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Economic Value Analysis of Battery Energy Storage System (BESS) in BRPL distribution network

Renewable Integration and Sustainable Energy (RISE) Initiative

under

Greening the Grid (GTG) Program

A Joint Initiative by USAID and Ministry of Power

New Delhi, July 13, 2020

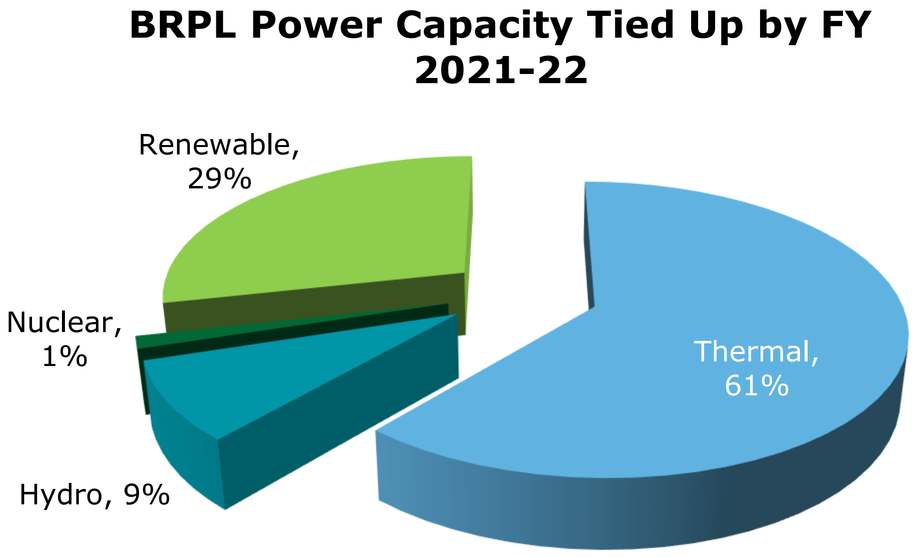
Presenter:

Anish Mandal, GTG-RISE and Director, Deloitte

Justification for Battery Energy Storage System

BRPL would be adding ~ 1200 MW of variable RE capacity by FY22.

In view of studying the impact of such high RE share on the network and real-time scheduling (in order to adhere to Grid codes), BRPL has requested USAID to conduct a study in assessing the economic feasibility of deploying BESS in their distribution network



- GTG-RISE team has used the Deloitte proprietary model for the evaluation of economic viability of deploying a Battery Energy Storage System (BESS) in the BRPL distribution network

Key Questions

What are the various benefits that BESS is going to provide and how do you value those?

What would be the optimal capacity for the BESS to be deployed?

Is there a economic feasibility/ business case for deployment of BESS in the distribution network of BRPL?

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Benefits from Battery Energy Storage Systems

Ramping Support

1 › Battery system is used for ramping support when the RE (solar resources) generation reduces during the evening time

Energy Arbitrage

2 › BESS will enable energy arbitrage by charging when the energy cost is low and dispatch during peak hours.

Capacity Deferral

3 › The battery system is used for deferring distribution capacity enhancements

Benefit streams for BESS

Additional benefits include reduction in Transmission loss charges and reduction in outages

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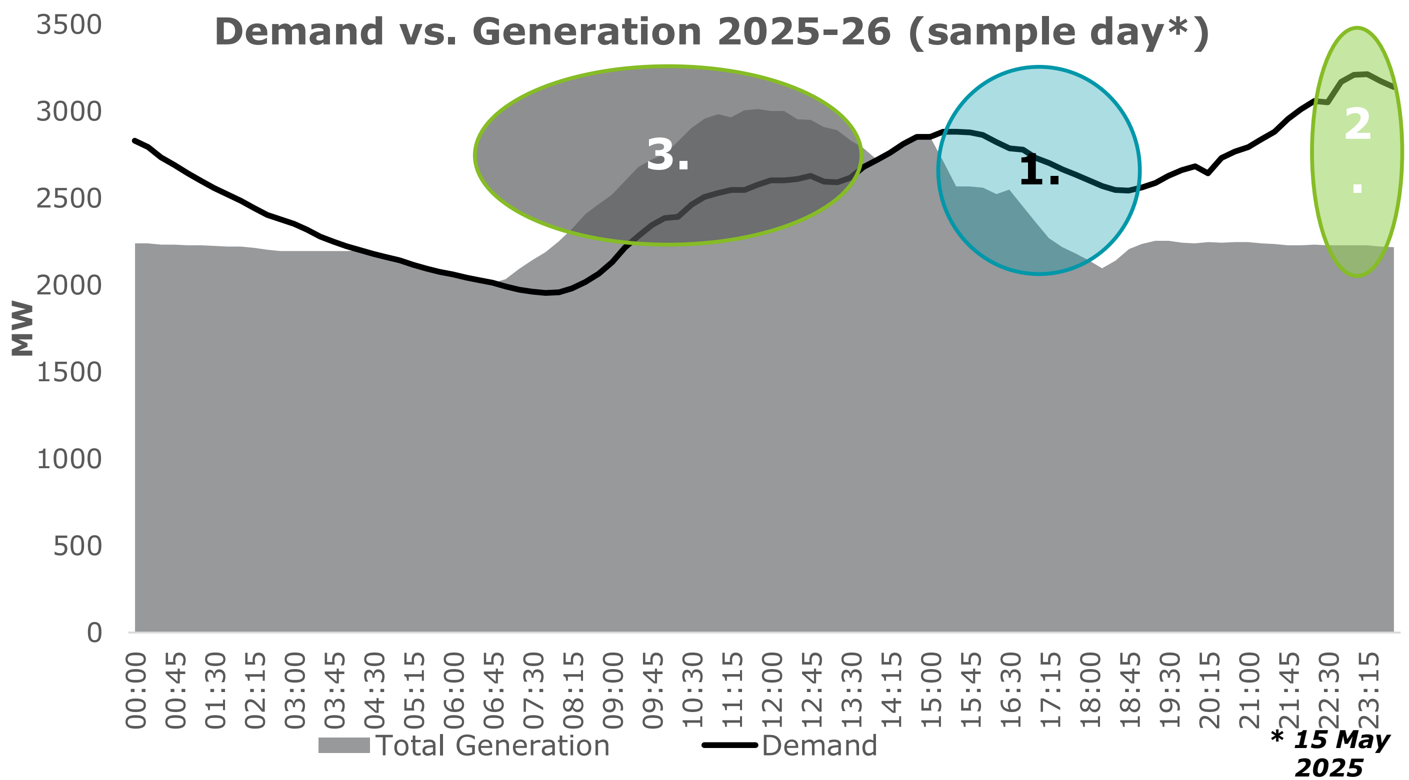
Illustrative example for Benefits Accrued from BESS



*** 15 May 2025***

1.Benefits from Ramping Support:

Slots with ramping constraints due to the inability of thermal generators to meet the demand due to ramping constraints when there is a reduction of RE generation.

BESS can discharge quickly to "even out" the generation.

2.Benefits from Energy Arbitrage:

BESS will run at slots with peak demand and help in peak reduction. The BESS will charge when the energy cost is low and dispatch during peak (high cost)

3.Excess Generation: As the country shifts to more RE generation, there will be excess of generation which can be used to charge the BESS at zero cost

Other Benefits

4.Capacity Deferral: The battery system is used for deferring distribution capacity enhancements.

5.Reduction in Transmission loss: Using battery system, we can prevent transmission losses to the extent of battery usage

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Assumptions used for dispatch simulations

Demand / Energy Cost / Generation Assumptions	
Parameter	**Assumption**
Range of data used	April ’18 – March ’19
Increase in power demand	4.5% p.a.
Year which BESS is deployed	2021-22
Renewable energy in 2022	771 MW (solar) + 400 MW (wind)
Increase in RE generation	20% p.a.

Analysis of dispatch simulations

- Data from evening slots was analysed in order to identify slots where ramping constraints are present which could be removed through a BESS system.
- Analysis of afternoon slots was also performed in order to estimate over-generation when RE generation is at its peak. Which can be used to charge the BESS.

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Methodology

Assessment of Battery Energy Storage system (BESS) along with battery sizing and evaluating effectiveness in distribution system

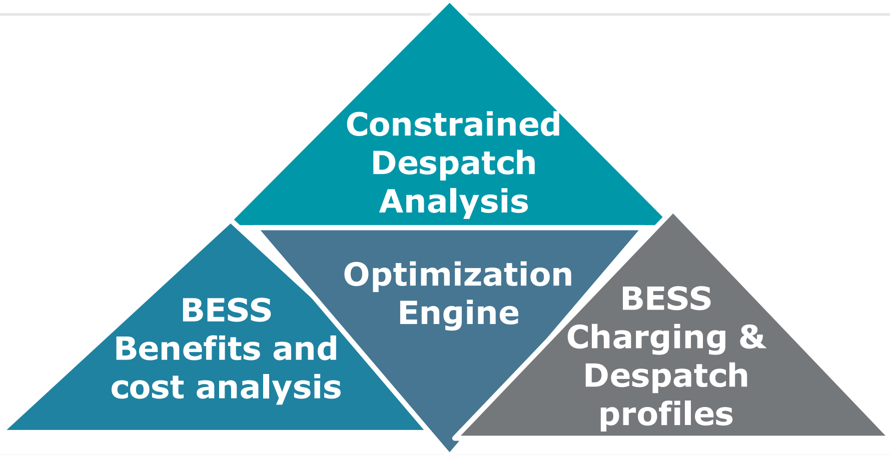
Client: **USAID's Greening the Grid (GTG)** is a five-year program implemented in partnership with India's **Ministry of Power (MOP)** under the **Asia - EDGE** (Enhancing Development and Growth through Energy) initiative. A central piece of GTG is the **RISE initiative** that involves implementation of RE grid integration pilots. This pilot involves distribution system modelling, Assessment of Battery Energy Storage system (BESS) along with battery sizing and evaluating effectiveness in distribution system

Methodology Adopted: USAID / BRPL have appointed Deloitte for the technical and market study to comprehend its network readiness for EV charging infrastructure. Scope of services include:-

- Assessment of Battery Energy Storage System effectiveness at distribution level considering feeder load, line congestions, DT capacity/overloading, RoW & network losses
- Modeling and simulation of BESS in distribution network to assess the technical and financial aspects
- Scenario based analysis for optimization of BESS size in distribution network; undertaking scenario based simulations to arrive at the most optimum size of BESS considering the load to support, load profile, battery types, no of cells in series and determining battery capacity.
- Value Analysis of BESS under two scenarios 1) Benefits to Discom; 2) Benefits to Consumer (Regulatory Business Case)

Objectives of the Assignment:

- Assessment of Battery Energy Storage system (BESS) along with battery sizing and evaluating effectiveness in distribution system
- Support BRPL in developing a regulatory business case and assist BRPL in filing petition and make representations



Impact Delivered & Accolades:

1. Dispatch Analysis and distribution system modelling
2. Value Stack Analysis –
   A. capex deferral, ramping support, peak shifting (Regulatory b-case)
   B. DSM penalty reduction, capex deferral, peak shifting (Discom b-case)
3. Identification of locations for placement of BESS along with sizing estimates
4. Regulatory Business Case, petition, etc.

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Electric Vehicle Charging Infrastructure and Impacts on Distribution Network

Release Event of EV White Paper, July 13, 2020

Presenter: Anish Mandal, GTG-RISE and Director, Deloitte

Renewable Integration and Sustainable Energy (RISE) Initiative
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There are a range of requirements which distribution utilities must consider while setting up a framework for supporting an EV charging eco-system.

Proliferation of EVs is dependent on appropriate planning and impact study

Agenda

- Key considerations for Distribution Utilities while planning for EVs
- Key issue to be addressed and how it can be addressed scientifically
- Modeling the utility network
- Conclusions

Key considerations for Distribution Utilities while planning for EVs

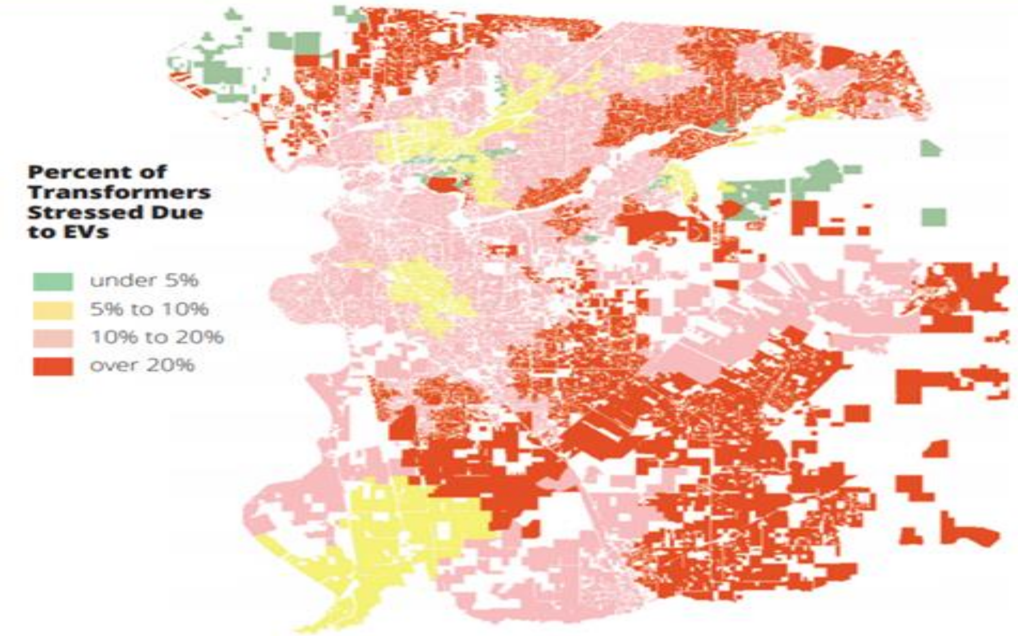
Distribution utilities face critical challenges in provisioning and managing access to EV charging infrastructure for the end consumers

- **Network Upgrades:** A key challenge is the identification of necessary distribution system upgrades to support EV charging stations along with its associated costs and cost recovery mechanisms.
- **Impact on components:** Distribution utilities need to analyze the impact of EV charging on distribution transformer loading along with aspects such as increased ohmic losses and degradation of network components leading to reduced component life span.
- **Location:** Identification of locations in distribution network for setting up of EV charging stations to optimize the existing available infrastructure to support EV charging would be key.
- **Business model:** Commercial challenges which include medium to long term planning for network upgrades, modes of financing and recovery, setting up of pricing mechanisms for EV charging, and provisions of incentive mechanisms for setting up of charging stations should also be a focus area.

Modelling and analysis to understand impact on distribution grid and power procurement

1. **Planning:** Scenario based analysis provides specific EV penetration level that a network can manage based on existing topology and upgrades.
2. **Component loading:** Insights into number of transformers which may be overloaded and thus require upgrades can be analyzed.
3. **Cost estimation:** Based on analysis of upgrade requirement, short, medium, and long-term costs can be derived.
4. **Impact of consumer behavior:** Impact of managed charging measures such as ToU on network components.
5. **Optimizing solutions:** A range of solutions to reduce integration cost can be first tested before deployment is carried out.

Case Study: Sacramento Municipal Utility District (SMUD)



Source: Smart Electric Power Alliance, and SMUD, 2017

The Sacramento case study above showcases important insights that can be derived from a modelling exercise to understand the impact of EV integration and adopt solutions accordingly. Smart Charging can reduce grid upgrade expense by 70% based on modelling study for SMUD

Prioritization framework for deploying EVSE and identification of manageable overloading instances through Managed Charging (Active)

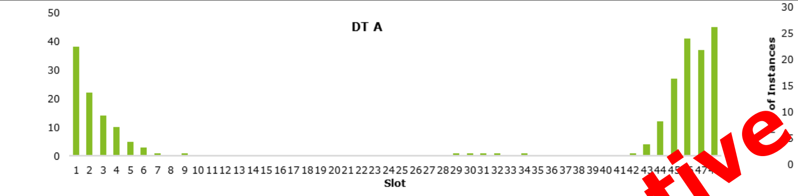
Preliminary analysis

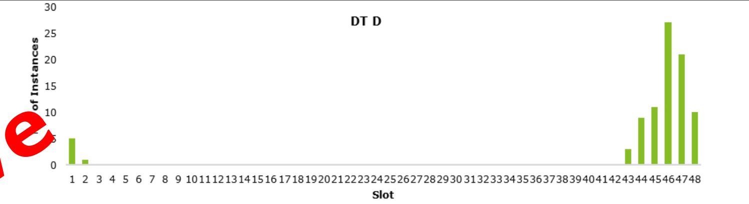
- This analysis has been carried out on maximum load data of a distribution feeder to determine the years in which each of the DT loading cross 70% of their rated capacity.

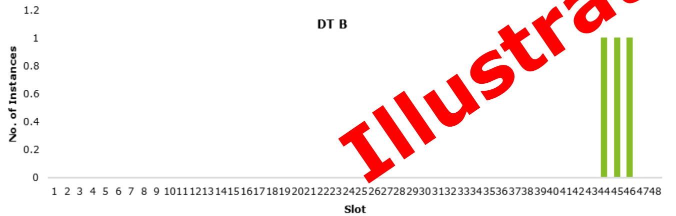
Deep dive analysis

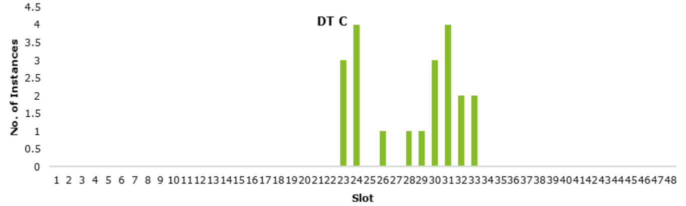
- The deep dive analysis is carried out for each slot in the entire year to analyze the number of slots that are observed under overloading instances
- Slots where DTs are overloaded are categorized into:-
  - Manageable: where overloading can be compensated by shifting the EV load
  - Unmanageable: where overloading can not be compensated even after shifting the EV load

Results









Managed charging hours for each DT are:
DT A: Slot 45 to slot 1
DT B: Slot 44 to slot 1
DT C: Overloaded in base year itself
DT D: Slot 45 to slot 1
DT E: Slot [illegible], [illegible] & slot 30 to slot 33 (Since, the overloading patterns are distributed, TOU *based tariff could be considered for this DT)*

DT number	Year of overloading
A	2019
B	2020
C	2021
D	2025
E	2029

Managed charging can relive the distribution system of its over-loading to a substantial extent whereas in some pockets, the same may not be possible considering differing load shapes and user requirement

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Regulatory interventions for enabling EV charging framework

Cost recovery of network upgrades

- Utilities are able to invest and recover the costs in creating the back-bone infrastructure

Tariff framework specifically for EV charging

- EV consumers are charged affordable and competitive rates

Creating a managed charging framework

- Allows utilities to manage the charging behavior of EV consumers

Market based framework for enabling EV and other DR providers to participate in ancillary services

- Enables a market framework to participate in demand response

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Conclusion

1. ***Adequate capacity planning needs to be done for at least a 10-year horizon***

2. ***There should be scientific modelling studies/ multiple system cost scenarios developed with/-without storage systems, with/ without RE based charging, with/ without managed charging etc., to effectively design the network***

3. ***Utilities should start representing to concerned regulators for justification and subsequent introduction of managed charging practices, TOU tariff pricing, etc.***

4. ***Mechanisms such as rate-basing and progressive regulations like ancillary services would go a long way in framing up conducive regulatory landscape for EVs***

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