribution lines	N/A	N/A
Subtotal		718 or higher
Power Supply Quality Improvement		
SCADA/EMS system and software for frequency control	World Bank document	Approx. 1.2
Dispatch optimization software	Ditto	Approx. 0.4
Subtotal		1.6 or higher
Electricity Access		
On-grid rural electrification for the rest 140,000 km	REB (1,300,000 taka/m of lines and facilities)	182

Item	Source	Estimated Cost (billion BDT [1] 2016 constant price)
Off-grid solutions	World Bank SREP Final Report (October 2015) Table 3-10	262 or higher
Subtotal [2]		182~262 or higher
Total		7.5 trillion or higher (2016 constant price)

Note 1: USD/BDT Exchange rate: 1 BDT = 0.01247 USD (as of June 2017)
Note 2: To improve the energy access especially in rural areas, either ICS or biogas digester (or mix of each) can be implemented. This subtotal indicates the higher side of the required investment amount.

While recognising the critical need for increased private financing for power infrastructure investment, this SSP also acknowledges that there are challenges in this regard which need to be overcome. In particular, there are issues with high risk premium heavily due to the poor creditworthiness of the single buyer (BPDB), limited transparency of the procurement process including irregularities and prolonged delays in contracting which discourage private investment in the power sector,, as well as relatively limited financing available from local banks, . Some of these issues have been, and will be partially tackled through other intermediate outputs (e.g. raising the power tariff for final consumers is one of such achievements. It will go some way towards reducing the overall subsidy to power generation, and hence reduce the risk premium) as well as the implementation strategies covered in Section 3.4. With regard to the latter, it is important to address the legal and regulatory issues around increased access to local financing and improvements to the procurement process. However, dedicated efforts will also be required under this intermediate outcome to promote private financing.

2.12 Power tariff responding to the increase of supply cost

Similar to the energy sector, Bangladesh also needs to face up to the reality that power tariff should be raised to respond to the financial need for the expansion and quality enhancement of power infrastructure (as seen in the **Table 3-2** Estimated Investment Cost in Power Sector (Constant Price). The expensive import fuel costs should be incorporated into the power tariff as well.

PSMP2016 proposes that a slow, steady, yet continuous tariff raise (10.3% in nominal BDT) could realize financial sustainability of the energy sector, and mitigate negative impact on economic development (see PSMP2016, Ch.21).

Sector Outcome 3: Well-articulated Demand Side Measures (DSM) policy adopted and implemented

Finally, the following intermediate outcomes must be achieved to realize Sector Outcome 3 (Well-articulated Demand Side Measures (DSM) policy adopted and implemented). In line with internationally accepted terminology, the following references to 'energy efficiency' under each intermediate outcome covers both primary and secondary energy (power).

Intermediate Outcomes

3.1 Energy Efficiency Conservation promotion programmes including energy management, labeling, green building and awareness raising implemented

Bangladesh will need to meet a massive increase in the demand for energy and power consumption and infrastructure that would likely be accompanied with cost increase arising from increased imports. In such case, it is critical to reduce energy and power consumption on the demand side to narrow the demand-supply gap.

GoB is aware of this need and 7FYP placed the improvement of energy efficiency as its policy priority. Especially for the demand-side management (DSM), JICA-supported Energy Efficiency and Conservation Master Plan (EEC-MP 2015) articulated that Bangladesh could reduce power demand by 20% by 2030 compared with a 'business as usual' case if it successfully implements EEC programmes. This can be translated into roughly 8,000MW avoided capacity.

Based on the EEC-MP, GoB will implement multi-dimensional DSM programmes with three components of activities:

1. Energy Management and Auditing: Framework of Energy Management programme which defines "designated large energy consumers" and mandatory energy management and certification system.
2. Green Building Rating Programme: Promotion of "green" (energy efficient) building rating.
3. Energy Efficient Labelling Programme: Promotion of energy efficient home appliances through labelling.
4. Awareness Raising: Promotion of public awareness for the energy efficiency and conservation.

The JICA has agreed on a concessional loan (12 billion yen, approximately 8.6 billion Taka) in 2016 to support those activities, especially 1) to 3) above.

It should be noted, however, that the EEC-MP did not address the issues of the transport and fertilizer sectors, although the former is the largest contributor to the demand increase in primary energy (oil products), and the latter is potentially a major contributor to improve energy efficiency. These are dealt with in Intermediate Outcomes 3.3 and 3.4 below.

3.2 Preferential taxation on energy efficient appliances in place

There should be some financial incentives when the EEC programme is implemented to bring behavioural changes among people. Financial incentives may include, for example, concessional loan, preferential tax, and subsidies.

Among such incentives, JICA has provided the concessional loan for EEC investment, such as factory equipment, building facilities and home appliances. The designated financial institutions will provide their customers with lower interest rate than the market rate for the EEC investment.

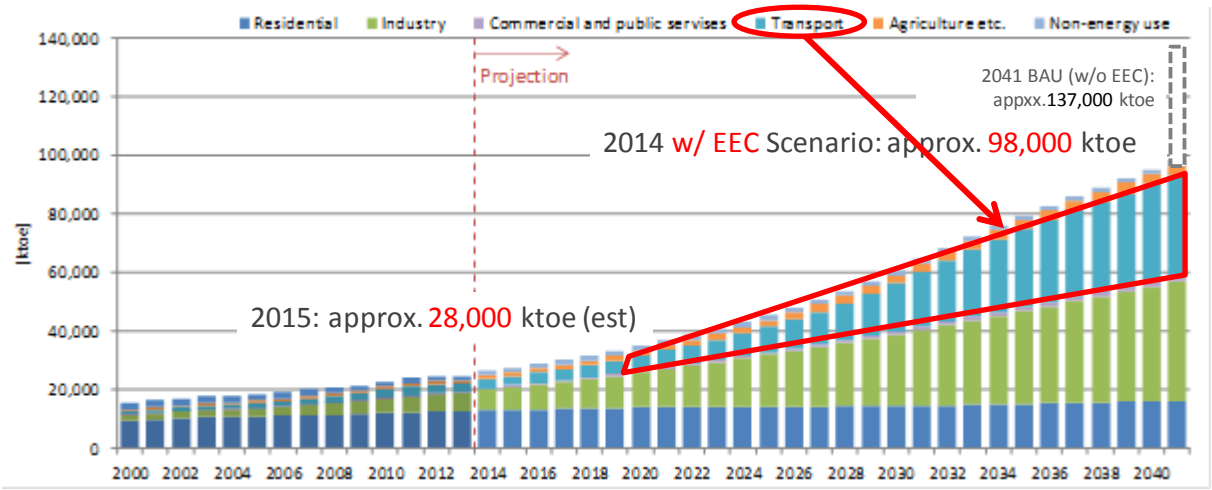
When providing preferential taxes such as tax reduction, exemption and accelerated depreciation, the GoB will need to consider how to cover the loss of tax revenues when tax collection is to be reduced.

3.3 Energy efficiency of vehicles improved

The transport sector will be one of the most rapidly growing sectors in terms of energy demand (**Figure 3-9**). This will be caused by rapid motorization and the increase in car ownership along with income growth, similar to many growing middle-income countries in Asia. The transport sector will contribute mostly to the demand growth for oil products (**Figure 3-10**).

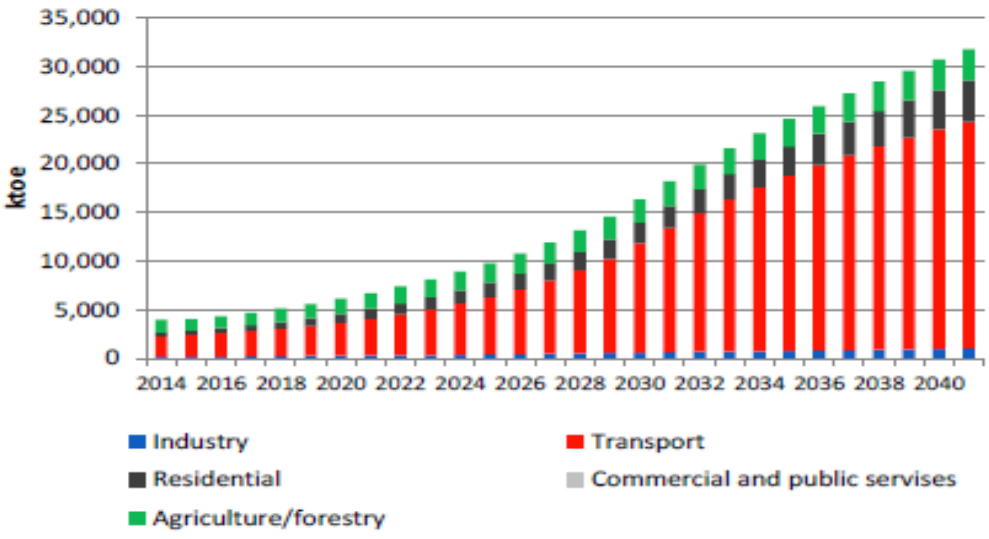
Hence, Bangladesh will need to promote energy efficient vehicles. Such regulations and incentive systems is observed in Thailand that took a similar path of economic growth to Bangladesh in the past (see PSMP2016 Section 6.4 for Thailand's experience).

Figure 3-9 Final Energy Consumption Projection with EEC Scenario 2015-2041 (identical to Figure 2-4)



Source: PSMP2016

Figure 3-10 Oil Demand Projection for Non-Power Sectors, 2014 to 2041



Source: PSMP2016

3.4 Energy efficiency in fertilizer factories improved

The fertilizer sector in Bangladesh is another major source of inefficient use of gas, and therefore has a large potential to improve energy efficiency.

Although the fertilizer sector was out scope from the EEC-MP, GoB must take an action to address the inefficiency of this sector. The return will be mitigation of waste of natural gas that is worth a unit of nuclear power generation (see **Figure 3-7**).

IMPLEMENTATION STRATEGIES

3.4 Strategies to Achieve 7FYP Targets

This section presents key regulatory and institutional reforms which are required to achieve the sector objectives outlined in Chapter 3. Regarding the latter, specific arrangements for the coordination of key Development Partners (DPs) within the sector are specified and sector coordination on cross-cutting areas is outlined, including coordination mechanisms between and among MDAs themselves, as well as with non-government actors.

Achievements under 6FYP

Under the 6FYP, the following regulatory reforms were undertaken:

- Sustainable and Renewable Energy Development Authority (SREDA) Act 2012 (based on this, SREDA was established in 2014, but was not operational until 2015)
- BREB Act 2013
- Interim Action Plan for Improvement of Energy Efficiency and Conservation
- Clean Cook Stove Country Action Plan
- Special Act for Quick Procurement in Power and Energy Sector
- Electricity (Amendment) Act 2014

In addition, the 6FYP aimed to finalise the National Coal Policy, but this remains a priority for regulatory reform under the 7FYP, potentially under a broader framework of a National Energy Policy.

Underpinning both regulatory and institutional reforms, the Bangladesh Power Development Board (BPDB) prepared a Power System Master Plan (PSMP) in 2010 with support from JICA. Responding to the rapid evolution within the power sector, an updated version of the PSMP, called the Power Sector Master Plan (PSMP) 2016 was prepared, with a final version of the report produced in September 2016. The adoption of the PSMP 2016 is a key priority in the 7FYP period.

Priorities under the 7FYP

The GoB made some notable progress on institutional and regulatory reforms in FY2015-2016, the initial year of the 7FYP period. The following legal and regulatory laws and regulations were enacted or amended:

- Emergency Energy and Power Supply Special Act 2010 (amended in 2015)
- Atomic Energy Regulatory Act, 2012
- Bangladesh Energy and Power Research Council Act, 2015
- BERC Dispute Settlement Regulations (amended in 2015)
- Energy Efficiency and Conservation Rules, 2016
- Energy Efficiency and Energy Conservation Master Plan, 2016

In addition, the following documents were drafted and soon to be approved:

- Electricity Act 2016 (draft final)
- National Energy Policy (draft)
- Energy Conservation Act (draft)
- Renewable Energy Policy of Bangladesh, 2008 (revision in draft stage)

Challenges under 7FYP

Legal and Regulatory Issues

Building on the progress above, the GoB will address the following legal and regulatory issues in the remainder of the 7FYP period.[29]

Develop regulations on safety and security standards for nuclear power plants. The Bangladesh Atomic Energy Regulatory Authority (BAERA) will develop those regulations in close collaboration with the Ministry of Science and Technology (MoST). Those regulations will be aligned with broader issues including the ratification of, and compliance with:

- ✓ International laws and standards, such as civil liability for nuclear damage; and
- ✓ International Atomic Energy Agency (IAEA) recommendations, such as safety standards and spent fuel management cycle establishment.

Develop laws and rules for the improvement of power quality. This could be addressed, for example, by amending the current Electricity Act and Grid Code to incorporate penalty for power frequency management.

Develop regulations on periodical maintenance of power plants. These regulations will stipulate the right for on-site inspection by a governmental body.

Develop legal framework for the National Load Dispatch Centre (NLDC). This will enable the NLDC to be further developed as an independent system operator, and achieve more efficient and higher quality of power supply.

Development of rules and systems for Demand Side Management. The rules and systems for DSM will include such components as follows:

- ✓ Amended New Building Code that incorporates the concept of the Green Building Code; and
- ✓ Energy Management/Audit Programme and Energy Efficiency Labelling Programme.

Further develop an enabling framework for private sector investment. While there are many important and useful policies and guidelines already in place[30] to facilitate private sector involvement in the power and energy sector, it will be crucial to improve the legal and regulatory framework to encourage increased private sector investment. In particular, the following are priorities:

- ✓ Establishment of a formal, PPP regulatory body;
- ✓ Strengthening procurement regulation;
- ✓ Adoption of tax exemptions for Foreign Direct Investment (FDI); and
- ✓ Adjusting banking sector regulation to increase the availability of long-term financing[31].

[29] For detail, see PSMP 2016.

[30] These are as follows: Private Sector Power Generation Policy of Bangladesh (1996); Policy Guidelines for Small Power Plant (SPP) in Private Sector (1998); Policy Guidelines for Public Private Partnerships; Policy Guidelines for Enhancement of Private Participation in the Power Sector (2008); and the Bangladesh Private Sector Infrastructure Guidelines.

[31] Discussions in this regard are already taking place – see 'Bangladesh Bank (BB) to bend rules for banks to invest beyond limit', Financial Express, 19th September 2017, which reports that the BB could bend certain

Institutional Issues

Besides the legal and regulatory framework that is conducive to achieving sector objectives, some institutional issues in the following will be addressed over the 7FYP period:

- ***Adopt a comprehensive National Energy Policy.*** This policy will include elements of the current draft National Coal Policy (drafted in 2007). The Theory of Change in Chapter 3 discussed this issue in detail, stressing the importance of this policy to achieve a reliable, affordable, and efficient energy supply. This policy will include Gas Allocation Policy, Domestic Gas Exploration Policy, and Energy Subsidy Policy.
- ***Amend the Renewable Energy Policy 2008.*** The amendment of this policy will ensure that the increased access to off-grid clean energy will be met by biogas sources or Improved Cook Stoves (ICS), not by increased use of LPG.
- ***Adopt Power Sector Master Plan (PSMP) 2016.*** The adoption of this plan will guide long-term planning of the power and energy sector to achieve Vision 2041.
- ***Support the organisational transformation of Petrobangla and the Bangladesh Power Development Board (BPDB) to make it more attractive for private sector investments/loans.*** Organisational transformation of Petrobangla and BPDB will increase the credibility of these institutions, encouraging private sector investment which is essential for filling the current financing gap[32].
- ***Develop institutional capacity of the National Load Dispatch Centre (NLDC).*** This will enable the NLDC to be further developed as an independent system operator, and achieve more efficient and higher quality of power supply.
- ***Strengthen Bangladesh Energy Regulatory Commission (BERC).*** This will enable the BERC to execute its mandate on licensing, energy pricing, and quality of utility performance (including energy efficiency, consumer satisfaction, and dispute resolution).
- ***Strengthen Sustainable and Renewable Energy Development Authority (SREDA).*** This will enable SREDA to better deliver its core mandate of coordinating and facilitating the development of renewable energy and energy efficiency. The mandates include (1) increasing the share of renewable energy in the energy mix (reducing dependency on fossil fuels), (2) taking appropriate measures for energy saving, and (3) undertaking continuous assessment of new sustainable energy solutions.
- ***Strengthen procurement capacity within relevant MDAs.*** The MDAs will be better equipped to handle the large and more complex procurements required in the power and energy sector. For national procurement, MDAs will increase procurement through the e-GP system, namely, a web-

conditions of the Bank Company Act, allowing banks to lend beyond 25% of their paid-up capital to single borrowers to facilitate the financing of large private power plants. An inter-ministerial committee looking into this matter also recommended that the government should provide a state guarantee for large-sized loans, considering power a high-priority sector.

[32] The PSMP 2016 projects that Petrobangla's financial conditions are likely to become unsustainable in the future without subsidies (Section 20.2), as BPDB's already have. BPDB's revenue is currently far below its generation cost, and both its generation and distribution divisions are in a financial deficit (Section 19.3).

based dashboard through which Procuring Agencies (PAs) and Procuring Entities (PEs) can perform their procurement-related activities using a dedicated, secure portal.

Human Resource Issues

In addition to important legal, regulatory and institutional issues, human resource capacity is also a crucial implementation strategy for the achievement of the Power and Energy Sector Goal. In particular, the following capacities need to be strengthened over the remainder of the 7FYP period:

- Capacity of Power and Energy sector officials and utilities to undertake procurement and contracting in transparent and timely manner;
- Financial management and technical capacity to implement timely maintenance for energy and power infrastructure;
- Financial management capacity, including building on improvements made in billing, collection and arrears; and
- Capacity of staff to undertake proper and timely O&M of power plants, especially for USC and nuclear power plants, which are new to Bangladesh.

Development Partners (DP) Coordination Mechanisms

The Energy Sector Working Group under the Local Consultative Group (LCG) mechanism will be a venue for dialogues on the power and energy sector, and facilitate coordination and cooperation between the GoB and DPs.[33] The members of DPs of the Power Sector Working Group include Asian Development Bank (Chair), Japan, Korea, Norway, UN Agencies, USA, and World Bank.

Sector Coordination Mechanisms

GED's SDG mapping document emphasises the importance of other institutional actors to achieve sector objectives of the power and energy sector. Those actors are listed in the following:

- Ministry of Science and Technology (MoST) -- Issues related to nuclear power generation;
- Ministry of Foreign Affairs (MoFA) -- Issues related to energy and power imports;
- SREDA -- Issues related to the dissemination of information on Demand Side Management (DSM), energy conservation measures and access to clean energy; and
- Economic Relations Division (ERD) -- Issues related to facilitation of mobilization of resources from development partners.

Addressing some specific topics will require close coordination among key institutional actors in the following:

- MoPEMR and Ministry of Road Transport and Bridges -- Proper planning and execution of infrastructure construction projects for imported coal, LNG, LPG and oil;

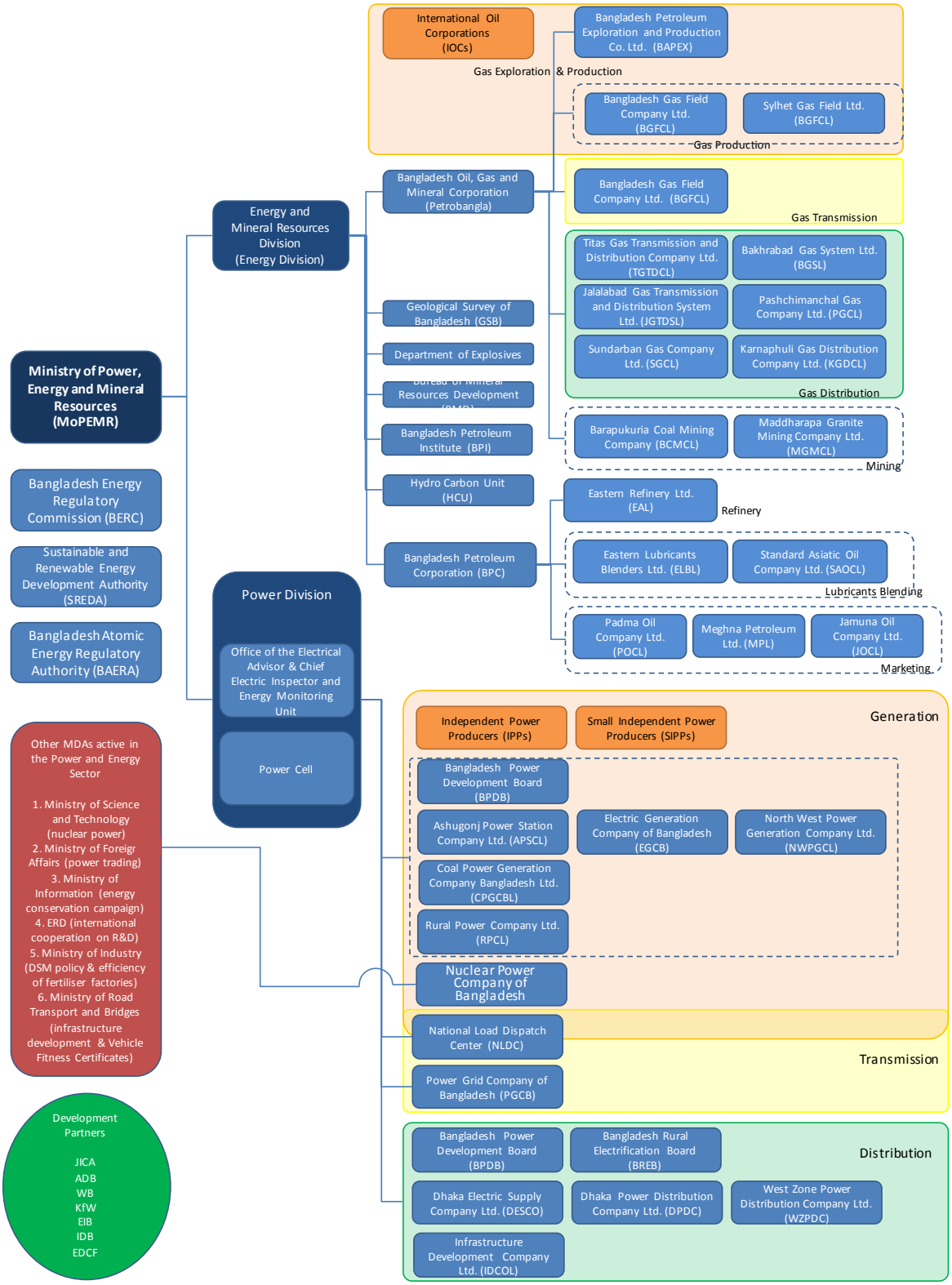
[33] Economic Relations Division. 2015. Bangladesh Joint Cooperation Strategy 2010-2015. Annex 3 of this document presents an LCG Working Group Mapping.

- MoPEMR and Bangladesh Road Transport Authority (BRTA) -- Improving energy efficiency of vehicles, perhaps through revised Fitness Certification measures;
- MoPEMR and Ministry of Industries -- Adopting and implementing a comprehensive, well-articulated DSM policy. This will take into consideration the improvement in technology to achieve more efficient energy use in existing fertilizer factories under the purview of the Ministry of Industries; and
- Power Division and EMRD under MoPEMR -- Ensure that fuel supply is available to meet power generation initiatives contained in various policy documents.
- MoPEMR and Local Government Engineering Department (LGED) -- MoPEMR needs to coordinate with Local Government and Rural Development (LGRD) on off-grid renewable energy solutions.

Figure 4.1 overleaf presents an institutional map of the range of MDAs and DPs in the power and energy sector.

Civil society organisations such as NGOs and NPOs play an important role in interacting with GoB particularly on nuclear power plant, and social and environmental impacts that could be potentially caused by power plant development. Although such interaction may be perceived as time consuming, it is critical to increase transparency of public activities and enhance mutual trust between civil society and the GoB.

Figure 4.1 Institutional Map of the Power and Energy Sector



3.5 Financing Strategy

Financing Projection under 7FYP

The power and energy sector financing needs for the 7FYP period are enormous, amounting to around 2.3 per cent of GDP per year or Tk. 2,415 billion (circa $31 billion[34]). Of this, Tk. 1,461 (circa $19 billion) is estimated as needing to come from the public purse (see **Table 4.1** below). This financing strategy is based on a combination of PPP financing for power generation plus measures to contain energy subsidies. In terms of the latter, the 7FYP assumes that the subsidy on power will be brought down to zero in FY2016 and then kept at that level.

Table 4.1 Power and Energy Sector Financing Requirements (Taka billion FY2016 Prices)

	Generation (Public)	Generation (Private)	Total Generation	Transmission	Distribution	Primary Energy	Total Public	% of GDP
FY2016	108	40	148	81	42	23	254	1.6
FY2017	259	106	365	81	42	28	382	2.4
FY2018	103	30	133	81	42	30	226	1.4
FY2019	195	347	542	81	42	32	318	1.7
FY2020	183	284	467	81	42	34	306	1.6
Total:	**848**	**807**	**1655**	**404**	**209**	**147**	**1486**	**8.7**

Source: 7FYP (p.368).

ADP allocations for the period 2016-2020 for the Power and Energy sector in constant (2015/16) prices are shown in **Table 4.2** below. The high importance attached to the power sector is reflected in the fact that it is projected to absorb almost 15 per cent of the total ADP in constant prices.

Table 4.2 7FYP ADP Allocations for Power & Energy Sector (constant 2015/16 prices, Tk. billion)

Ministry	FY2016	FY2017	FY2018	FY2019	FY2020	Total
Energy & Mineral Resources Division	19.9	32.6	36.7	40.8	45.7	175.7
Power Division	164.9	159.0	153.2	170.2	190.4	837.7
Total	184.8	191.5	189.9	211.1	236.1	1013.4

Source: 7FYP (p.370).

It is important to note that these figures do not include the ADP allocation for nuclear power. To date, Tk. 4,775.31cr[35] has been spent on nuclear power development, with a further Tk. 218.65cr allocated

[34] Bangladesh Bank conversion rate (February 2016).

[35] According to the RADP FY 2016-17, pg. 520.

in the RADP FY2016 – 17 for the first phase of construction of the Rooppur nuclear power plant. Moreover, as seen in the Table 3-2 Estimated Investment Cost in Power Sector (Constant Price) , the cumulative cost for nuclear power up to 2040 could be over 2,600 billion Taka just for the plant part (i.e. *excluding spending for others such as security measures, nuclear waste cycle management or compensation allowance*).

Based on the estimated financing requirements and ADP allocations, one can arrive at an estimated funding gap for the sector over the 7FYP period (please see **Table 4.3**). Some of this gap will be covered by the agencies' own-fund contributions but the remaining shortfall will still be considerable and will need to be met by an increased ADP allocation, enhanced private sector involvement or a deferred (i.e. delayed) investment programme.

Table 4.3 Estimated Public Sector Funding Shortfall (constant 2015/16 prices, Tk. billion)

	FY2016	FY2017	FY2018	FY2019	FY2020	Total
Public Financing Requirement	254	382	226	318	306	1486
ADP Allocation	184.8	191.5	189.9	211.1	236.1	**1013.4**
Shortfall	**-69.2**	**-190.5**	**-36.1**	**-106.9**	**-69.9**	**-472.6**

Source: Authors' calculations.

The above-highlighted gap is evident in the financial accounts of Power and Energy sector agencies. For instance, the latest available Annual Report (for the fiscal year 2014-2015) of Bangladesh Power Development Board (BPDB) shows a net loss of BDT 73 billion based on BDT 219 billion of operating revenue and BDT 285 billion total expenses (including both operating expenses and non-operating expenses).[36] Despite the loss incurred, BPDB has invested BDT 2.7 billion as from their own fund for the 13 projects they have enlisted in the Revised ADP 2014-2015[37]. These losses will need to be absorbed by the GoB which creates pressure on the overall national budget.

A special fund has also been established to finance renewable energy based power plants with Tk. 4 billion allocated to it in FY2015.

Estimating "Fiscal Space" using MYPIP

The financing projection under the 7FYP indicated that a large funding shortfall would be expected in the power and energy sector in the 7FYP period. The Multi-Year Public Investment Programme (MYPIP), which is being developed by Programming Division under SPIMS, can offer a more up-to-date projection based on the information from ADP, RADP, and DPPs/TPPs in this sector.

Table 4.4 presents an indicative summary of MYPIP in the power and energy sector. In the MYPIP, fiscal space of the power and energy sector is calculated in a simple formula in the following:

Fiscal Space = Sector budget ceiling – Forward baseline estimates.

[36] BPDB Annual Report 2014-2015, p. 82

[37] According to the 'Detailed Annual Phasing of Cost' information incorporated in the DPPs and RDPPs of the Revised ADP2014-2015 Investment projects under BPDB.

Sector budget ceiling is a top-down hard ceiling over the next three years at the sector level in the MTBF, whereas forward baseline estimate (FBE) is the resource needs of ongoing projects of MDAs for the next three years. While determine the 'Budget Ceiling' the Tripartite (MDAs, Finance Division and Planning Commission) Meeting Working Paper can also provide information. Fiscal space, therefore, assesses the "fiscal room" for adding new projects in the power and energy sector over the next three years.[38]

A few observations can be made from **Table 4.4**:

- ***Fiscal space of the power and energy sector is negative in FY2018-19 and FY2019-20, and only becomes positive in FY2020-2021.*** This indicates that the estimated total cost of ongoing projects in the coming two years exceeds the sector budget ceiling during those periods if those ongoing projects are completed on time and the project budget is disbursed as planned. The negative fiscal space means that financing ongoing projects from development budget will not be sufficient to cover total cost of those projects in the coming two years.

- ***There is clear need to expand 'fiscal space' by exploring other sources of financing.*** Expanding fiscal space will allow the power and energy sector to implement ongoing projects with adequate levels of funding and complete them on time. The potential other sources of financing may include, but not limited to: (1) increasing self-finance by autonomous bodies under MoPEMR; (2) increasing PPP arrangements; (3) adjusting electricity tariff policies; (4) enhancing efficiency of the power and energy sector by various means discussed in Chapters 3 and 4; and (5) increasing sector-specific foreign assistance.

- ***Adoption of new projects will require careful analysis of fiscal space.*** Negative fiscal space means that there is no 'fiscal room' for new projects in the coming two years, and that new projects should only be considered from FY2020-21 and after. This is not to imply that new projects should not be adopted in the power and energy sector in the coming two years. It is certainly possible to adopt new projects, and yet there should be stronger justifications than the time of "positive fiscal space," by conducting careful analysis on the implication of a new project on fiscal space.

Table 4.4 Summary of MYPIP in the Power and Energy sector

Unit: Crore Taka

MTBF Ceiling / ADP Allocation	FY2017-18 (actual) (1)	FY2018-19	FY2019-20	FY2020-21
Power and Energy Sector				
1) Budget Ceiling	22,832	25,116	27627	30390
2) Forward Baseline Estimates	22,832	41,186	40913	26510

[38] The methodology to estimate forward baseline estimates (FBEs) and fiscal space is explained in detail in the forthcoming document, *the Guidelines for Formulating and Using Multi-Year Public Investment Programme (MYPIP)*, under SPIMS.

MTBF Ceiling / ADP Allocation	FY2017-18 (actual) [1]	FY2018-19	FY2019-20	FY2020-21
3) Fiscal space (=1 – 2)	0	-16,070	-13,286	3,880
Power Sub-Sector				
1) Budget Ceiling	21,359	23,495	25,844	28,429
2) Forward Baseline Estimates	21359	38575	37,130	24,179
3) Fiscal space (= 1 – 2)	0	-15,080	-11,285	4,250
Energy Sub-Sector				
1)Budget Ceiling	1,474	1,621	1,783	1,961
2) Forward Baseline Estimates	1,474	2,610	3,783	2,332
3) Fiscal Space (= 1- 2)	0	-608	-2,000	-370

At the moment, the MYPIP dataset does not capture either self-financed projects of autonomous organisations, or own fund contributions by agencies to larger projects. This is because these self-financed projects and own fund contributions are not part of the ADP allocation and are not taken into account in the MTBF ceilings.

Self-financed projects

The power sub-sector has the largest amount of self-financed projects. Power has 16 self-financed projects in FY 2017-18, with a total allocation of Tk. 1136.15 cr on ADP 2017-18. This is equal to about 5% of the ADP allocation to the power sub-sector for investment programmes. For the energy sub-sector, there are 26 projects in FY 2017-18 financed by own funds, namely the Gas Development Fund (GDF), with a total budget allocation in ADP 2017-18 of Tk. 1,987.57cr. This is equal to 135% of the ADP allocation to the energy sub-sector.

Own-fund contributions

For the power sub-sector, the power division aims for an own contribution of 5% of the project cost, mainly used for land acquisition. The energy sub-sector aims for own contributions as well, but a generalised proportion of this is yet to be determined.

Private Financing

As seen in the Chapter 3.2 of this SSP, both Power and Energy sub-sectors could require investment in the order of some dozen of trillions of Taka (in the current price) in the long-run as seen in the Table 3-1 and Table 3-2. Though such financial requirements do not immediately mean huge investment needs in the short-run, the GoB must start taking action to further accelerate the private financing *now*, such as implementing feasibility study with renowned international consultants, and increasing sectors' accountability and sustainability through sector reforms, including addressing the legal and

regulatory issues around access to increased local financing and improvements to the procurement process (to increase transparency and reduce irregularities). Otherwise Bangladesh may experience the delay of required private financing since these actions will take at least a few years to complete.

In particular, the power generation development shows the severe gap between power generation targets and realities. According to the PSMP2016, Bangladesh should add nearly 9,000MW between 2016 and 2020; however, there are only generation plans for adding an additional 1760 MW capacity in total, all of which belong to the public generation companies. Furthermore, the total cost to cover the additional 9,000MW from 2016 to 2020 is estimated some 1,300 billion BDT. The total 1760 MW power generation projects identified require some 127 billion BDT, and the execution agencies' own financing and private financing are some 51 million BDT and 17 million BDT respectively. This means that the 1760MW projects may require public financing of 59 billion BDT.

From this analysis, Bangladesh still needs more than 7,000MW generation project pipelines, plus solid financial source to support the construction. The countermeasure should be the same as mentioned above. GoB needs to take solid actions to promote private financing.

4 SECTOR RESULTS FRAMEWORK

This Chapter presents the Sector Results Framework (SRF) of the power and energy sector in the 7th FYP period in 2016-2020. The participants of the SSP formulation workshop for the power and energy sector in March 2017 collectively developed this SRF, based on the sector Theory of Change in Chapter 3. One particularity of the Power and Energy Sector SRF is that it captures rather a long-term targets and financial gaps. This is possible thanks to PSMP2016. Annex III presents the long-germ SRF with targets and financing gaps in 2020-2040.

Result Chain	Indicators	Lead Responsible Institution	Type of Project	Baseline		Reference Source for Baseline	Intermediate Targets				Final Target (Yr 2020)	Reference Source for Targets	Cumulative ADP Contributions Year 1-5 (Estimated)
			I: Infra P:Policy and/or Reform I&P: Hybrid	Year	Value		Yr 1 2016	Yr2 2017	Yr3 2018	Yr4 2019			
Sector Goal: Ensure sustainability in production, consumption and use of energy and mineral resources													
	Total primary energy supply (ktoe/year)	MoPEMR	I&P	2014	36,888	PSMP2016 Big Data	39,740	41,044	41,175	43,390	46,122	PSMP2016 Big Data	
	Per capita electricity consumption (kWh/year)	MoPEMR	I&P	2016	304	PSMP2016 Big Data	304	336	367	401	441	PSMP2016 Big Data	
	Energy intensity (toe/million Taka)	MoPEMR	I&P	2014	4.77	PSMP2016 Big Data	4.5	4.34	4.05	3.97	3.91	PSMP2016 Big Data	
Sector Outcome 1: Reliable, affordable and efficient energy supply achieved and sustained													
1.1 Clear policy on long-term energy sources including energy security and fuel source diversification developed and approved	Clear policy on long-term energy sources including energy security and fuel source diversification developed and approved	MoPEMR	P	2016	None	-	No	Yes	Yes	Yes	Yes		-

NOTE: Target values needs to be reviewed and agreed by Energy Division and Power Division. Values still need to be added for the cells highlighted in orange

Result Chain	Indicators	Lead Responsible Institution	Type of Project	Baseline		Reference Source for Baseline	Intermediate Targets				Final Target (Yr 2020)	Reference Source for Targets	Cumulative ADP Contributions Year 1-5 (Estimated)
			I: Infra P:Policy and/or Reform I&P: Hybrid	Year	Value		Yr 1 2016	Yr2 2017	Yr3 2018	Yr4 2019			
1.2 Production of domestic gas and coal efficiently increased	Success ratio of exploratory drilling (TBD)	Petrobangla	I	2015									
	Amount of domestic gas produced (BCF/year)	Petrobangla	I	2014	892	Petrobangla Annual Report 2015	872	892	874	842	837	Load factor: 0.9	
	Amount of domestic coal extracted (million ton/year)	Petrobangla	I	2015	0.7	Petrobangla Annual Report 2015	N/A	N/A	N/A	N/A	1,100	PSMP2016 Section 9.4.1	
	Amount of condensate produced (ton/year OR ktoe/year)	Petrobangla	I	2015	3	Petrobangla Annual Report 2015	N/A	N/A	N/A	N/A	N/A		-
1.3 Infrastructure to import coal, gas and oil products developed	A deep sea port for coal and LNG import	Ministry of Shipping and MoPEMR	I	2016	0	-	N/A	N/A	N/A	N/A	N/A	PSMP2016 Big Data	
	Number of coal (transhipment) terminals	MoPEMR	I	2016	0	-	0	0	0	0	2	PSMP2016 Big Data	45,000
	Number of tanks at land-based LNG terminal (1tank = 180 million litter LNG)	MoPEMR	I	2016	0	-	N/A	N/A	N/A	N/A	N/A	PSMP2016 Section 8.5.2	
	Number of FSRU	MoPEMR	I	2016	0	-	0	0	0	1	1	PSMP2016 Big Data	
	Capacity of oil production storage (kton)	BPC	I	2015	1,100	Energy Division							
	Amount of coal "efficiently" imported (million ton/ year)	Petrobangla	I	2015	1.1	PSMP2016 Table 9-12	0	0	0	0	18	PSMP2016 Table 9-12	-
	Amount of gas imported (MMSCFD/ year)	Petrobangla	I	2016	0	-	0	0	0	500	700	PSMP2016 Big Data	-
	Amount of oil (crude oil + oil products) imported (thousand tons/ year)	BPC	I	2013	5,100	Energy Division	7,056	7,496	6,715	7,663	6,408	PSMP2016 Big Data	-
1.4 System loss for oil import reduced	Number of SPM installed	Energy Division	I	2016	0	PSMP2016	0	0	1	1	1	PSMP2016 Section 10.1.3	
	Amount of oil pilferage reduced (ton/ year OR ktoe/year)	Energy Division	I	2016	?	?							

Result Chain	Indicators	Lead Responsible Institution	Type of Project	Baseline		Reference Source for Baseline	Intermediate Targets				Final Target (Yr 2020)	Reference Source for Targets	Cumulative ADP Contributions Year 1-5 (Estimated)
			I: Infra P:Policy and/or Reform I&P: Hybrid	Year	Value		Yr 1 2016	Yr2 2017	Yr3 2018	Yr4 2019			
1.5 Gas transmission and distribution pipeline expanded and efficiency improved (loss reduced and condensate production increased)	KM of gas transmission pipeline installed (km)	Petrobangla	I	2015	2,536	Petrobangla Annual Report 2015							
	KM of gas distribution pipeline installed (km)	Petrobangla	I	2015	2,372	Petrobangla Annual Report 2015							
	KM of gas service line installed (km)	Petrobangla	I	2015	16,603	Petrobangla Annual Report 2015							
	Pre-paid meter installed (number)	Petrobangla	I	2015	13,100	JICA Preparatory Survey for Energy Efficiency and Conservation Promotion Financing Project	N/A	N/A	273,100	273,100	273,100	Petrobangla Annual Report 2015	
1.6 Access to renewable energy increased (biogas for cooking and improved cooking stove (ICS))	Number of clean cook stove installed (million)	SREDA	I	2011	0.51	Country Action Plan for Clean Cookstoves						Country Action Plan for Clean Cookstoves	
	Amount of biogas produced (thousand m^3/day as capacity)	SREDA	I	2015	190	PSMP2016 Section 13.5.2	190	341	493	644	795	PSMP2016 Section 13.5.2	
	Amount of biogas produced added (thousand m^3/day as capacity)	SREDA	I			PSMP2016 Section 13.5.2	0	151	303	454	605	13750 digester *11m^3/day	
1.7 Private financing promoted and increased for energy infrastructure investment	Percentage of private financing to infrastructure development increased (% of GDP)	MoPEMR	I&P	?	? (South Asia infra spending average: 6.9%)								

Result Chain	Indicators	Lead Responsible Institution	Type of Project	Baseline		Reference Source for Baseline	Intermediate Targets				Final Target (Yr 2020)	Reference Source for Targets	Cumulative ADP Contributions Year 1-5 (Estimated)
			I: Infra P:Policy and/or Reform I&P: Hybrid	Year	Value		Yr 1 2016	Yr2 2017	Yr3 2018	Yr4 2019			
1.8 Energy tariff responding to the increase of supply cost	Ratio of gas tariff coverage to the supply cost (%)	BERC	P	**2016**	-	PSMP2016 Ch.21	-	-	7%	9%	11%	PSMP2016 Fig 21-5	-
	Ratio of oil tariff coverage to the supply cost (%)	BERC	P	2016	?								-
	BPC Annual Report every year published	BPC	P	2016	No	N/A	-	-	Yes	Yes	Yes	-	
Sector Outcome 2: Reliable, affordable, efficient and quality power supply achieved and sustained													
2.1 Power supply through both generation and imports increased	Total installed power generation capacity (within Bangladesh territory) (MW)	Power Division	I	2015	10,895MW (including derated capacity)	PSMP2016 Ch.11	12,214	13,081	14,151	14,999	21,133	PSMP2016 Big Data Sheet "★ Summary (All)" Line40	
	Proportion of private-owned generation (IPP only, rental exclude) (%)	Power Division	I&P	2013	29%	PSMP2016 Section 2.3.5 and BPDB Annual Report 2014-2015							
	Rental/ Quick-rental power plant (Number, or MW)	Power Division	P	2015	40	PSMP2016 Section 2.3.5							-
2.2 Renewable energy power generation increased	Installed Renewable Energy Capacity (on and off-grid) (MW)	SREDA	I&P	2016	432	PSMP2016 Section 13.2.1	432	608	1,116	1,724	2334	SREDA web site	
	On-grid renewable generation capacity (MW)	SREDA	I&P	2016	232	PSMP2016 Section 13.2.1						SREDA web site	
	Off-grid renewable power generation (MW)	SREDA	I	2016	200	PSMP2016 Section 13.2.1						SREDA web site	

Result Chain	Indicators	Lead Responsible Institution	Type of Project	Baseline		Reference Source for Baseline	Intermediate Targets				Final Target (Yr 2020)	Reference Source for Targets	Cumulative ADP Contributions Year 1-5 (Estimated)
			I: Infra P:Policy and/or Reform I&P: Hybrid	Year	Value		Yr 1 2016	Yr2 2017	Yr3 2018	Yr4 2019			
2.3 Availability and efficiency of thermal power plants improved	Capacity of power plant repowered and/or converted (added MW)	Power Division	I										
	Average thermal efficiency of power plants (%)	Power Division	I	2015	33%	PSMP2016 Section 19.3.4							
	Loss of Load Expectation (LOLE) (%)	PGCB	I&P	N/A	N/A	PSMP2016 11.12.2						PSMP2016 11.12.2	-
2.4 Electricity Act and BERC Act 2013 revised and implemented to ensure operation and maintenance of power plant including periodical inspection	Regulations for periodical maintenance developed and approved (Electricity Act and/or BERC Act 2013 revised)	?	P	2016	No	-	No	No	Yes	Yes	Yes	-	-
	Rights of the on-site inspection by a governmental body established	?	P	2016	No	-	No	No	Yes	Yes	Yes	-	-
2.5 Technical and non-technical loss reduced	Transmission loss (%)	PGCB	I	2016	2.73%	BPDB Annual Report 2015-2016	2.73%					PSMP2016 Section Table 15-10	
	Distribution system loss (%)	Distribution Companies	I	2016	11%	PSMP2016 Big Data Sheet "key statistics"	11%						
	Distribution commercial loss (%)	Distribution Companies	I&P										
	Non-technica loss (commercial loss) (%)	Distribution Companies	I										

Result Chain	Indicators	Lead Responsible Institution	Type of Project	Baseline		Reference Source for Baseline	Intermediate Targets				Final Target (Yr 2020)	Reference Source for Targets	Cumulative ADP Contributions Year 1-5 (Estimated)
			I: Infra P:Policy and/or Reform I&P: Hybrid	Year	Value		Yr 1 2016	Yr2 2017	Yr3 2018	Yr4 2019			
2.6 Power transmission and distribution network expanded	Length of new transmission lines commissioned (circuit Km)	PGCB	I	2015	9,807.49	PGCB Annual Report 2015-2016	9,807.494						
	Capacity of transmission substations (MVA)	PGCB	I	2016	22,551	PGCB Annual Report 2015-2016	22,551						
	Length of new distribution lines commissioned (Km)	Distribution Companies	I	2016	41,920	BPDB Annual report 2015-2016	41,920						
2.7 Access to power, both on-grid and off-grid, increased	Access to Electricity	Power Division	I	2015	77%	PSMP2016 Table 15-28	77%	83%	90%	94%	99%	PSMP2016 Section 15.9.5	
2.8 More stable and high quality power supplied	Fluctuation of system frequency (Hz plus/minus 50Hz, OR % change of system frequency)	Power Division	I&P	2015	±1.0 Hz	PSMP2016 Section 16.2.2	±1.0 Hz	N/A	N/A	N/A	N/A	PSMP2016	
	SAIFI (System Average Interruption Frequency Index)	Power Division	I&P										
	SAIDI (System Average Interruption Duration Index)	Power Division	I&P										
	SAIDI (System Average Interruption Duration Index)	Power Division	I&P										
	Introduction of Economic Load Dispatch (ELD)	Power Division	I&P	N/A	N/A								
2.9 Electricity Act, Grid Code, NLDC operational rules revised and implemented to improve network power quality	Electricity Act amended	Power Division	P	2016	No	-	No	No	Yes	Yes	Yes	-	
	National Grid Code amended	Power Division	P	2016	No	-	No	No	Yes	Yes	Yes	-	
	NLDC operational rule amended	Power Division	P	2016	No	-	No	No	Yes	Yes	Yes	-	
	Number of governor-free generator (newly installed)	Power Division	P	2016	No	-	No	No	Yes	Yes	Yes	-	

Result Chain	Indicators	Lead Responsible Institution	Type of Project	Baseline		Reference Source for Baseline	Intermediate Targets				Final Target (Yr 2020)	Reference Source for Targets	Cumulative ADP Contributions Year 1-5 (Estimated)
			I: Infra P:Policy and/or Reform I&P: Hybrid	Year	Value		Yr 1 2016	Yr2 2017	Yr3 2018	Yr4 2019			
2.10 IAEA recommendations implemented, including strengthening of safety management, nuclear fuel cycle including waste management, ratification of international lows of civil liability of nuclear damage	Bangladesh Atomic Energy Regulations Act 2011 adopted	BAERA	P	2016	No	-	N0	Yes	Yes	Yes	Yes	-	
	Independent regulatory body established	BAERA	P	2016	Yes	-	Yes	Yes	Yes	Yes	Yes	-	
	Other IAEA Safety Standards met	BAERA	P	2016	No	-	No	Yes	Yes	Yes	Yes	-	
	Nuclear fuel cycle incl. waste management established	BAERA	P	2016	No	-	No	No	Yes	Yes	Yes	-	
	Ratification of the Int'l treaties completed (e.g. Vienna Convention on Civil Liability for Nuclear Damage)	BAERA	P	2016	No	-	No	Yes	Yes	Yes	Yes	-	
	Public acceptance obtained (% of public opinion favourable to NPP)	BAERA	P	2016	N/A	-						-	
2.11 Private financing promoted and increased for power infrastructure investment (except rental/quick-rental power plants)	Percentage of private financing to infrastructure development increased (except rental/quick-rental power plants) (% of GDP)	MoPEMR	P	?	? (South Asia infra spending average: 6.9%)								
2.12 Power tariff responding to the increase of supply cost	Ratio of tariff coverage to the supply cost (%)	BERC	P	2016	87%	According to BERC, it should be measured as the ratio of the average bulk power tariff to the average bulk power supply cost	87%					PSMP2016, Section 21.4.1, Table 21-14	
	Ratio of tariff change to the supply cost change (%)	BERC	P	-	-		-						

Result Chain	Indicators	Lead Responsible Institution	Type of Project	Baseline		Reference Source for Baseline	Intermediate Targets				Final Target (Yr 2020)	Reference Source for Targets	Cumulative ADP Contributions Year 1-5 (Estimated)
			I: Infra P:Policy and/or Reform I&P: Hybrid	Year	Value		Yr 1 2016	Yr2 2017	Yr3 2018	Yr4 2019			
Sector Outcome 3. Well-articulated Demand Side Management (DSM) policy adopted and implemented													
3.1 Energy Efficiency Conservation promotion programs including energy management, labelling, green building and awareness raising implemented	Amount of concessional loan disbursed under Energy Management program	SREDA	P	2016	0	JICA Preparatory Survey for Energy Efficiency and Conservation Promotion Financing Project	0						
	Amount of concessional loan disbursed under Green Building program	SREDA	P	2016	0	JICA Preparatory Survey for Energy Efficiency and Conservation Promotion Financing Project	0						
	Amount of concessional loan disbursed under Labelling program	SREDA	P	2016	0	JICA Preparatory Survey for Energy Efficiency and Conservation Promotion Financing Project	0						
3.2 Preferential taxation on energy efficient appliances in place	Preferential taxation (including tax reduction and exemption, and accelerated depreciation) approved and implemented	SREDA	P	2016	No	JICA Preparatory Survey for Energy Efficiency and Conservation Promotion Financing Project	No	Yes	Yes	Yes	Yes	JICA Preparatory Survey for Energy Efficiency and Conservation Promotion Financing Project	
3.3 Energy efficiency of vehicles improved	Introduction of Eco-car program	MoPEMR?	P	2016	No	PSMP2016 Section 6.4.2	No	No	No	No	Yes	PSMP2016 Section 6.4.2	
	Fuel consumption efficiency (km/l or miles per gallon)	MoPEMR?	P	2016	N/A	PSMP2016 Table 6-8	N/A	N/A	N/A	N/A			
3.4 Energy efficiency in fertilizer factories improved	Fuel consumption efficiency to produce a unit of fertilizer (MCF of natural gas/ton of fertilizer)	MoPEMR	I&P	2014	44	PSMP2106 Section 7.5.2	44	N/A	N/A	N/A		PSMP2106 Section 7.5.2	

5 ASSUMPTIONS AND RISKS

During the Power and Energy SSP Formulation Workshop over 3 – 5 March 2017, an active discussion was held amongst participants on assumptions underlying the Theory of Change. The exercise of identifying assumptions was used as a check on the logic of the Theory of Change, especially on the causal links between Intermediate Outcomes and Sector Outcomes as well as between Sector Outcomes and Sector Goal. Consequently, gaps in the Theory of Change were identified and the necessary changes reflected in Chapter 3.

However, this exercise yielded some assumptions made about factors beyond the control of actors in the sector, and these assumptions have been re-formulated as risks, with the accompanying risk mitigation measures designed to reduce the chances of the risk occurring and/or reduce the impact of the risk if it does occur.

Table 5-1 Risks and Mitigation Measures

Description of Risk	Affected Sector Outcome (SO)/ Intermediate Outcome (IO)	Means of Mitigation
Failure to eliminate operational deficits through price rises and/or efficiency gains leads to further weakening of the sector's financial viability.	All infrastructure (investment)-flagged Intermediate Outcomes	Lobbying to ensure that tariff rises are allowed Enhanced focus on strengthening generation efficiency
Cost overruns with development projects reduces the fiscal space at the sector level.	All infrastructure (investment)-flagged Intermediate Outcomes	Strengthening formulation of DPPs, including accuracy in costing Enhanced project implementation capacity including procurement
Delays with project implementation lead to shortfalls in required infrastructure expansion/enhancement.	All infrastructure (investment)-flagged Intermediate Outcomes	Appropriate "early warning" signals in place so that delays are identified early and swift measures can be taken to rectify problems
Development of the deep-sea port for coal and LNG imports is delayed	IO 1.3 Infrastructure to import coal, gas, and oil products developed	Developing FSRU infrastructure for the imports of LNG to reduce the impact of possible delays in deep-sea port.

Description of Risk	Affected Sector Outcome (SO)/ Intermediate Outcome (IO)	Means of Mitigation
Little consideration for O&M cost does not sustain the periodical maintenance over plant life.	IO 1.5 Gas transmission and distribution pipeline expanded and efficiency improved (loss reduced and condensate production increased) IO 2.3 Availability and efficiency of thermal power plants improved	Measures to explicitly identify and allocate O&M funding, for both on-going and planned investment projects
Increases in the international prices of import fuels	SO 1. Reliable, affordable and efficient energy supply achieved and sustained	Maximum use of domestic energy resources as well as renewable energy sources Measures to increase energy efficiency in both supply and demand sides
Depreciation of Taka against foreign currencies	SO 1. Reliable, affordable and efficient energy supply achieved and sustained All infrastructure (investment)-flagged Intermediate Outcomes	Enhanced project implementation capacity including procurement to shorten the project duration and avoid project delay Maximum use of domestic energy resources as well as renewable energy sources Measures to increase energy efficiency in both supply and demand sides

6 ANNEXES

6.1 ANNEX I – SDG Goals 9, 12 and 13

Goal 9 (Industry, innovation, infrastructure) Targets:

1) Develop quality, reliable, sustainable and resilient infrastructure, including regional and trans-border infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all.
2) Promote inclusive and sustainable industrialization and, by 2030, significantly raise industry's share of employment and gross domestic product, in line with national circumstances, and double its share in least developed countries.
3) Increase the access of small-scale industrial and other enterprises, in particular in developing countries, to financial services, including affordable credit, and their integration into value chains and markets.
4) By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries taking actions in accordance with their respective capabilities.
5) Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending.
6) Facilitate sustainable and resilient infrastructure development in developing countries through enhanced financial, technological and technical support to African countries, least developed countries, landlocked developing countries and Small Island developing States.
7) Support domestic technology development, research, and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities.
8) Significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020.

Goal 12 (Ensure sustainable consumption and production patterns) Targets:

1) Implement the 10-year framework of programmes on sustainable consumption and production, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries.
2) By 2030, achieve the sustainable management and efficient use of natural resources.
3) By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.
4) By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment.
5) By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse.
6) Encourage companies, especially large and transnational companies, to adopt sustainable practices and to integrate sustainability information into their reporting cycle.
7) Promote public procurement practices that are sustainable, in accordance with national policies and priorities.

8) By 2030, ensure that people everywhere have the relevant information and awareness for sustainable development and lifestyles in harmony with nature.
9) Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production.
10) Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes local culture and products.
11) Rationalize inefficient fossil-fuel subsidies that encourage wasteful consumption by removing market distortions, in accordance with national circumstances, including by restructuring taxation and phasing out those harmful subsidies, where they exist, to reflect their environmental impacts, taking fully into account the specific needs and conditions of developing countries and minimizing the possible adverse impacts on their development in a manner that protects the poor and the affected communities.

Goal 13 (Climate action) Targets:

1) Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries.
2) Integrate climate change measures into national policies, strategies, and planning.
3) Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning.
4) Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible.
5) Promote mechanisms for raising capacity for effective climate change-related planning and management in least developed countries and Small Island developing States, including focusing on women, youth, and local and marginalized communities.

6.2 ANNEX II – BIBLIOGRAPHY

Bangladesh Institute of Development Studies. 2016. *Bangladesh Economic Review*.

Bangladesh Power Development Board. 2016. *Bangladesh Power Development Board Annual Report 2014-2015*.

Cabinet Division. 2017. *FY2016-2017 Annual Performance Agreements (APA) for Power Division and EMRD*.

Economic Relations Division. 2010. *Bangladesh Joint Cooperation Strategy 2010-2015*.

General Economics Division. 2016. *7th Five Year Plan*.

General Economics Division. 2016. *Mapping of Ministries and Divisions by Sustainable Development Goals' Targets*.

Finance Division. 2017. *FY2016-2017 Ministry Budget Framework (MBF) of Power Division and EMRD*.

Power Division. 2016. *Power Sector Master Plan 2016*.

Power Division. 2016. *Power Division Medium Term Strategy and Business Plan (MTSBP) 2016-2020*.

United Nations. 2015. *Transforming Our World – the 2030 Agenda for Sustainable Development.*

6.3 Annex III Long-Term Sector Results Framework 2020-2040

1 USD = 80.2081 BDT

Result Chain	Indicators	Lead Responsible Institution	Type of Project	Baseline		Reference Source for Baseline	Intermediate Targets		Final Targets		Reference Source for Targets	Estimated Construction Cost in 2016 (Constant Price)		Financial Sources 2017-2020 (million BDT)			
			I: Infra P:Policy and/or Reform I&P: Hybrid	Year	Value		Year 2020	Year 2025	Year 2030	Year 2040		Estimated Cost (million BDT)	Reference Source	Total	Private	Agency's own finance and/or Sector Fund	ADP/RADP
Sector Goal: Ensure sustainability in production, consumption and use of energy and mineral resources																	
	Total primary energy supply (ktoe/year)	MoPEMR	I&P	2015	38,981	PSMP2016 Big Data	46,122	61,252	80,645	130,827	PSMP2016 Big Data	-	-	-	-	-	-
	Per capita electricity consumption (kWh/year)	MoPEMR	I&P	2016	304	PSMP2016 Big Data	470.0799	675.4759	888.8238	1500	PSMP2016 Big Data	-	-	-	-	-	-
	Energy intensity (toe/million Taka)	MoPEMR	I&P	2015	4.5	PSMP2016 Big Data	3.91	3.64	3.53	3.42	PSMP2016 Big Data	-	-	-	-	-	-
Sector Outcome 1: Reliable, affordable and efficient energy supply achieved and sustained																	
1.1 Clear policy on long-term energy sources including energy security and fuel source diversification developed and approved	Clear policy on long-term energy sources including energy security and fuel source diversification developed and approved	MoPEMR	P	2016	None		Done	-	-	-		-	-	-	-	-	-
1.2 Production of domestic gas and coal efficiently increased	Success ratio of exploratory drilling (TBD)	Petrobangla	I	2015								-	-	-	-	-	-
	Amount of domestic gas produced (BCF/year)	Petrobangla	I	2014	892	Petrobangla Annual Report 2015	837	572	549	657	Load factor: 0.9	39,847	PSMP2016 Table 7-10				
	Amount of domestic coal extracted (million ton/year)	Petrobangla	I	2015	0.7	Petrobangla Annual Report 2015	1,100	2,100	6,200	11,200	PSMP2016 Section 9.4.1	?	?				
	Amount of condensate produced (ton/year OR ktoe/year)	Petrobangla	I	2015		Petrobangla Annual Report 2015					PSMP2016 Big Data	-	-	-	-	-	-

1 USD = 80.2081 BDT

Result Chain	Indicators	Lead Responsible Institution	Type of Project	Baseline		Reference Source for Baseline	Intermediate Targets		Final Targets		Reference Source for Targets	Estimated Construction Cost in 2016 (Constant Price)		Financial Sources 2017-2020 (million BDT)			
			I: Infra P:Policy and/or Reform I&P: Hybrid	Year	Value		Year 2020	Year 2025	Year 2030	Year 2040		Estimated Cost (million BDT)	Reference Source	Total	Private	Agency's own finance and/or Sector Fund	ADP/RADP
1.3 Infrastructure to import coal, gas and oil products developed	A deep sea port for coal and LNG import	Ministry of Shipping and MoPEMR	I	2016	0	-	0	0	1	1	PSMP2016 Big Data	400,000++	PSMP2016 Supplement Study by JICA				
	Number of coal (transhipment) terminals	MoPEMR	I	2016	0	-	2	3	3	3	PSMP2016 Big Data	110,000	FS for Coal transshipment terminal project in Matarbari	110,000	65,000		45,000
	Number of land-based terminal storage tanks	MoPEMR	I	2016	0	-	0	0	3	14	PSMP2016 Section 8.5.2	181,270	PSMP2016 8.5.2				
	Number of FSRU	MoPEMR	I	2016	0	-	1	2	2	2	PSMP2016 Big Data	?	?				
	Amount of coal imported (million ton/year)	MoPEMR	I	2015	1.1	PSMP2016 Table 9-12	18	21	25	38	PSMP2016 Table 9-12	-	-	-	-	-	-
	Amount of gas imported (MMSCFD/year)	MoPEMR	I	2016	0	-	700	1,200	2,200	3,700	PSMP2016 Big Data	-	-	-	-	-	-
	Amount of oil imported (thousand tons/year)	MoPEMR	I	2013	5,100	Energy Division	6,256	9,930	16,509	30,965	PSMP2016 Big Data	-	-	-	-	-	-
1.4 System loss for oil import reduced	Number of SPM installed	Energy Division	I	2016	0	PSMP2016	1	N/A	N/A	N/A	PSMP2016 Section 10.1.3	50,531	PSMP2016 Section 10.1.3				
	Amount of oil pilferage reduced (ton/year OR ktoe/year)	Energy Division	I	2016	?	?		N/A	N/A	N/A		-	-	-	-	-	-
1.5 Gas transmission and distribution pipeline expanded and efficiency improved (loss reduced and condensate production increased)	KM of gas transmission pipeline installed (km)	Petrobangla	I	2015	2,536	Petrobangla Annual Report 2015		N/A	N/A	N/A		?	?				
	KM of gas distribution pipeline installed (km)	Petrobangla	I	2015	2,372	Petrobangla Annual Report 2015		N/A	N/A	N/A		?	?				
	KM of gas service line installed (km)	Petrobangla	I	2015	16,603	Petrobangla Annual Report 2015		N/A	N/A	N/A		?	?				
	Pre-paid meter installed (number)	Petrobangla	I	2015													

1 USD = 80.2081 BDT

Result Chain	Indicators	Lead Responsible Institution	Type of Project	Baseline		Reference Source for Baseline	Intermediate Targets		Final Targets		Reference Source for Targets	Estimated Construction Cost in 2016 (Constant Price)		Financial Sources 2017-2020 (million BDT)			
			I: Infra P:Policy and/or Reform I&P: Hybrid	Year	Value		Year 2020	Year 2025	Year 2030	Year 2040		Estimated Cost (million BDT)	Reference Source	Total	Private	Agency's own finance and/or Sector Fund	ADP/RADP
1.6 Access to renewable energy increased (biogas for cooking and improved cooking stove (ICS))	Number of clean cook stove installed (million)	SREDA	I	2011	0.51	Country Action Plan for Clean Cookstoves	7.51	?	30	30	Country Action Plan for Clean Cookstoves	?	?				
	Amount of biogas produced (thousand m3/day as capacity)	SREDA	I	2015	190	PSMP2016 Section 13.5.2	640	1015	1390	3000	PSMP2016 Section 13.5.2	242	PSMP2016 Section 13.4.6 for 60 million m3/day gas from glass-fibre digesters				
	Amount of biogas produced added (thousand m3/day as capacity)	SREDA	I			PSMP2016 Section 13.5.2	450	825	1200		2017-2021: 600,000 m3/day --> 2017-2020: 450,000 m3/day 2021-2025:	?	?				
1.7 Private financing promoted and increased for energy infrastructure investment	Percentage of private financing to infrastructure development increased (% of GDP)	MoPEMR	I&P	?	? (South Asia infra spending average: 6.9%)							-	-	-	-	-	-
1.8 Energy tariff responding to the increase of supply cost	Ratio of gas tariff coverage to the supply cost (%)	BERC	P	**2016**	100%	PSMP2016 Ch.21	11%	26%	62%	100%	PSMP2016 Fig 21-5	-	-	-	-	-	-
	% of every year tariff raise			**2016**	100%	No loss at Petrobangla (only with domestically produced gas)	1.697936	4.103208	9.915755	15.99984	PSMP2016 Table 1-22 (nominal Taka-base, inflation rate factored in)	-	-	-	-	-	-
	Index to international price (100=16 USD/MMBTU)			**2016**	6%	PSMP2016 Fig 21-5	0.106121	0.256451	0.619735	0.99999	calculated	-	-	-	-	-	-
	Ratio of oil tariff coverage to the supply cost (%)	BERC	P	2016	?		N/A	N/A	N/A	100%		-	-	-	-	-	-
	BPC Annual Report every year published	BPC	P	2016	No	-	Yes	Yes	Yes	Yes	-	-	-	-	-	-	-

1 USD = 80.2081 BDT

Result Chain	Indicators	Lead Responsible Institution	Type of Project	Baseline		Reference Source for Baseline	Intermediate Targets		Final Targets		Reference Source for Targets	Estimated Construction Cost in 2016 (Constant Price)		Financial Sources 2017-2020 (million BDT)			
			I: Infra P:Policy and/or Reform I&P: Hybrid	Year	Value		Year 2020	Year 2025	Year 2030	Year 2040		Estimated Cost (million BDT)	Reference Source	Total	Private	Agency's own finance and/or Sector Fund	ADP/RADP
Sector Outcome 2: Reliable, affordable, efficient and quality power supply achieved and sustained																	
2.1 Power supply through both generation and imports increased	Total installed power generation capacity (within Bangladesh territory) (MW)	Power Division	I	2015	10,895MW (including derated capacity)	PSMP2016 Ch.11	21,133	24,461	30,422	53,266	PSMP2016 Big Data Sheet "★ Summary (All)"	6,416,648	PSMP2016 Supplement Study by JICA (plant cost ONLY, constant price)				
	Power generation capacity through power trade (MW)	Power Division	I	2015	500	PSMP2016 Ch.14	1,200	2,500	5,000	9,000	PSMP2016 Big Data Sheet "10 PDP(MW)"						
	Proportion of private-owned generation (IPP only, rental exclude) (%)	Power Division	I&P	2013	29%	PSMP2016 Section 2.3.5 and BPDB Annual Report 2014-2015											
	Rental/Quick-rental power plant (Number, or MW)	Power Division	P	2015	40	PSMP2016 Section 2.3.5		0	0	0		-	-	-	-	-	-
2.2 Renewable energy power generation increased	Installed Renewable Energy Capacity (on and off-grid) (MW)	SREDA	I&P	2016	432	PSMP2016 Section 13.2.1	2,301	N/A	N/A	N/A	SREDA web site						
	On-grid renewable generation capacity (MW)	SREDA	I&P	2016	232	PSMP2016 Section 13.2.1	1,454	N/A	N/A	N/A	SREDA web site						
	Off-grid renewable power generation (MW)	SREDA	I	2016	200	PSMP2016 Section 13.2.1	847	N/A	N/A	N/A	SREDA web site						
2.3 Availability and efficiency of thermal power plants improved	Capacity of power plant repowered and/or converted (added MW)	Power Division	I														
	Average thermal efficiency of power plants (%)	Power Division	I	2015	33%	PSMP2016 Section 19.3.4											
	Loss of Load Expectation (LOLE) (%)	PGCB	I&P	N/A	N/A	PSMP2016 11.12.2	N/A	N/A	0.3	0.3	PSMP2016 11.12.2	-	-	-	-	-	-

1 USD = 80.2081 BDT

Result Chain	Indicators	Lead Responsible Institution	Type of Project	Baseline		Reference Source for Baseline	Intermediate Targets		Final Targets		Reference Source for Targets	Estimated Construction Cost in 2016 (Constant Price)		Financial Sources 2017-2020 (million BDT)			
			I: Infra P:Policy and/or Reform I&P: Hybrid	Year	Value		Year 2020	Year 2025	Year 2030	Year 2040		Estimated Cost (million BDT)	Reference Source	Total	Private	Agency's own finance and/or Sector Fund	ADP/RADP
2.4 Electricity Act and BERC Act 2013 revised and implemented to ensure operation and maintenance of power plant including periodical inspection	Regulations for periodical maintenance developed and approved (Electricity Act and/or BERC Act 2013 revised)	?	P	2016	No	-	Yes	Yes	Yes	Yes	-	-	-	-	-	-	-
	Rights of the on-site inspection by a governmental body established	?	P	2016	No	-	Yes	Yes	Yes	Yes	-	-	-	-	-	-	-
2.5 Technical and non-technical loss reduced	Transmission loss (%)	PGCB	I	2016	2.73%	BPDB Annual Report 2015-2016	N/A	1.6%	N/A	N/A	PSMP2016 Section Table 15-10						
	Distribution system loss (%)	Distribution Companies	I	2016	11%	PSMP2016 Big Data Sheet "key statistics"			N/A	N/A							
	Distribution commercial loss (%)	Distribution Companies	I&P						N/A	N/A							
	Non-technica loss (commercial loss) (%)	Distribution Companies	I														
2.6 Power transmission and distribution network expanded	Length of new transmission lines commissioned (circuit Km)	PGCB	I	2015	9,807.49	PGCB Annual Report 2015-2016						997,949	PSMP2016 Table 15-27			8,998	
	Capacity of transmission substations (MVA)	PGCB	I	2016	22,551	PGCB Annual Report 2015-2016											
	Length of new distribution lines commissioned (Km)	Distribution Companies	I		41,920	BPDB Annual report 2015-2016											
2.7 Access to power, both on-grid and off-grid, increased	Access to Electricity	Power Division	I	2015	77%	PSMP2016 Table 15-28	99%	100%	100%	100%	PSMP2016 Section 15.9.5						

1 USD = 80.2081 BDT

Result Chain	Indicators	Lead Responsible Institution	Type of Project	Baseline		Reference Source for Baseline	Intermediate Targets		Final Targets		Reference Source for Targets	Estimated Construction Cost in 2016 (Constant Price)		Financial Sources 2017-2020 (million BDT)			
			I: Infra P:Policy and/or Reform I&P: Hybrid	Year	Value		Year 2020	Year 2025	Year 2030	Year 2040		Estimated Cost (million BDT)	Reference Source	Total	Private	Agency's own finance and/or Sector Fund	ADP/RADP
2.8 More stable and high quality power supplied	Fluctuation of system frequency (Hz plus/minus 50Hz, OR % change of system frequency)	Power Division	I&P	2015	±1.0 Hz	PSMP2016 Section 16.2.2	N/A	±0.5Hz	±0.5Hz	±0.2Hz	PSMP2016						
	SAIFI (System Average Interruption Frequency Index)	Power Division	I&P														
	SAIDI (System Average Interruption Duration Index)	Power Division	I&P														
	SAIDI (System Average Interruption Duration Index)	Power Division	I&P														
	Introduction of Economic Load Dispatch (ELD)	Power Division	I&P	N/A	N/A		-	TBD	TBD	TBD							
2.9 Electricity Act, Grid Code, NLDC operational rules revised and implemented to improve network power quality	Electricity Act amended	Power Division	P	2016	No	-	Yes	Yes	Yes	Yes	-	-	-	-	-	-	-
	National Grid Code amended	Power Division	P	2016	No	-	Yes	Yes	Yes	Yes	-	-	-	-	-	-	-
	NLDC operational rule amended	Power Division	P	2016	No	-	Yes	Yes	Yes	Yes	-	-	-	-	-	-	-
	Number of governor-free generator (newly installed)	Power Division	P	2016	No	-	Yes	Yes	Yes	Yes	-	-	-	-	-	-	-
2.10 IAEA recommendations implemented, including strengthening of safety management, nuclear fuel cycle including waste management, ratification of international lows of civil liability of nuclear damage	Bangladesh Atomic Energy Regulations Act 2011 adopted	BAERA	P	2016	No	-	Yes	Yes	Yes	Yes	-	-	-	-	-	-	-
	Independent regulatory body established	BAERA	P	2016	Yes	-	Yes	Yes	Yes	Yes	-	-	-	-	-	-	-
	Other IAEA Safety Standards met	BAERA	P	2016	No	-	Yes	Yes	Yes	Yes	-	-	-	-	-	-	-
	Nuclear fuel cycle incl. waste management established	BAERA	P	2016	No	-	Yes	Yes	Yes	Yes	-	-	-	-	-	-	-
	Ratification of the Int'l treaties completed (e.g. Vienna Convention on Civil Liability for Nuclear Damage)	BAERA	P	2016	No	-	Yes	Yes	Yes	Yes	-	-	-	-	-	-	-
	Public acceptance obtained (% of public opinion favourable to NPP)	BAERA	P	2016	No	-	Yes	Yes	Yes	Yes	-	-	-	-	-	-	-

1 USD = 80.2081 BDT

Result Chain	Indicators	Lead Responsible Institution	Type of Project	Baseline		Reference Source for Baseline	Intermediate Targets		Final Targets		Reference Source for Targets	Estimated Construction Cost in 2016 (Constant Price)		Financial Sources 2017-2020 (million BDT)			
			I: Infra P:Policy and/or Reform I&P: Hybrid	Year	Value		Year 2020	Year 2025	Year 2030	Year 2040		Estimated Cost (million BDT)	Reference Source	Total	Private	Agency's own finance and/or Sector Fund	ADP/RADP
2.11 Private financing promoted and increased for power infrastructure investment (except rental/quick-rental power plants)	Percentage of private financing to infrastructure development increased (except rental/quick-rental power plants) (% of GDP)	MoPEMR	P	?	? (South Asia infra spending average: 6.9%)												
2.12 Power tariff responding to the increase of supply cost	Ratio of tariff coverage to the supply cost (%)	BERC	P	2016	87%	According to BERC, it should be measured as the ratio of the average bulk power tariff to the average bulk power supply cost	10.7%/yr at norminal BDT	10.7%/yr at norminal BDT	9.5%/yr at norminal BDT	9.5%/yr at norminal BDT	PSMP2016, Section 21.4.1, Table 21-14	-	-	-	-	-	-
	Ratio of tariff change to the supply cost change (%)	BERC	P	-	-							-	-	-	-	-	-
Sector Outcome 3. Well-articulated Demand Side Management (DSM) policy adopted and implemented																	
3.1 Energy Efficiency Conservation promotion programs including energy management, labelling, green building and awareness raising implemented	Amount of concessional loan disbursed under Energy Management program	SREDA	P	2016	0	JICA Preparatory Survey for Energy Efficiency and Conservation Promotion Financing Project											
	Amount of concessional loan disbursed under Green Building program	SREDA	P	2016	0	JICA Preparatory Survey for Energy Efficiency and Conservation Promotion Financing Project											
	Amount of concessional loan disbursed under Labelling program	SREDA	P	2016	0	JICA Preparatory Survey for Energy Efficiency and Conservation Promotion Financing Project											

1 USD = 80.2081 BDT

Result Chain	Indicators	Lead Responsible Institution	Type of Project	Baseline		Reference Source for Baseline	Intermediate Targets		Final Targets		Reference Source for Targets	Estimated Construction Cost in 2016 (Constant Price)		Financial Sources 2017-2020 (million BDT)			
			I: Infra P:Policy and/or Reform I&P: Hybrid	Year	Value		Year 2020	Year 2025	Year 2030	Year 2040		Estimated Cost (million BDT)	Reference Source	Total	Private	Agency's own finance and/or Sector Fund	ADP/RADP
3.2 Preferential taxation on energy efficient appliances in place	Preferential taxation (including tax reduction and exemption, and accelerated depreciation) approved and implemented	SREDA	P	2016	No	JICA Preparatory Survey for Energy Efficiency and Conservation Promotion Financing Project	Yes	Yes	Yes	Yes	JICA Preparatory Survey for Energy Efficiency and Conservation Promotion Financing Project	-	-	-	-	-	-
3.3 Energy efficiency of vehicles improved	Introduction of Eco-car program	MoPEMR?	P	2016	No	PSMP2016 Section 6.4.2	Yes	Yes	Yes	Yes	PSMP2016 Section 6.4.2	-	-	-	-	-	-
	Fuel consumption efficiency (km/l or miles per gallon)	MoPEMR?	P	2016	N/A	PSMP2016 Table 6-8						-	-	-	-	-	-
3.4 Energy efficiency in fertilizer factories improved	Fuel consumption efficiency to produce a unit of fertilizer (MCF of natural gas/ton of fertilizer)	MoPEMR	I&P	2014	44	PSMP2106 Section 7.5.2			25	25	PSMP2106 Section 7.5.2						