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	Recommendations for actions are useful, realistic and hierarchic			

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Table of Contents

Table of Tables

Table of Figures

Abbreviations

ADB	Asian Development Bank
AS	Ancillary Services
ASEAN	Association of Southeast Asian Nations
BERC	Bangladesh Energy Regulatory Commission
BESS	Battery Energy Storage System
BPDB	Bangladesh Power Development Board
BREB	Bangladesh Rural Electrification Board
CAPEX	Capital Expenditure
CCGT	Combined Cycle Gas Turbine
DG INTPA	Directorate General for International Partnerships
DNO	Distribution Network Operator
EE	Energy Efficiency
EPC	Engineering, Procurement, and Construction
EU	European Union
EUD	European Union Delegation
EV	Electric Vehicle
GC-BESS	Grid Connected Battery Energy Storage System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GoB	Government of Bangladesh
GW	Gigawatts
GWh	Gigawatts Hours
HFO	Heavy Fuel Oil
IPP	Independent Power Producer
LNG	Liquefied Natural Gas
MW	Megawatts
MWh	Megawatt Hours
NGO	Non-Governmental Organisation
NKE	Non-Key Expert
NLDC	National Load Dispatch Centre
O&M	Operation and Maintenance
OEM	Original Equipment Manufacturer
P2P	Peer-to-Peer
PGCB	Power Grid Company of Bangladesh
PPA	Power Purchase Agreement
PPP	Public-Private Partnership
PV	Photovoltaic
RE	Renewable Energy
SPV	Special Purpose Vehicle
SREDA	Sustainable and Renewable Energy Development Authority
T&D	Transmission and Distribution
TAF	Technical Assistance Facility
TEI GET	Team Europe Initiative on Green Energy Transition
VfM	Value for Money
VRE	Variable Renewable Energy
WZPDCL	West Zone Power Distribution Company Limited

1. INTRODUCTION

1.1. BACKGROUND

The European Union Delegation (EUD) and the Directorate-General for International Partnerships (DG INTPA), through the European Union (EU) Global Technical Assistance Facility (TAF) for Sustainable Energy, are supporting the Government of Bangladesh (GoB) in the development of a power system that provides maximum coverage of the country's energy demand through renewable and sustainable energy while reducing demand through energy efficiency (EE). In Bangladesh, the Team Europe Initiative on Green Energy Transition (TEI GET) is co-chaired by the EU and Germany and includes EU Member States and like-minded partners.

In view of these overarching objectives, the EU TAF has deployed a team of five non-key experts (NKEs) to support the GoB in the following objectives:

- Assess available energy storage technologies for potential application in supporting the Green Energy Transition in Bangladesh;
- Assess current grid conditions and the role of energy storage in potential ancillary services (AS);
- Identify possible locations of energy storage solutions on the grid that may ease current constraints and deliver added benefits, such as capital expenditure (CAPEX) deferral;
- Assess energy storage requirements under different levels of variable renewable energy (VRE) integration;
- Develop the key steps for an energy storage roadmap for Bangladesh;
- Generate insights and knowledge products for sensitising key stakeholders in relation to the role and potential for energy storage applications in Bangladesh.

As per the scope of the assignment and in alignment with the inception report, the deliverables listed in *Table 1* have been produced.

Table 1: Expected Deliverables of the Assignment

Deliverables / Outputs	Outcomes/ Engagement Framework
Deliverable 1: Preliminary Insights Paper	Knowledge Paper - sensitization and initial engagement with the stakeholders
Deliverable 2: As-Is Assessment Report	State of the Sector Report – facilitate engagement to achieve buy-in and early-stage ownership of project outputs within key stakeholders
Deliverable 3: Identification, Scoping and Prioritisation Report	Project Preparatory Activities – generate interest and buy-in for potential investment programmes
Deliverable 4: Options and Business Models Assessment	Commercial Arrangements for Potential Investment Projects – generate interest, demonstrate commercial viability, achieve agreement in relation to value-additions and value for money (VfM) for Bangladesh
Deliverable 5: Roadmap Report	Policy and Advisory Paper – disseminate across key power sector agencies, identify champions and obtain high-levels/senior decision-maker interest/buy-in for potential programmes

This report is the final deliverable (Deliverable 5) of the assignment and presents the **Roadmap for Energy Storage in Bangladesh**. It provides a synthesis of the assessments carried out by the team during the assignment, including but not limited to the review of energy storage technologies (Deliverable 1), the As-Is assessment of key power utilities (Deliverable 2), the assessment of potential investment options (Deliverable 3), review of candidate business models and structures for the deployment of energy storage applications (Deliverable 4), and finally a review of the enabling environment for the successful deployment of energy storage in Bangladesh (Chapters 3 and 4 of this report). This report includes an overlay of key enablers for energy storage applications with tentative time horizons for the development and adoption of the enabling environment in Bangladesh. Finally, the report identifies potential interventions for consideration by the GoB and development partners to support the development of an enabling environment for each use-case.

This Report provides an indicative roadmap only, with further planning studies and assessment required for each use-case and investment option.

1.2. STRUCTURE OF THE REPORT

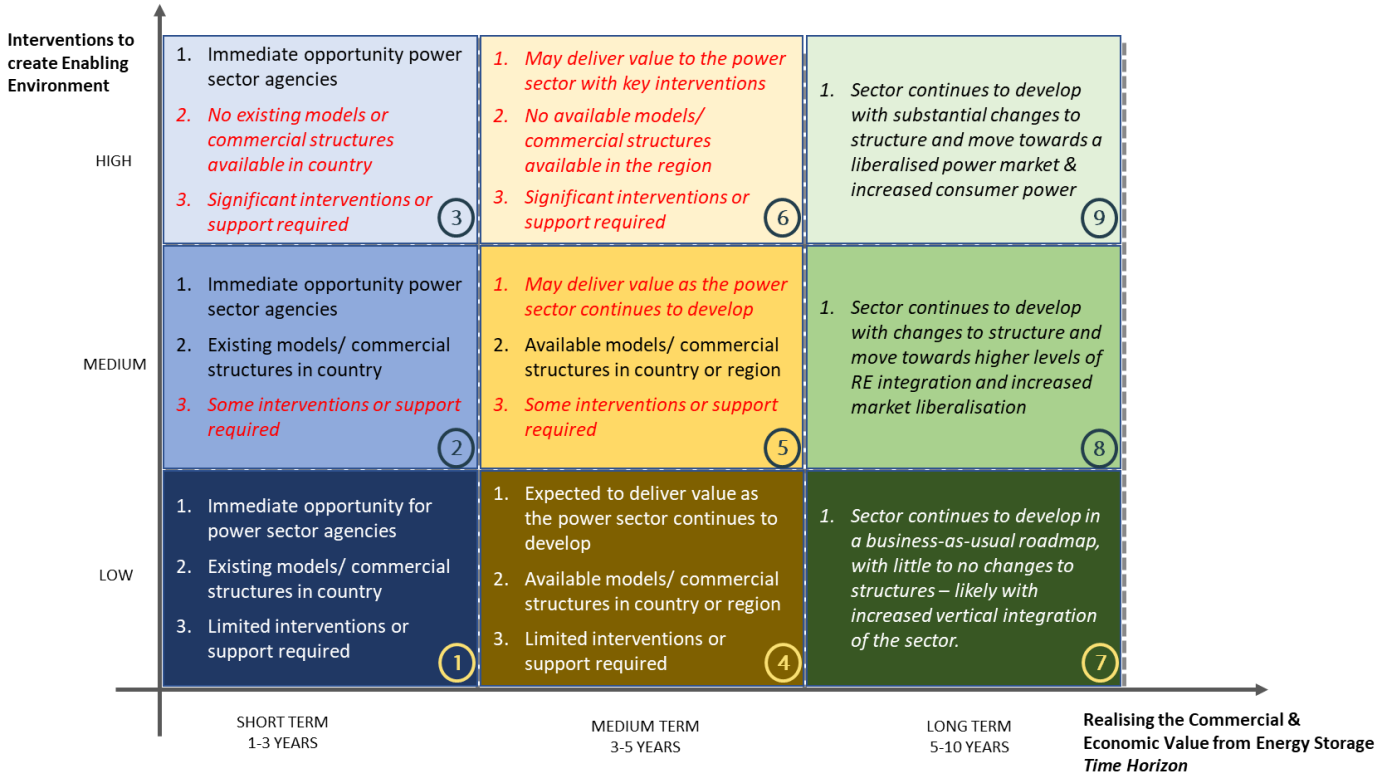
This report is based on interactions with various power sector agencies and stakeholders, and an analysis of the power sector in Bangladesh. The report is structured in the following manner:

- **Chapter 1** provides the background of the assignment and an overview of the structure of this report;
- **Chapter 2** introduces the key assessment frameworks that were used to develop the roadmap;
- **Chapter 3** provides details of the underlying assessment in relation to the existing enabling environment for each energy storage use-case;
- **Chapter 4** provides a high-level summary of the Energy Storage Roadmap for Bangladesh.

2. INTRODUCING THE FRAMEWORK FOR THE ROADMAP

The key objective of the energy storage roadmap is to provide the GoB and key stakeholders with an indicative timeframe of actions/ interventions for consideration to enable the deployment of energy storage in the country. The overarching framework for the roadmap is illustrated below (*Figure 1*).

Figure 1: Overarching Framework for the Roadmap



The diagram above shows a 3X3 matrix describing the potential time horizon for the deployment of different energy storage applications in Bangladesh, as well as the level of interventions relating to an enabling framework that may be required to enable power sector agencies (and the private sector) to implement projects. The horizontal axis illustrates the likely timeline for power sector agencies and private investors to realise commercial and economic benefits from projects. The following time-horizons were considered for the periods identified on the horizontal axis:

- **Short-term**: considered as one-three years. A time frame in which available technologies are expected to remain constant (with limited disruption). No new technologies are expected to achieve a commercially competitive position compared to existing technologies. From a policy and regulatory perspective, in the short-term only limited revisions to existing regulations and policies are expected to be implemented;
- **Medium-term**: considered as three-five years: A time frame in which existing technologies are expected to deliver substantial cost reductions through greater commercialisation and industrial process improvements. New emerging technologies are expected to enter the market and achieve increased cost competitiveness during this period. The medium-term would be characterised by the introduction of new policies and legislation, as well as the revision to significant policies;
- **Long-term**: considered as five-ten years: A time frame in which new technologies are expected to achieve commercial viability and replace existing technologies. This time frame remains very

speculative and based on broad future energy scenarios. Furthermore, substantial institutional, regulatory and policy changes may be achieved in this long-term period.

The vertical axis provides an indication of the level of interventions required from the Government or other development partners to create an enabling framework for the successful deployment of energy storage projects.

Each of the nine possible scenarios are further detailed below:

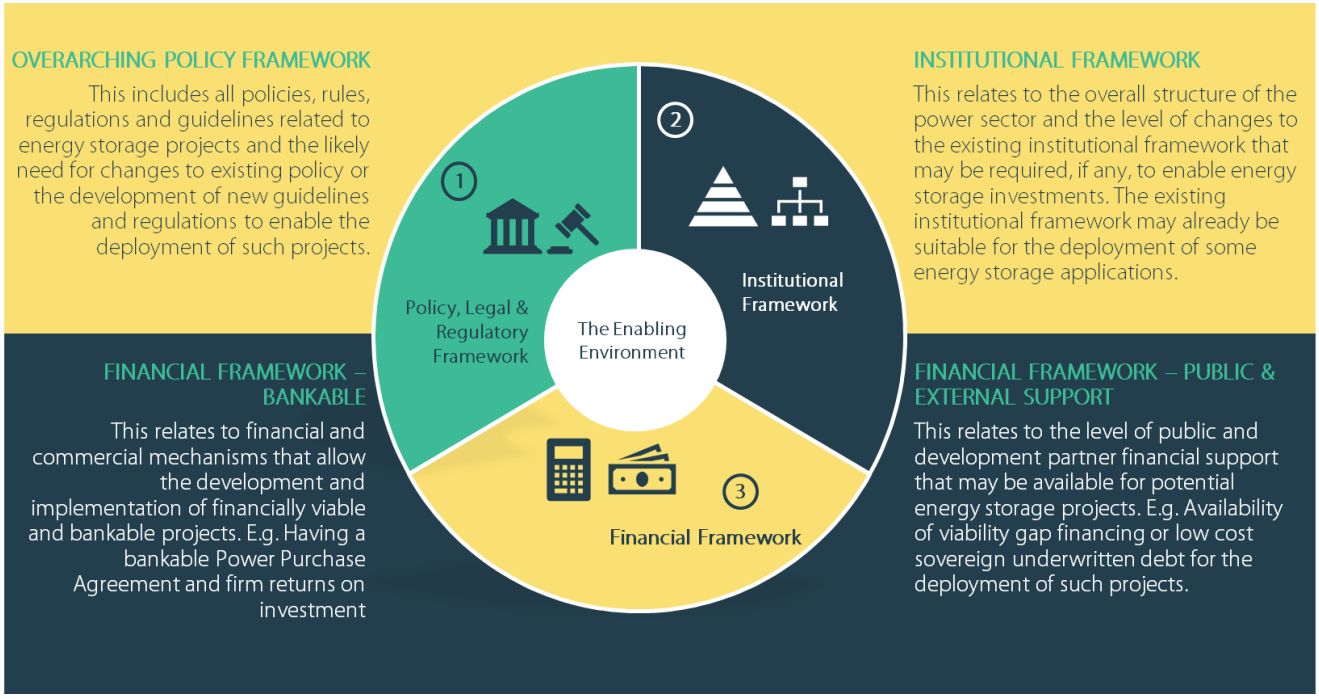
1. **Short-Low Scenario**: This scenario includes use-cases that demonstrate the following conditions:
    - *Represents an immediate opportunity for power sector agencies* to realise economic and commercial benefits from the deployment of energy storage assets. This includes opportunities such as the grid connected battery energy storage systems (GC-BESS) projects scoped and assessed as a part of Deliverable 3, addressing an immediate need in the power sector;
    - *There are existing models/ commercial structures in country* that could be readily used or adapted to deliver potential projects. For example, the GC-BESS project can utilise the existing model Power Purchase Agreement (PPA) available with the Bangladesh Power Development Board (BPDB) and an availability-based payment model, with limited changes to reflect the technical requirements of the system;
    - *This scenario is categorised by the limited level of interventions required* from the government or development partners to enable the development and implementation of energy storage projects. The use-cases identified under this scenario can be deployed within the existing policy and institutional framework of the power sector and would not require public sector funding support.
2. **Short-Medium Scenario**: This scenario will require *some intervention and/or support* from the government or development partners and represents a set of applications that can deliver commercial and economic value to the power sector in the short-term. The use-cases identified under this scenario can be deployed within the existing policy and institutional framework of the power sector, or with limited adjustments and would require little public sector funding support. For example, grid connected Battery Energy Storage Systems (BESS) used to offset peaking power plants and in load management applications.
3. **Short-High Scenario**: This scenario requires *high level of interventions and development partner support*. Furthermore, use-cases in this category *do not have any existing models or commercial structures available in the country.* Thus, to enable BESS projects in the short term, high level of support would be required. However, these use-cases may deliver significant economic and commercial benefits to the power sector and the broader economy in the immediate term, which may warrant consideration of the substantial interventions required.
4. **Medium-Low Scenario**: This scenario includes use-cases that demonstrate the following conditions:
    - *Use cases that are expected to deliver value as the power sector continues to develop.* These are cases which may already be able to deliver some value to the power sector in the in the short term, however, need further progression of technology/ costs in the medium term. As the sector continues to develop the value/ need for these use cases are also expected to grow;
    - *There are existing models/ commercial structures in the country* that could be readily used or adapted to deliver potential projects, as for the short-term framework. BESS can be used for example to reinforce the network in areas with significant associated costs of network expansion, e.g., large cities;
    - As for the previous case, *this scenario is categorised by the limited level of interventions required* from the government or development partners to enable the development and

implementation of energy storage projects. The use-cases identified under this scenario can be deployed within the existing policy and institutional framework of the power sector and would not require public sector funding support.

5. **The Medium-Medium Scenario**: This scenario, in addition to the points of the previous medium-term horizon, includes use-cases that *may deliver value as the power sector continues to develop.* This section comprises new technologies which are entering the market and could start to achieve cost competitiveness in the medium term. These use cases are expected to require some level of government intervention and funding support. Furthermore, this scenario also includes applications that would require continued evolution of the power sector (e.g., continued renewable energy (RE) integration) to achieve commercial viability. For example, BESS used to address regional power imbalances may become increasingly important for the sector with significant RE integration in the future.
6. **The Medium-High Scenario**: Similar to the Short-High Scenario above, this scenario is categorised by the need for a high level of interventions and support and a lack of existing models. Furthermore, the use-cases in this category would only be able to deliver value to the sector as the power sector continues to grow and develop.
7. **The Long-Low Scenario**: This scenario can be identified as *the business-as-usual roadmap*. Little to no chances to power sector structures and policy support are expected, with likely increased vertical integration of the sector. New technologies would be entering commercialisation stages, and existing technologies would be increasing cost competitive with conventional solutions. This scenario assumes that the overarching structure of the power sector remains somewhat unchanged, representing a situation where the majority of the sector remains in public ownership. Given that domestic (due to declining reserves, increasing demand and limited exploration) and international gas price pressures (BP Energy Outlook 2023 – Liquefied Natural Gas (LNG) trade increasing in the near term up to 2030 in nearly all modelled scenarios) are expected to continue, the need for optimising the efficiency of combined cycle gas turbine (CCGT) power plants. This would continue to improve the business case and viability of solutions such as the integration of BESS with such plants, and the use of commercial contracts such as tolling PPAs to allow for arbitrage between the gas and electricity markets.
8. **The Long-Medium Scenario**: This scenario assumes that *the power sector continues to develop with changes to its structure with the move towards higher levels of RE integration and increased market liberalisation.* This scenario represents a continued evolution of the power sector and in line with the long-term objectives of the GoB of investment, growth, development, and sustainability.
9. **The Long-High Scenario**: This scenario can be identified by a substantial growth of consumer influence in the power sector. Future Energy Scenarios in developed power sectors (such as those prepared by National Grid in the UK) define this as the “consumer power” scenario, where in addition to increased market liberalisation and growth of RE, consumer choices and decisions have a substantial impact on investment decisions in the sector. This includes the likely electrification of transport, growth of consumer electronics and appliances, continued growth of domestic cooling (and heating demand), development of the connected home, etc.

The diagram below (*Figure 2*) describes the key criteria for the assessment of the enabling framework. This framework is key to the assessment and classification of each use-case under one of the nine possible scenarios:

Figure 2: Framework for Assessing the Existing Enabling Environment



3. CLASSIFYING EACH USE-CASE

This section presents the team's assessment of each use-case as a part of the overall roadmap for energy storage in Bangladesh, as well as identifying key enablers/ interventions / support that may be required from the public sector and development partners. The table below summarises the classification of the different energy storage applications across the nine possible scenarios identified above.

Table 2: Classifying Each Use-Case

SCENARIO	POTENTIAL USE CASES	ASSESSMENT OF ENABLING ENVIRONMENT
Short-term Scenarios: *1) Short-Low* *2) Short-Medium* *3) Short-High*	• BESS deployed with RE plants	• **Section 3.1**, and assessed as a short-term potential application with a **high level of interventions** expected for implementation.
	• BESS deployed for peak shaving, load management and replacement of liquid fuel-based peaking power plants	• **Section 3.2**, and assessed as a short-term potential application with a **medium level of interventions** expected for implementation.
	• BESS and Photovoltaic (PV) for supporting and Enabling the Electrification of Transport	• **Section 3.3**, and assessed as a short-term potential application with a **medium level of interventions** expected for implementation.
	• Supporting rooftop solar and community electrification through BESS enabled solutions and user-level Peer-to-Peer (P2P) electricity trading	• **Section 3.4**, and assessed as a short-term potential application with a **medium level of interventions** expected for implementation.
	• BESS and PV for electrification of island communities	• **Section 3.5**, and assessed as a short-term potential application with a **low level of interventions** expected for implementation.
	• Portable electricity solutions for displaced communities	• **Section 3.6**, and assessed as a short-term potential application with a **low level of interventions** expected for implementation.
	• PV and batteries for street lighting	• **Section 3.7**, and assessed as a short-term potential application with a **low level of interventions** expected for implementation.

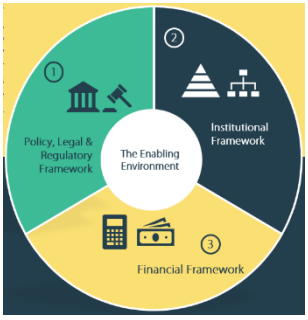
SCENARIO	POTENTIAL USE CASES	ASSESSMENT OF ENABLING ENVIRONMENT
Medium-term Scenarios: *4) Medium-Low* *5) Medium-Medium* *6) Medium-High*	• Providing AS	• **Section 3.8**, and assessed as a short-term potential application with a **high level of interventions** expected for implementation.
	• CAPEX deferral for transmission and distribution (T&D) investments	• **Section 3.9**, and assessed as a short-term potential application with a **high level of interventions** expected for implementation.
	• Reactive Power Support and other balancing services at a distribution level	• **Section 3.10**, and assessed as a short-term potential application with a **high level of interventions** expected for implementation.
	• BESS enabled islanding of large energy users, and the provision of demand response (Battery Islanding)	• **Section 3.11**, and assessed as a short-term potential application with a **medium level of interventions** expected for implementation.
Long-term Scenarios: *7) Long-Low* *8) Long-Medium* *9) Long-High*	• Integrated energy optimisation solutions	• **Section 3.12**, and assessed as a short-term potential application with a **high level of interventions** expected for implementation.
	• Supporting regional balancing requirements	• **Section 3.13**, and assessed as a short-term potential application with a **medium level of interventions** expected for implementation.

The following sections present the assessment in relation to the existing enabling environment for each energy storage application and the required level of intervention of their successful implementation.

3.1. BATTERIES WITH RE PLANTS TO SUPPLY ROUND THE CLOCK POWER

Table 3: Existing Enabling Environment for Batteries with RE Plants

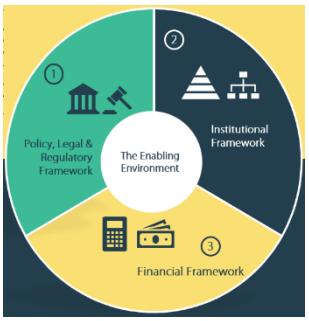
USE-CASE	Batteries with RE Plants to Supply Round the Clock Power	INVESTMENT OPTION REFERENCE (DELIVERABLE 3)	PV-BESS and Distribution Network Operator (DNO)-BESS

The Enabling Environment	
POLICY FRAMEWORK	**INSTITUTIONAL FRAMEWORK**
Re-powering of existing solar PV projects as been recommended as the potential business model/ scheme for early-stage deployment. Such a scheme would require limited changes to the existing policy framework and would require the Independent Power Producer (IPP) or public generation company to sign new PPAs for additional capacity with BPDB and the relevant distribution company.	 Institutions from the public sector that would need to be engaged for supporting the deployment of energy storage as a part of this application would include BPDB (as the single-buyer), the relevant distribution company (as a distribution off-taker), and the connection provider (transmission company – Power Grid Company of Bangladesh (PGCB), or distribution company).
Distribution companies are currently allowed to sign PPAs with generators (up to certain thresholds). Therefore, **there is an existing policy framework that can support the PV-BESS** application. However, the DNO-BESS services require substantial enabling policies and regulations.	In relation to a **potential re-powering project, the relevant institutions have substantial experience** in relation to PPAs. Therefore, the institutions are able to support any such initiative if existing model PPAs are used. However, **DNO-BESS services would require significant capacity building and skills transfer** to allow the companies to define and procure for such services. This would include capacity building across a wide range and depth of topics from basic training on energy storage technologies, use-cases and commercial frameworks, through to advanced training on the operations, management and maintenance of energy storage assets and the implementation of energy storage applications associated with round the clock power and the associated commercial contracts. Some of the training topics may include: • Roles of storage in power grid, including an understanding of flexibility; • Applications of energy storage, technologies and trends; • Energy storage system components and performance indicators; • Specify and model electrical energy storage systems; • Design electrical installations containing electrical energy storage systems; • Principle types of electrical energy storage systems and how to fairly assess their relative merits; • Island-mode and connected mode operation, and how to design safe systems; • Planning, installation and commissioning of electrical energy storage systems;

	• Local generation and electrical energy storage to optimise usage of local generation; • Maintenance drivers for electrical energy storage systems.
FINANCIAL FRAMEWORK – BANKABLE	**FINANCIAL FRAMEWORK – PUBLIC & EXTERNAL SUPPORT**
The **existing PPA framework in Bangladesh remains a bankable commercial contract** that can be used for the deployment of this application. Availability or energy payments may be considered to deliver the required/ expected returns on investment.	**Public financial support is not expected** to be required for the deployment of this model. However, there would be a **need for support in relation to the ring-fencing of investments** within existing Special Purpose Vehicles (SPVs) and the formation of new SPVs. This would require support from development partners in the short term.
EXISTING ENABLERS & BARRIERS	**TENTATIVE INTERVENTIONS**
Enablers: • Re-powering experience in neighbouring countries, i.e., India; • Existing bankable PPA model; • Limited policy and regulatory requirements for PV-BESS applications. **Barriers:** • No policy or regulatory framework for the pricing and contracting of DNO-BESS services; • Limited experience in Bangladesh.	• Development partner support in building awareness of re-powering schemes; • Development partner technical assistance in early transactions to support the financial and commercial structuring of the projects; • Development of distribution network operational support services and pricing with support from development partners; • Government policy on re-powering of existing solar PV projects (or projects in development) with additional services provided through energy storage. This would require the following indicative steps from the Government: o Policy statement enabling solar power plants to augment capacity and apply for a new PPA on the same site; o Guidelines on re-powering of solar assets, including expected timelines and generation efficiency (in MWp per acre) thresholds for re-powering. This may include guidelines on accelerated depreciation allowances for outdated/ retired assets, tax benefits for additional investments and increasing generation potential, etc.; o Government evaluation of solar projects by state-owned generation companies to establish and implement first of its kind projects based on the guidelines and policy statements.
ENABLING ENVIRONMENT REQUIREMENTS	**HIGH**
SCENARIO	**3**

3.2. PEAK SHAVING & REPLACEMENT OF LIQUID FUEL-BASED PEAKING POWER PLANTS (& LOAD MANAGEMENT – THE GC-BESS CANDIDATE PROJECT)

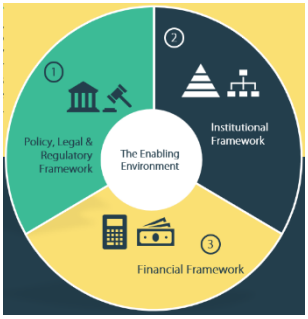
Table 4: Existing Enabling Environment for Peak Shaving and Replacement of Liquid Fuel-Based Peaking Power Plants

<table>
<tr><td>USE-CASE</td><td>Peak Shaving & Replacement of Liquid Fuel-Based Peaking Power Plants (& Load Management)</td><td>INVESTMENT OPTION REFERENCE (DELIVERABLE 3)</td><td>GC-BESS</td></tr>
<tr><td colspan="4">The Enabling Environment</td></tr>
<tr><td colspan="2">POLICY FRAMEWORK</td><td colspan="2">INSTITUTIONAL FRAMEWORK</td></tr>
<tr><td colspan="2">The development of standalone grid connected BESS projects can be done through the existing regulations governing power generation projects with recommended changes to the grid code and licencing regime. For example, the Bangladesh Energy Regulatory Commission (BERC) Licensing Regulations 2006 do not include rules for licensing of energy storage technologies (except for pumped storage).</td><td colspan="2">The institutional framework for the procurement and deployment of such projects is well established in the country. BPDB is experienced in undertaking similar contracts with private sector as well as for public generation companies and public procurement of turnkey/ Engineering, Procurement, and Construction (EPC) solutions. Involvement of other stakeholders include the transmission company and the national load dispatch centre.</td></tr>
<tr><td colspan="4"> 
</td></tr>
<tr><td colspan="2">Short-term adaptations for deployment of grid connected BESS applications may include the limited deployment of solar PV to enable the generation facility to operate under generation facility definitions specified in the 2019 Grid Code Clause 2.1 (definitions).</td><td colspan="2">The national load dispatch centre would likely require capacity building support and suitable skills transfer to enable them to better schedule the utilisation of the BESS facility. This can be provided by Original Equipment Manufacturers (OEMs), Operation and Maintenance (O&M) contractors, or private developers during the project life cycle.</td></tr>
<tr><td colspan="2">FINANCIAL FRAMEWORK – BANKABLE</td><td colspan="2">FINANCIAL FRAMEWORK – PUBLIC & EXTERNAL SUPPORT</td></tr>
<tr><td colspan="2">The existing model PPA in Bangladesh is bankable and may be adapted for the deployment of grid connected BESS. The existing PPA model allows for both availability and energy payments. An availability payment model has been recommended for early-stage developments.</td><td colspan="2">Public financial support is not expected to be required for the deployment of this model. These projects may be developed through private investment and IPPs, or through sovereign lending support from development partners.</td></tr>
<tr><td colspan="2">EXISTING ENABLERS & BARRIERS</td><td colspan="2">TENTATIVE INTERVENTIONS</td></tr>
<tr><td colspan="2">Enablers:</td><td colspan="2">• Development partner support in capacity development at power sector agencies in relation to the operation of BESS systems;</td></tr>
</table>

• Availability payment model in the existing PPA structure allows for relatively simple project structuring; • Much of existing regulatory policy framework can be leveraged to deploy early-stage projects; • Some key licencing conditions would need to be addressed. **Barriers:** • No policy framework for energy storage in Bangladesh; • Limited experience and knowledge of grid connected energy storage in Bangladesh.	• Broad government policy statement on energy storage and updates to licencing regime; • Early-stage pilot programmes such as the planned 2MW grid connected BESS funded by the Asian Development Bank (ADB) would further support capacity building and knowledge transfer.
ENABLING ENVIRONMENT REQUIREMENTS	**MEDIUM**
SCENARIO	**2**

3.3. SUPPORTING AND ENABLING THE ELECTRIFICATION OF TRANSPORT (THE EV-BESS CANDIDATE PROJECT)

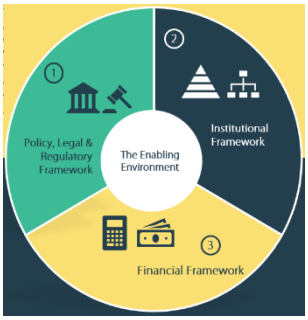
Table 5: Existing Enabling Environment for Supporting and Enabling the Electrification of Transport

USE-CASE	Supporting and Enabling the Electrification of Transport (the EV-BESS Candidate Project)	INVESTMENT OPTION REFERENCE (DELIVERABLE 3)	Electric Vehicle (EV)-BESS
The Enabling Environment			
POLICY FRAMEWORK		**INSTITUTIONAL FRAMEWORK**	
The power sector continues to support the ongoing electrification of transport in Bangladesh, through various initiatives undertaken by distribution companies and the roll-out of an EV charging tariff. Draft EV Charging Guideline to Incentivize Charging Station Development has been prepared by SREDA and is currently being considered for legal implementation.		EV-BESS projects would involve two sectoral stakeholder groups – transport and electricity. This increases the number of stakeholders involved substantially and while they remain interdependent in relation to the growth of EVs, there is **opportunity for greater collaboration and coordination between the sectors**, and their relevant agencies.	
Further enabling policy guidelines surrounding the standardisation of EV safety and inspections are being undertaken as well as formalising the registration of electric 2 and 3 wheelers. However, it is important to note that **the policy framework remains nascent and developing**.		Various power sector agencies including Bangladesh Rural Electrification Board (BREB) and West Zone Power Distribution Company Limited (WZPDCL) have already deployed EV charging stations, as have various private investors (including SolShare). Therefore, these is **substantial experience in the sector that may be leveraged** to further scale up EV-BESS projects.	

FINANCIAL FRAMEWORK – BANKABLE	FINANCIAL FRAMEWORK – PUBLIC & EXTERNAL SUPPORT
The current financial model for EV-BESS deployment in Bangladesh relies on a service payment to EV-BESS projects. This **payment model does not create bankable projects** due to the lack of any long-term fixed revenue streams. However, additional commercial revenue streams may be leveraged to improve commercial viability of these projects.	**Public financial support may be required** for projects that are not able to leverage additional commercial revenue streams to improve project financial viability. **Development partner support** in this use-case would be mainly focused on the provision of low cost and sovereign backed debt to public utilities and to the private sector through suitable debt and grant funding schemes.
EXISTING ENABLERS & BARRIERS	**TENTATIVE INTERVENTIONS**
Enablers: • Existing projects in Bangladesh from both public distribution companies as well as by the private sector; • Favourable EV charging policy. **Barriers:** • Lack of a registration and licencing process of electric 2 and 3 wheelers; • Financial model and bankability of the projects remain limited.	• Government policy on EVs in the transport and electricity sector; • Government may consider area wise licencing/ franchising model for EV charging station deployment to support the continued electrification of transport in the country; • Development partner financing support to achieve financial viability.
ENABLING ENVIRONMENT REQUIREMENTS	**MEDIUM**
SCENARIO	**2**

3.4. SUPPORTING ROOFTOP SOLAR AND COMMUNITY ELECTRIFICATION

Table 6: Existing Enabling Environment for Supporting Rooftop Solar and Community Electrification

USE-CASE	Supporting Rooftop Solar and Community Electrification	INVESTMENT OPTION REFERENCE (DELIVERABLE 3)	N/A
The Enabling Environment			
POLICY FRAMEWORK			**INSTITUTIONAL FRAMEWORK**
There are **various policies and guidelines supporting rooftop solar** including, but not limited to, the Renewable Energy Policy 2008, the Net Metering Guidelines 2018, etc. **The policy framework could be broadened** to enable community-based electrification/ electricity sharing through the integration of BESS systems with rooftop solar systems.			Various institutional stakeholders involved in the rooftop solar use-case include SREDA, distribution companies, rooftop systems providers, private investors, and financial institutions. Given the success of the solar home systems programme in Bangladesh, most institutional stakeholders have **substantial experience and expertise which may be leveraged for this use-case**.

FINANCIAL FRAMEWORK – BANKABLE	FINANCIAL FRAMEWORK – PUBLIC & EXTERNAL SUPPORT
The **prevailing financial framework** for rooftop solar, which would be applicable, for BESS supported community electrification schemes, is based on the existing bulk tariffs. The applicable tariffs for net metering and settlement period limit the commercial value of solar rooftop schemes.	This use-case is not expected to require public or development partner financial support.
EXISTING ENABLERS & BARRIERS	**TENTATIVE INTERVENTIONS**
Enablers: • Net Metering Policy, and related circulars from the Government in support of rooftop solar deployment. **Barriers:** • No policy framework in relation to community electrification enabled by BESS supported solar rooftop solutions and electricity trading between consumers; • Financial viability limited by net metering tariffs, and lack of tax incentives for deployment of behind the meter PV+BESS solutions.	• Technical assistance for the formulation of guidelines in relation to community electrification and electricity sharing between consumers.
ENABLING ENVIRONMENT REQUIREMENTS	**MEDIUM**
SCENARIO	**2**

3.5. ISLAND ELECTRIFICATION

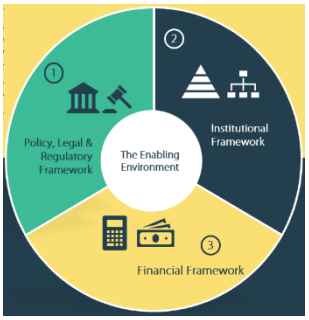
Table 7: Existing Enabling Environment for Island Electrification

USE-CASE	Island Electrification	INVESTMENT OPTION REFERENCE (DELIVERABLE 3)	N/A
The Enabling Environment			
POLICY FRAMEWORK		**INSTITUTIONAL FRAMEWORK**	
The **island electrification effort in Bangladesh has been underpinned by the overarching national objectives** of delivering 100% electrification. As a part of achieve these objectives, various solutions were deployed to provide electricity to island communities, including distributed generation (diesel), and solar supported with diesel mini grids.		Key institutional stakeholders involved in the deployment of this use-case would be distribution companies, existing mini grid operators, SREDA and the private sector. **All key institutional stakeholders have substantial experience** with solar deployment.	

GoB's focus on increased integration of RE provides a key policy driver for the deployment of BESS supported solar PV for island communities.	Furthermore, BESS supported solar programmes for island communities are currently being implemented under an ADB supported programme by WZPDCL.
FINANCIAL FRAMEWORK – BANKABLE	**FINANCIAL FRAMEWORK – PUBLIC & EXTERNAL SUPPORT**
Given recent experiences with mini grids in the country, the prevailing financial framework for such an application can be considered as only partially bankable (with public distribution companies adopting most of the mini grids that were tendered to private developers).	Early-stage deployments of BESS supported PV solutions for islands may require development partner or public sector financial support. This is due to higher perceived costs of mini grids compared to the retail tariff (subsidised).
EXISTING ENABLERS & BARRIERS	**TENTATIVE INTERVENTIONS**
Enablers: • BESS supported solar PV applications are cost competitive compared to diesel-based systems (with no price distortions); • 100% electrification and sectoral priorities of delivering sustainable 24/7 power for all. **Barriers:** • Cost of mini-grid solutions remain high compared to subsidised retail tariffs.	• Early stage-developments supported by development partners; • Public sector financial support to reduce cost of customers.
ENABLING ENVIRONMENT REQUIREMENTS	**LOW**
SCENARIO	**1**

3.6. DISPLACED COMMUNITIES

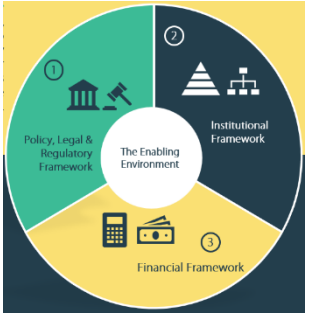
Table 8: Existing Enabling Environment for Provision of Electricity to Displaced Communities

USE-CASE	Displaced Communities	INVESTMENT OPTION REFERENCE (DELIVERABLE 3)	N/A
The Enabling Environment			
POLICY FRAMEWORK			**INSTITUTIONAL FRAMEWORK**
No policies or guidelines in place for providing temporary or portable electricity solutions to displaced communities. There are no service obligations for distribution companies to provide electricity solutions for displaced communities in Bangladesh.			Distribution companies and non-governmental organisations (NGOs) (in the absence of service area obligations) would be key institutional stakeholders for the deployment of this application. **There is adequate technical and community engagement capabilities** within involved institutional stakeholders to deploy this use-case.

However, there are no policy barriers to the delivery of such solutions under the current policy and regulatory framework.	
FINANCIAL FRAMEWORK – BANKABLE	**FINANCIAL FRAMEWORK – PUBLIC & EXTERNAL SUPPORT**
There are no commercially viable financial models for the deployment of this use case.	Given the substantial social and economic value delivered by this application, the regulator may consider inclusion of electricity for displaced communities under general service obligations and regulated revenues of public distribution companies (thereby socialising the cost of electrification).
EXISTING ENABLERS & BARRIERS	**TENTATIVE INTERVENTIONS**
Enablers: • None. **Barriers:** • No demonstrated commercially viable delivery model (without public financial support); • Level of engagement and need for continued interaction with local communities.	• Supporting electricity provision for displaced communities through price regulation mechanisms for the distribution sector; • Demonstration projects with development partner support to illustrate the viability of the use-case and the economic returns on investment.
ENABLING ENVIRONMENT REQUIREMENTS	**LOW**
SCENARIO	**1**

3.7. STREET LIGHTING (INCLUDING OFF-GRID)

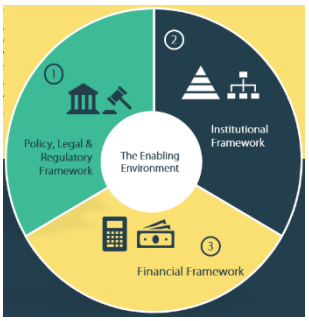
Table 9: Existing Enabling Environment for Provision of Street Lighting (and Off-Grid Lighting)

USE-CASE	Street Lighting (including Off-Grid)	INVESTMENT OPTION REFERENCE (DELIVERABLE 3)	N/A
The Enabling Environment			
POLICY FRAMEWORK		**INSTITUTIONAL FRAMEWORK**	
There are **no policies or guidelines** in place for the deployment of solar street lighting or off-grid lighting. **However, there are no policy barriers** to the delivery of such solutions under the current policy and regulatory framework.		Key institutions involved in the delivery of such a solution would include distribution companies, municipal authorities and city corporations, and private service providers. While there is **no institutional experience in relation to the deployment of this solution**, there is substantial expertise in relation to solar systems.	
FINANCIAL FRAMEWORK – BANKABLE		**FINANCIAL FRAMEWORK – PUBLIC & EXTERNAL SUPPORT**	

These projects are likely to be delivered through public procurement and turnkey contracts. Scope for private concessions and Public-Private Partnerships (PPPs) remain limited due to possible reluctance from distribution companies that may perceive these deployments as a loss of revenue.	Public sector financial support may only be required to replace existing street lighting with solar PV + BESS.
EXISTING ENABLERS & BARRIERS	**TENTATIVE INTERVENTIONS**
Enablers: • Similar programmes have been proposed in the past. In 2011, ADB proposed support for a solar street lighting programme. A similar programme was successfully delivered in Nepal. **Barriers:** • No experience in the procurement or deployment of such systems; • Potential reluctance from existing institutional stakeholders.	• Overarching policy statement from the Government in relation to sustainable street lighting; • Development partner support for the implementation of early-stage projects.
ENABLING ENVIRONMENT REQUIREMENTS	**LOW**
SCENARIO	**1**

3.8. ANCILLARY SERVICES

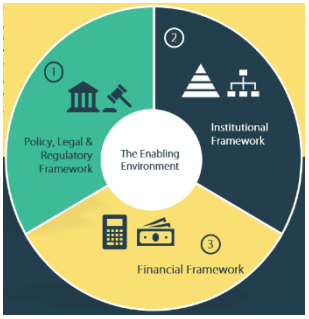
Table 10: Existing Enabling Environment for Ancillary Services

USE-CASE	Ancillary Services	INVESTMENT OPTION REFERENCE (DELIVERABLE 3)	N/A
The Enabling Environment			
POLICY FRAMEWORK		**INSTITUTIONAL FRAMEWORK**	
Bangladesh **does not currently have a market for AS**. There is also no clear financial incentive for generators to provide primary, secondary and tertiary responses (beyond technical specification in the PPAs).		PGCB outlined the importance of AS in its 2020 Grid Management Action Plan. The Grid Code 2019 also provides details on different operating reserves from generators. However, PGCB has **no experience in the procurement of AS**.	
Furthermore, there are **no rules or guidelines** surrounding the procurement of AS by PGCB/ National Load Dispatch Centre (NLDC). As a result, there is an **absence of any commercial AS policy framework** in Bangladesh.		In the absence of relevant Ancillary Services (AS) procurement experience at PGCB, the single-buyer, BPDB, may manage a procurement process to secure the necessary AS for NLDC. The **overall capacity** in the sector to manage such a procurement process **remains limited.**	

FINANCIAL FRAMEWORK – BANKABLE	FINANCIAL FRAMEWORK – PUBLIC & EXTERNAL SUPPORT
There is **no financial framework** related to the provision of AS by generators or other service providers in Bangladesh. AS financial frameworks in the Association of Southeast Asian Nations (ASEAN) (in countries such as Vietnam) may be considered as regional examples, with well developed AS products in UK, USA and in EU.	Substantial development partner support would be required to provide the necessary technical assistance required for the development and implementation of AS policy, market rules and guidelines.
EXISTING ENABLERS & BARRIERS	**TENTATIVE INTERVENTIONS**
Enablers: • Recognition of the urgent need for AS in Bangladesh by PGCB. **Barriers:** • Lack of policy or guidelines related to AS; • No AS product definitions or specifications (beyond those in the Grid Code and PPA); • No financial framework.	• Substantial development partner support in the preparation of definitions of AS and suitable specifications of AS products; • Development partner support in the development of AS market rules and policy guidelines; • Development partner support in capacity building to NLDC/ PGCB and BPDB for the procurement of AS; • GoB implementing an AS Policy (and guidelines, rules and regulations).
ENABLING ENVIRONMENT REQUIREMENTS	**HIGH**
SCENARIO	**6**

3.9. CAPEX DEFERRAL FOR TRANSMISISON AND DISTRIBUTION

Table 11: Existing Enabling Environment for CAPEX Deferral

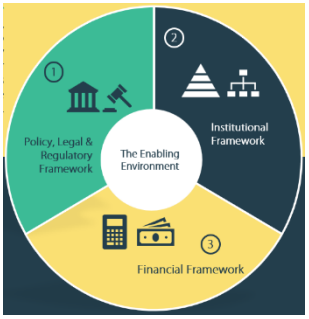
USE-CASE	CAPEX Deferral for T&D	INVESTMENT OPTION REFERENCE (DELIVERABLE 3)	N/A
The Enabling Environment			
POLICY FRAMEWORK			**INSTITUTIONAL FRAMEWORK**
There is **currently no policy framework which directly measures public funds utilization based on the commercial value creation through deferral options**. Furthermore, VfM in public sector infrastructure delivery and the use of public sector comparators in evaluating VfM are not widely used. The current performance framework for the utilities measures performance against CAPEX			Due to the current planning and budgeting process in the sector, all power sector agencies are provided with annual CAPEX budgets. Performance at the companies is evaluated against the successful implementation of the projects, i.e., CAPEX spend during the year as opposed to optimal utilisation of public sector funds.

spend as opposed to commercial value creation through deferral options.	As a result, there is limited interest from power sector agencies in CAPEX deferral options. The current **institutional and investment planning framework remains unfavourable** for CAPEX deferral projects.
FINANCIAL FRAMEWORK – BANKABLE	**FINANCIAL FRAMEWORK – PUBLIC & EXTERNAL SUPPORT**
There is **no financial framework** related to the CAPEX deferral projects or the evaluation thereof.	CAPEX deferral projects are not expected to rely on public or development partner funding support. However, early-stage/ pilot projects to demonstrate value creation from such programmes may be considered for development partner support.
EXISTING ENABLERS & BARRIERS	**TENTATIVE INTERVENTIONS**
Enablers: • None under current framework. **Barriers:** • Current metrics used to evaluate utility performance; • No financial, policy or regulatory framework for CAPEX deferral schemes.	• GoB may consider policy and regulatory mechanisms that incentivise CAPEX deferral and deliver greater value to the sector; • Alternate performance metrics (as opposed to Annual Development Plan Implementation) considered by the sector to measure the annual performance of public utilities; • Development partner support in the pilot/ demonstration projects related to CAPEX deferral schemes and options.
ENABLING ENVIRONMENT REQUIREMENTS	**HIGH**
SCENARIO	**6**

3.10. REACTIVE POWER SUPPORT

Table 12: Existing Enabling Environment for Provision of Reactive Power Support

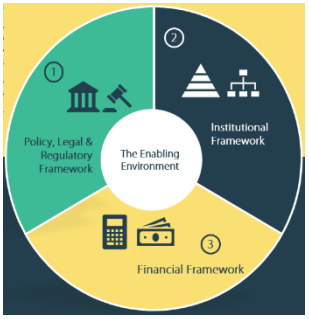
USE-CASE	Reactive Power Support	INVESTMENT OPTION REFERENCE (DELIVERABLE 3)	N/A
The Enabling Environment			
POLICY FRAMEWORK		**INSTITUTIONAL FRAMEWORK**	

The Grid Code 2019 defines the need and requirements for reactive power capability and control for power generators. However, it may be possible to deliver greater value by procuring these services from other providers (including BESS). There is **no policy framework in Bangladesh for balancing services** and balancing market mechanisms.		The key institutional stakeholder for this application could be NLDC/ PGCB. There is no experience within PGCB for the establishment of a balancing services market or for the competitive procurement of such services. **Substantial institutional capacity support and skills transfer would be required** for these use cases.
		Reactive power support may also be procured by distribution companies to support voltage levels on their networks and would also require substantial public and development partner support.
FINANCIAL FRAMEWORK – BANKABLE		**FINANCIAL FRAMEWORK – PUBLIC & EXTERNAL SUPPORT**
There is **no financial framework** related to the balancing services in Bangladesh.		The procurement of balancing services such as reactive power by the system operator (NLDC) may require substantial technical assistance to develop. Development partner financed investment programmes targeting reactive power support for distribution companies may be considered in the short term.
EXISTING ENABLERS & BARRIERS		**TENTATIVE INTERVENTIONS**
Enablers: • Broad definitions in the grid code. **Barriers:** • No financial, policy or regulatory framework for reactive power support services.		• Development partner supported investment programmes focussed on distribution level reactive power support services; • Policy and regulatory framework for balancing services from the GoB with support from development partners.
ENABLING ENVIRONMENT REQUIREMENTS		**HIGH**
SCENARIOS		**6 (distribution sector) & 8 (transmission sector)**

3.11. BATTERY ISLANDING

Table 13: Existing Enabling Environment for Battery Islanding

USE-CASE	Battery Islanding	INVESTMENT OPTION REFERENCE (DELIVERABLE 3)	N/A
The Enabling Environment			
POLICY FRAMEWORK		**INSTITUTIONAL FRAMEWORK**	

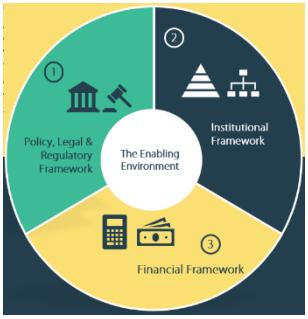
There are **no policies or guidelines on demand side response** from large energy users in the commercial and industrial sector. There are **no direct policy or regulatory barriers** for the deployment of such solutions allowing customers to continue operations during grid outages.		Key institutional stakeholders would include large electricity users and their representative bodies, distribution companies, service providers, private developers, and investors. There is a **lack of capacity within institutional stakeholders** in relation to the implementation of this use-case.
The most widely used solution are captive gas generators in industries (relying on subsidised domestic gas supplies).		However, there is **substantial experience in neighbouring countries** that may be leveraged to deliver early-stage projects.
FINANCIAL FRAMEWORK – BANKABLE		**FINANCIAL FRAMEWORK – PUBLIC & EXTERNAL SUPPORT**
There are no financial incentives for demand response or improving energy use in industries.		Early-stage projects may require public sector or development partner financial support to maintain or deliver operational cost savings for large energy users.
EXISTING ENABLERS & BARRIERS		**TENTATIVE INTERVENTIONS**
Enablers: • None. **Barriers:** • Subsidised domestic gas used in captive gas generators by industrial users; • Lack of a financial framework and incentive mechanisms for demand response.		• Technical support from development partners in the preparation of suitable demand side response policies, schemes and mechanisms in Bangladesh; • Detailed assessment of the costs of providing subsidised gas to industries compared to BESS-based (with solar PV if applicable) power quality and reliability solutions; • Overarching policy direction from the Government in relation to the use of fossil fuels by industrial and commercial users.
ENABLING ENVIRONMENT REQUIREMENTS		**MEDIUM**

3.12. INTEGRATED ENERGY OPTIMISATION SOLUTIONS FOR EXISTING COMBINED CYCLE GAS TURBINES (CCGTS)

Table 14: Existing Enabling Environment for Integrated Energy Optimisation Solutions

USE-CASE	Integrated Energy Optimisation Solutions for Existing CCGTs	INVESTMENT OPTION REFERENCE (DELIVERABLE 3)	N/A
The Enabling Environment			
POLICY FRAMEWORK		**INSTITUTIONAL FRAMEWORK**	

Energy optimisation for large generators such as for CCGTs deliver value under liberalised market conditions. This is due to the value generated from arbitrage between energy and electricity markets, as well as reduced fuel costs for power generation.



The institutional framework for this application would require generation and energy companies to actively participate. In the absence of active market interactions, there is **limited capacity at generation and energy companies.**

Energy and electricity markets in Bangladesh remain highly regulated (as are fuel and gas supply contracts). **Therefore, there is no policy framework supporting this use-case in Bangladesh.**

FINANCIAL FRAMEWORK – BANKABLE	FINANCIAL FRAMEWORK – PUBLIC & EXTERNAL SUPPORT
There is **no financial framework** or incentives for generation companies to increase their fuel efficiencies. Legacy PPAs have treated fuel costs as a pass-through item, which leave little incentive for generation companies to improve operational efficiencies, i.e., fuel costs associated with the generation of power from the facility are pass through to BPDB resulting in the IPP carrying no fuel supply risk, and are only required to meet a guaranteed heat rate for the facility. Recent PPAs have created an opportunity for generation companies (private IPPs) to engage with international energy market to achieve greater returns. However, relevant indexation of fuel costs may require increased scrutiny by BPDB.	This use-case may not require direct financial support from the public sector or development partners. Much of the support may be in the form of technical assistance targeted towards creating suitable incentive mechanisms.

EXISTING ENABLERS & BARRIERS	TENTATIVE INTERVENTIONS
Enablers: • None. **Barriers:** • No financial, policy or regulatory framework; • Regulated bi-lateral contracts between energy and generation companies; • No incentives to improve operational efficiencies and fuel consumption; • Legacy PPAs and the treatment of fuel costs as a pass-through item.	• Technical assistance support from development partners to create a policy and regulatory framework for increasing operational efficiencies of power generation assets; • Overarching framework and policy guidelines from the Government to enable interactions between energy and electricity markets.

ENABLING ENVIRONMENT REQUIREMENTS	**HIGH**
SCENARIO	**9**

3.13. ADDRESSING REGIONAL BALANCING REQUIREMENTS

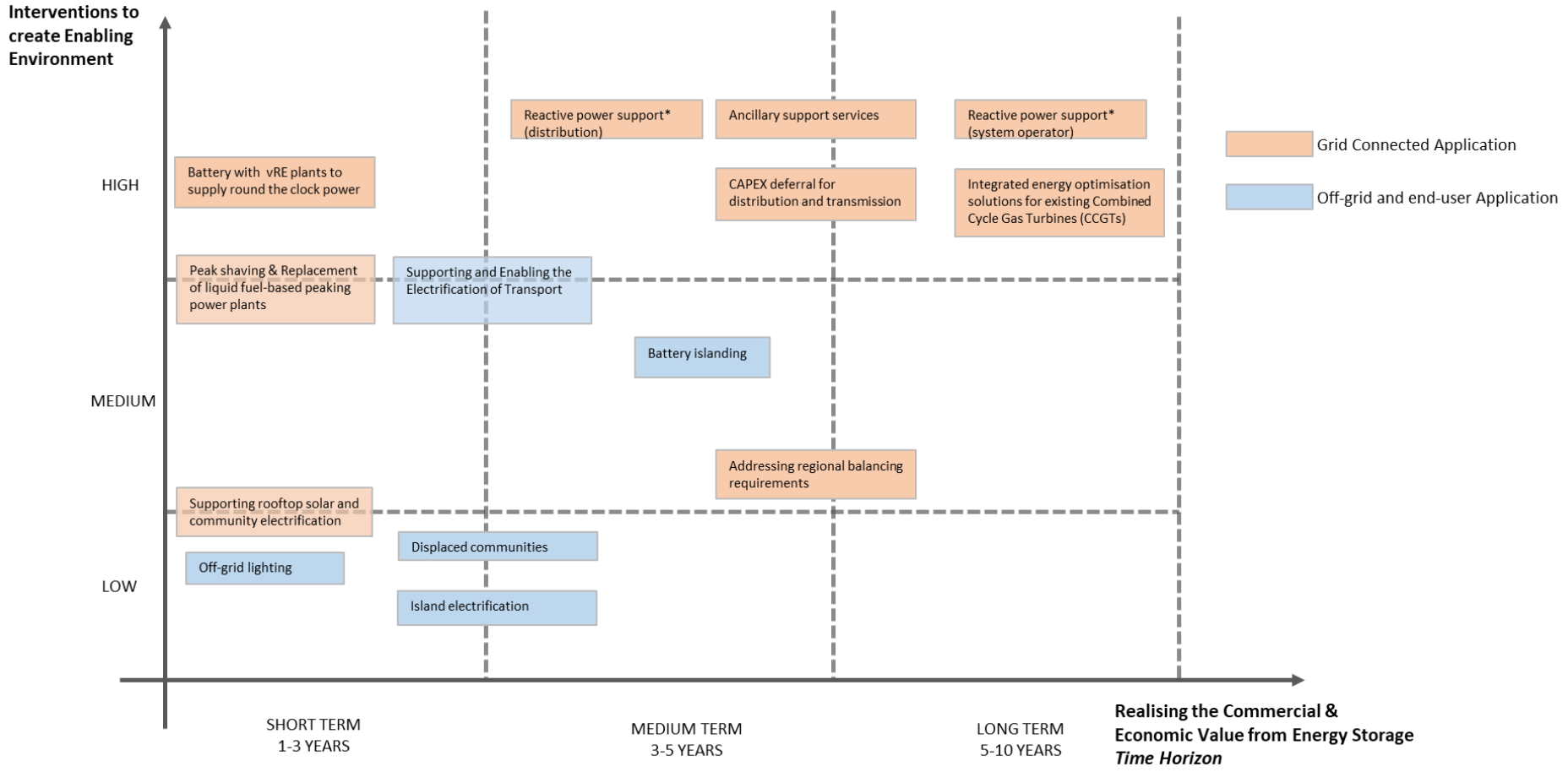
Table 15: Existing Enabling Environment for Addressing Regional Balancing Requirements

<table>
<tr><td>USE-CASE</td><td>Addressing Regional Balancing Requirements</td><td>INVESTMENT OPTION REFERENCE (DELIVERABLE 3)</td><td>N/A</td></tr>
<tr><td colspan="4">The Enabling Environment</td></tr>
<tr><td colspan="2">POLICY FRAMEWORK</td><td colspan="2">INSTITUTIONAL FRAMEWORK</td></tr>
<tr><td colspan="2">There is currently no policy or regulatory framework for addressing regional balancing requirements. The policy framework would also need to be informed by detailed national assessment of the use of energy storage and other existing reserves for grid balancing.</td><td colspan="2">The national system operator (NLDC) is responsible for establishing the requirements for regional balancing of the power system. With increased RE integration these services would become increasing important and PGCB/ NLDC would require an operation framework for the use of reserves for regional balancing requirements.</td></tr>
<tr><td colspan="2">FINANCIAL FRAMEWORK – BANKABLE</td><td colspan="2">FINANCIAL FRAMEWORK – PUBLIC & EXTERNAL SUPPORT</td></tr>
<tr><td colspan="2">There is no financial framework or incentive mechanisms in place to price the use of reserves and AS for balancing.</td><td colspan="2">This use-case may not require direct financial support from the public sector or development partners. However, technical assistance support would be required to support the establishment of balancing and operational practices.</td></tr>
<tr><td colspan="2">EXISTING ENABLERS & BARRIERS</td><td colspan="2">TENTATIVE INTERVENTIONS</td></tr>
<tr><td colspan="2">Enablers:
GoB commitment to integrating RE (including solar rooftop deployment).
Barriers:
No financial, policy or regulatory framework.</td><td colspan="2">Technical assistance support from development partners for detailed assessment on grid balancing requirements and to create a policy and regulatory framework for grid balancing.</td></tr>
<tr><td colspan="3">ENABLING ENVIRONMENT REQUIREMENTS</td><td>MEDIUM</td></tr>
<tr><td colspan="3">SCENARIO</td><td>8</td></tr>
</table>

4. SUMMARY OF THE ROADMAP

As illustrated in the chapters earlier, a wide range of energy storage applications and use-cases were assessed as a part of this study. The following figure provides a high-level summary of the envisaged Roadmap for Energy Storage in Bangladesh.

Figure 3: Summary of the envisaged Roadmap for Energy Storage in Bangladesh



The table below summarises the roadmap by identifying specific use-cases for consideration in the Bangladesh power sector over three future time horizons. The table also includes a summary of indicative actions and interventions that may be considered to enable the deployment of energy storage within the defined time horizons.

Table 16: High-Level Roadmap on for Energy Storage in Bangladesh

<table>
<tr><th rowspan="2">Short-term (1-3 years)</th><th colspan="2">Indicative Actions & Interventions</th></tr>
<tr><th>Government/ Power Sector Agencies</th><th>Development Partners</th></tr>
<tr><td rowspan="3">Use-cases:
BESS deployed with RE plants;
BESS deployed for peak shaving, load management and replacement of liquid fuel-based peaking power plants;
BESS and PV for supporting and enabling the electrification of transport;
Supporting rooftop solar and community electrification through BESS enabled solutions and user-level P2P electricity trading;
BESS and PV for electrification of island communities;
PV and batteries for street lighting;
Portable electricity solutions for displaced communities.</td><td>Government Policies & Regulation:
Re-powering of existing solar PV projects (or projects in development);
Updates to generator licencing regime;
Transport & Electricity Sector Policy on EVs;
Electricity provision for displaced communities through service obligations;
Review of tax regime in relation to energy storage.</td><td>Technical Assistance & Financial Support in:
Implementing early-stage transactions, pilots and demonstration programmes;
Development and definitions in relation to distribution network operational support services and pricing;
Formulation of guidelines in relation to community electrification and electricity sharing between consumers.</td></tr>
<tr><td>Supporting Sectoral Development through:
Policy statement on energy storage;
Public sector financial support to reduce cost of customers;
Policy statement in relation to sustainable street lighting.</td><td>Capacity Building & Knowledge Dissemination Support in:
Building awareness of repowering schemes;
Operation of grid connected BESS systems.</td></tr>
<tr><td>Through Public Procurement/ Tenders:
Area wise licencing/ franchising model for EV charging station;
Public procurement and deployment of relevant use-cases.</td><td>Policy Support in:
N/A (short-term initiatives, with most policy development work already underway).</td></tr>
<tr><td>Potential Short-term Market Size, subject to detailed studies</td><td colspan="2"><u>BESS deployed with RE plants</u>
India is planning for 30GW of energy storage to support approximately</td><td><u>BESS deployed for peak shaving, etc.</u>
The current demand curve for the Bangladesh Power System</td></tr>
</table>

for each application. **2.45GW / 7.3GWh**	*120GW of RE generation. If a similar ratio were to be considered for Bangladesh's short-term RE aspirations (~1GW in the next three years), the resulting energy storage requirements would amount to **250MW/ 500MWh of energy storage.** It is important to note that this requirement for Bangladesh would not be required for RE integration and rather to enable round-the-clock RE power and off-setting fossil-based power plants with RE.*		*indicates a difference of approximately 2GW between peak and off-peak hours. All of this peak capacity may be off set using BESS. However, the peak shaving application would overlap with potential BESS services provided deployed collocated with RE plants. Hence, an **estimated short-term potential of approximately 1GW/ 2GWh** may be considered.*
	<u>BESS and PV for supporting and enabling the electrification of transport</u> *Current estimates for electric 3-wheelers in Bangladesh vary between 2-5 million. Assessments carried out as a part of Deliverable 3 illustrated the commercial and economic case for the deployment of ~0.6MW/ 2.4MWh of BESS to support the charging of 500 vehicles. Assuming 50% of all vehicles are charged in garages, the immediate **short-term potential would amount to 1.2GW/ 4.8GWh – 3GW/ 12GWh of BESS.***		<u>Applications for which it was not possible to quantify the market potential without further detailed studies:</u> Supporting rooftop solar and community electrification BESS and PV for electrification of island communities PV and batteries for street lighting Portable electricity solutions for displaced communities.
Potential Economic Value/ Benefits to Bangladesh **>USD 1 billion in grid connected investments** **>USD 88m in fuel savings per year for the power sector**	<u>Value Chain Benefits</u> *Bangladesh's potential for energy storage deployments in the short-term are substantial, which would justify Government support/ intervention in the development of large domestic energy storage manufacturing capabilities. e.g., a 1GWh/ year giga-factory requires a **direct investment of ~USD 145m** (India Energy Storage Alliance) and creates ~80 jobs, and "offers significant value-creation opportunities for manufacturers, creates new jobs that pay well, and supports national economic growth" (McKinsey, Capturing the battery value-chain opportunity, January 2022).*		<u>Fuel Savings</u> *Based on recent PGCB operational reports, off-setting 2GWh of peaking Heavy Fuel Oil (HFO) generation would result in **USD 88 million in fuel cost savings per year** for the power sector.* *Additional fuel savings would be realised from the transport sector with the electrification of transport. However, a separate transport study would be required to quantify the fuel savings from the electrification of transport.*
	<u>Energy Storage Investments in the Power Sector</u> The estimated potential of 7.3GWh would amount to approximately USD 5 billion in total energy storage investments including **over USD 1 billion of grid connected investments.**		
Medium-term (3-5 years)	**Indicative Actions & Interventions**		

	Government/ Power Sector Agencies	Development Partners
Use-cases: 1. BESS enabled islanding of large energy users, and the provision of demand response; 2. Reactive Power Support and other balancing services at a distribution level; 3. Providing AS; 4. CAPEX deferral for T&D investments.	**Government Policies & Regulation:** • AS Policy (and guidelines, rules and regulations); • Policy and regulatory mechanisms that incentivise CAPEX deferral; • Policy and regulatory framework for balancing services; • Policy direction on the use of fossil fuels by industrial and commercial customers.	**Technical Assistance & Financial Support in:** • Preparation of definitions of AS and suitable specifications of AS products; • Pilot/ demonstration projects related to CAPEX deferral schemes and options; • Investment programmes focussed on distribution level reactive power support services; • Detailed assessment of the costs of providing subsidised gas to industries compared to BESS-based power quality and reliability solutions.
	Supporting Sectoral Development through: • Use of alternate performance metrics (as opposed to Annual Development Plan Implementation), e.g., VfM, innovation, service delivery.	**Capacity Building & Knowledge Dissemination Support in:** • The procurement and utilisation of AS.
	Through Public Procurement/ Tenders: • N/A.	**Policy Support in:** • Development of AS market rules and policy guidelines; • Development of regulatory framework for balancing services and mechanisms; • Preparation of suitable demand side response policies, schemes and mechanisms in Bangladesh.
Long-term (5-10 years)	**Indicative Actions & Interventions**	
	Government/ Power Sector Agencies	Development Partners

<table>
<tr>
<td rowspan="3">Use-cases:
1. Reactive power support for system operator;
2. Integrated energy optimisation solutions;
3. Supporting regional balancing requirements.</td>
<td>Government Policies & Regulation:
• Policy guidelines to enable interaction between energy and electricity markets;
• Policy and guidelines on balancing markets and mechanisms.</td>
<td>Technical Assistance & Financial Support in:
• Detailed assessment on grid balancing requirements.</td>
</tr>
<tr>
<td>Supporting Sectoral Development through:
• N/A.</td>
<td>Capacity Building & Knowledge Dissemination Support in:
• Power and energy markets;
• Developing awareness in liberalised and decentralised energy and electricity markets.</td>
</tr>
<tr>
<td>Through Public Procurement/ Tenders:
• N/A.</td>
<td>Policy Support in:
• Development of policy and regulatory framework for increasing operational efficiencies of power generation assets;
• Development of policy and regulatory framework for grid balancing.</td>
</tr>
</table>