ACCELERATING THE ROLE FOR ENERGY STORAGE, GRID-CONNECTED SOLAR PV, AND OTHER DISTRIBUTED RESOURCES TO SUPPORT ENERGY TRANSITION IN BANGLADESH

1. Assignment Overview

This technical assistance assignment supports the World Bank's US$515 million investment "Electricity Distribution Modernization Program" (EDMP) in Bangladesh (P174650), and is funded by ESMAP.

2. Assignment Description

Background:

The Government of Bangladesh (GoB) is navigating next steps in the development of its power system, including improving power quality and reliability. GoB is considering the role that increasingly competitive energy storage solutions (ESS), grid-connected rooftop solar photovoltaics (GRPV), and other distributed and flexible resources such as demand response and electric vehicle charging might play, and how the benefits can be realized.

This assignment assesses potential value and entry points for different applications of distributed and flexible energy resources across the Bangladesh power system, with the most significant focus on battery ESS (BESS) and GRPV. The assignment also includes scoping of opportunities for demand response as a source of system flexibility to defer capex investment in generation, transmission, and distribution, as well as scoping of requirements for grid strengthening required to serve growing demand for e-vehicle (EV) charging (using EV demand projections produced through a separate World Bank analysis).

Sector context: GoB has made considerable headway in increasing access to electricity and power generation capacity in the past decades. Access to grid electricity increased from a third of the population in 2000 to 95 percent by 2019. Installed generation capacity quadrupled from 4.5 GW to 18 GW in the same period.

Power system challenges: However, Bangladesh has experienced frequent and sustained load shedding, particularly during the peak summer months. GoB entered into emergency contracts to meet the supply shortfall, with inefficient, carbon-intensive, and expensive HFO and diesel capacity remaining in operation. Bangladesh's power system also suffers from under-investment in transmission and distribution networks, leaving them congested, disaster susceptible, and prone to outages. As demand in cities and towns have gone up considerably, there is significant pressure exerted on the distribution system with transformer and feeders getting overloaded. PowerCell reported more than 1500 transformers were burnt in June 2019. The level of unserved energy has been close to 1% of consumption in recent years. In 2019, Bangladesh had around 65,000 MWh of load shed – even with a relatively conservative estimate of $500/MWh of unserved energy, this translates into an economic loss of $32.5 million for a year. A substantial amount of unserved energy is also the result of scheduled and emergency outages and tripping of the network[1]. The GoB has signaled its openness to harness flexible energy resources as Bangladesh navigates this period of energy transition.

[1] World Bank analysis of PGCB data (September 2020).

Addressing barriers to grid-connected rooftop PV: Bangladesh Utilities have not been seen as proponents of distributed generation such as solar rooftops, which are perceived as siphoning off sales to high value customers. To address these barriers, the assignment seeks to identify business models for rooftop solar where both the utilities and consumers gain. Pre-feasibility investment analysis will review business models that scale up GRPV through utility-ownership models and public private partnerships, and identification of sites for potential investment including at special industrial zones.

A potential role for ESS: Bangladesh power agencies do not have experience analyzing, developing, or operating energy storage, creating a large barrier to initiating energy storage investment and bringing prices down. The merits of some ESS solutions such as batteries relative to competing solutions include its fast response, modularity and flexibility, though realizing the competitiveness of ESS sometimes requires stacking of different value streams. At the system level, among the services that can be served by ESS include energy arbitrage, spinning/non-spinning reserves, frequency regulation, voltage support, transmission congestion relief, resource adequacy and deferral and black start capabilities. Initial World Bank analyses in Bangladesh indicate that the frequency of grid outages make about 500 MW/2000MWh of Battery ESS (BESS) competitive today against operating diesel generation, by serving load during grid power outages by reducing how frequently the diesel generators have to operate. The competitiveness of BESS against captive sources of backup generation to reduce the costs of unreliable electricity in Bangladesh will grow markedly as BESS costs are expected to continue falling, and as the world enters a period of high energy prices following the war in Ukraine. Energy storage might soon (or already) be competitive in other applications as well, including deferral of capital investment in specific overloaded areas of the electricity network, providing for a shortage in ancillary services, mitigating summer load shedding, and facilitating interconnection and regional power trade with India through enhancement of power quality. These value streams for ESS increase with higher variable renewable energy (VRE) penetration, making storage an important consideration in Bangladesh's long term resource planning. In order to maximize value capture from ESS, a holistic view of the system needs to be assessed to identify the gaps in the current and future system operation conditions and requirements.

Objective of the assignment:

The assignment evaluates the potential of decentralized Grid-Connected Rooftop PV (GRPV), grid-connected battery energy storage systems (BESS), and other flexible and distributed energy resources to support a sustainable, reliable, and affordable power grid in Bangladesh.

On GRPV, the assignment is expected to assess a business case for bankable investments in GRPV for Special Economic Zones, and anticipate the localized impacts for the power system and distribution utilities.

On BESS, the assignment is expected to leverage power system analysis potentially including capacity expansion and production cost modeling, power flow analysis, and battery emulation to inform energy storage value stacking for investment placement, sizing, and technology.

The assignment reviews other trends in distributed energy resources, including electric vehicles, to determine near-term opportunities and challenges for the power system.

3. Scope of Work

The scope of work shall reflect the overall context described in the background, and would focus on the elements below:

- ***GRPV business case (~40% of effort):***

The assessment will analyze GRPV at Special Economic Zones (SEZ) and similar clusters of high-energy consumption in Bangladesh. The consultant will prepare a *pre-feasibility study and business case for GRPV investments, incorporating:*

- An assessment of theoretical GRPV potential (provided by the Bank using satellite measurement of available rooftop area and solar resource);
- Demand profiles for the SEZ (data to be retrieved by consultant from SEZ or BREB);
- Optimal sizing of the GRPV system, with potential inclusion of BESS (optimization to be undertaken by consultant based on information above);
- Power system-level impacts of each SEZ investment on production cost (consultant to analyze unit level dispatch)
- Power system-level impacts of each SEZ investment on and distribution assets (consultant to analyze potential for GRPV to reduce over-loading on distribution feeders, substations, etc);
- Economic analysis of the potential investments for both the SEZ as well as for BREB (consultant to use tariff orders and above inputs to assess IRR and cash flow impacts);
- Review of possible business models to advise on strategies that save on costs for SEZ, power system, and improve utility finances (consultant to review ownership options by SEZ, independent producer, or BREB).

- ***BESS entry points toward a roadmap (~50% of effort):***

The investment case for BESS is not well examined in Bangladesh, with an analysis of technical, economic, and regulatory dimensions needed to assess highest potential entry points. Potential applications include mitigating T&D outages and providing grid services such as peaking support, frequency control and ancillary services, voltage support, or enabling conditions for cross-border synchronization.

Toward preparing pre-feasibility studies for highest value applications for BESS in the near term, the consultant is expected to:

- Coordinate with power sector agencies to shortlist sections of the grid, using models as needed, where there are near-term system needs to serve the above applications. This includes, for instance, shortlisting sections experiencing the most significant frequency and duration of outages, and with the highest share of critical loads (hospitals, telecommunication, water stations, etc);
- Model the relevant network area to assess value-stacking potential and indicative sizing of the BESS assets;
- Prepare financial modeling for high potential sites considering the value for BESS owner as well as at system level (i.e. unserved load).

- ***Other distributed resources as sources of flexibility (10% of effort):***

The consultant should briefly review in the Bangladesh context opportunities and challenges created by other distributed energy resources in the Bangladesh power system. This includes:

- Evaluation and mapping out the potential that demand-response may have across the power system, in increasing system reliability, and deferring T&D investments. Potential sources of demand response include industrial and commercial customers, as well as coordinated charging of Electric Vehicles on the power system. Availability of these resources should be assessed and aligned with power system needs including periods of peak demand and periods of excess supply.

4. Methodology of the assignment

The methodology of the assignment will be iterative and cooperative by nature, with high degrees of coordination with key stakeholders of the public sector, the World Bank, and other development partners.

The consultants will be responsible for:

- **Desk research**: Remain up to speed on recent and in-progress publications relevant to the assignment, including from development partners, academia, and the GoB.
- **Data collection**: While the World Bank can facilitate data discussions with Government counterparts, the consultant is responsible for data on power system data (to the extent available), and latest technology trends and costs.
- **Simulations and Modeling of Power System:** Modeling including production cost simulation, power flow analysis, and battery emulation is expected as part of pre-feasibility analysis and for value-stacking.
- **Collaborative stakeholder involvement:** The research, analysis, and modeling shall be conducted in close collaboration with the World Bank and GoB power sector agencies. The consultant should interact with the World Bank team on a weekly basis for reviews, feedback and to overcome obstacles. The consultant should ensure that key personnel from the power sector agencies gain an adequate understanding of the modeling, approaches and findings such that they feel ownership of the results.

5. Deliverables

The main deliverables include:

1. GRPV Assessment
2. BESS Assessment
3. Synthesis report on investment opportunities for flexible and distributed resources

A workshop presenting the findings is expected with the relevant stakeholders identified by the client.

The consultants shall provide all raw modeling data and simulations, including the details of all variables and assumptions.