Distribution Planning and Analysis for Distribution Feeders in Delhi, India

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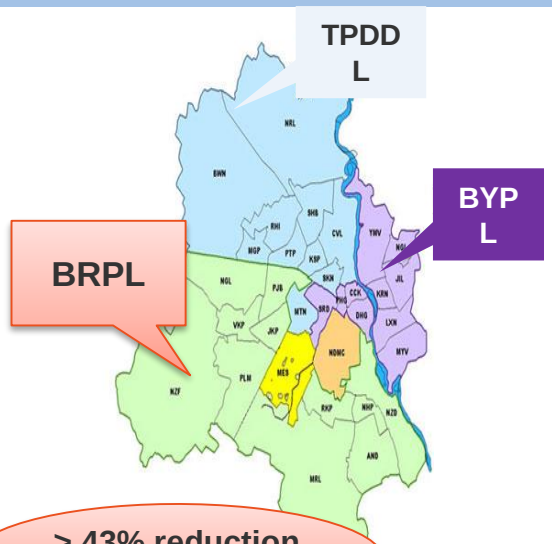
BSES Rajdhani Power Ltd. – A Profile

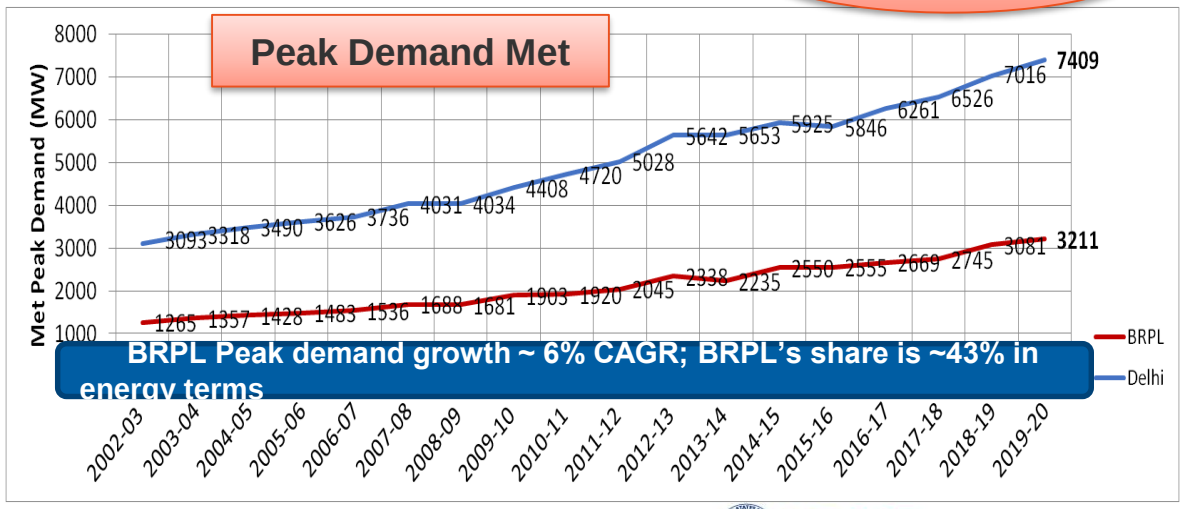
Distribution Area	**750 sq. Km**
No. of customers	**2.55 Mln.**
Customer Density	**3400 /sq Km**
Max Demand met (Till Date)	**3211 MW**
Annual Billed energy FY19	**12,194 MU**
AT&C Loss FY19	**8.06 %**

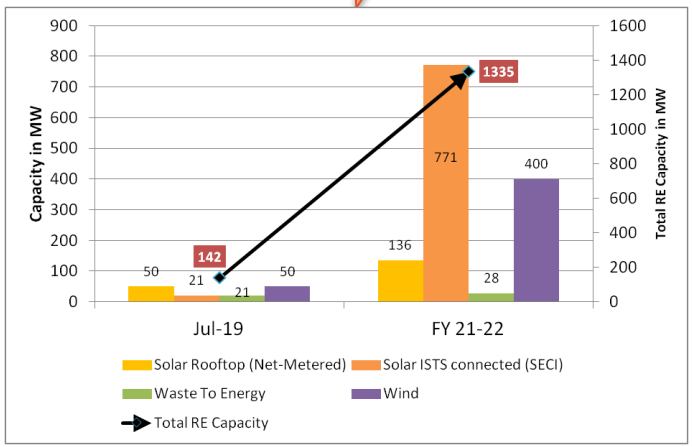


Consumer Mix

About 86% residential contributing to ~70% consumption

RE ~ 29% of portfolio (1300MW+) by '21-22





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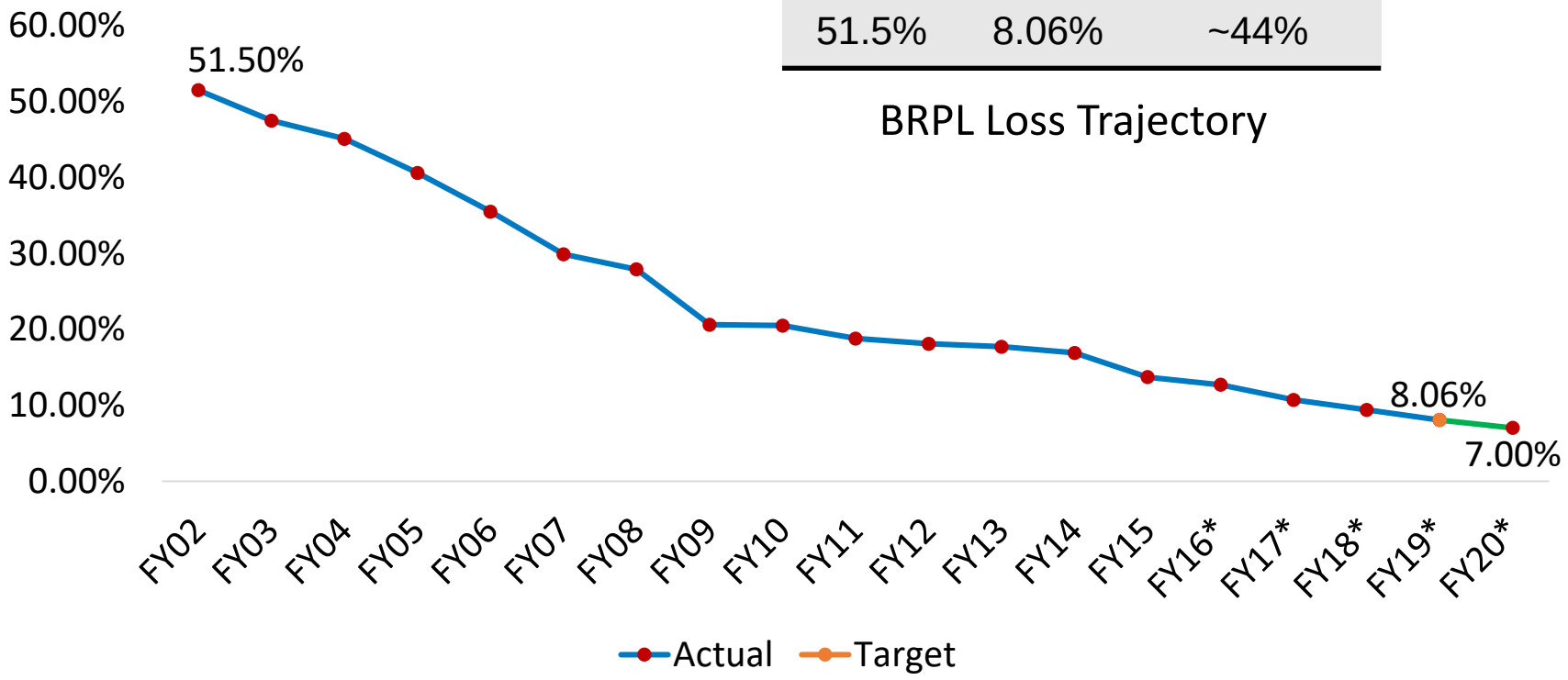
Steep Loss reduction post- privatization

FY02	FY19*	Reduction
51.5%	8.06%	~44%



~44% reduction in losses post takeover against 20% rise in a decade up-to privatization

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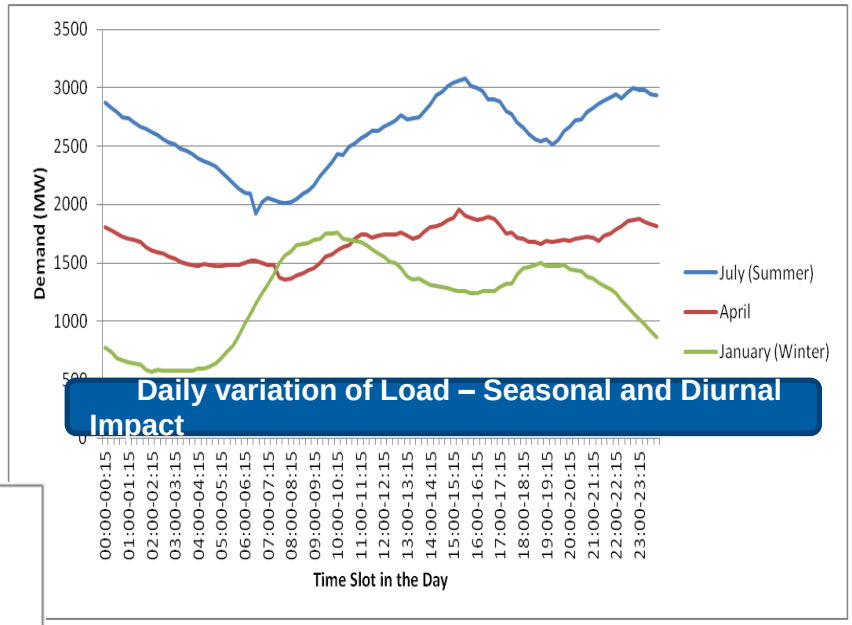
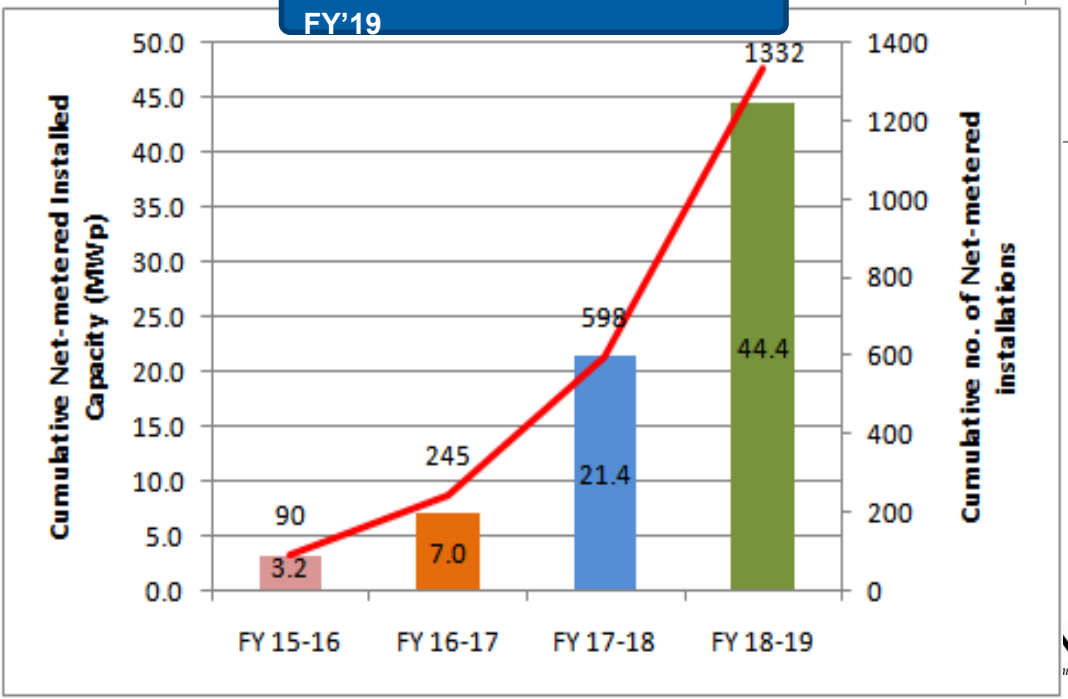
Power Portfolio & Network Landscape (1/2)

- Large seasonal and diurnal variation in demand and hence loading of assets
- High RE share including robust growth in Roof Top Solar



Daily variation of Load – Seasonal and Diurnal Impact

> 50% addition in RTS in FY'19



Daily variation in load	
Summer (Jul)	~1160 MW
Winter (Jan)	~1200 MW
Fall/Spring (Oct/ Apr)	~600 MW

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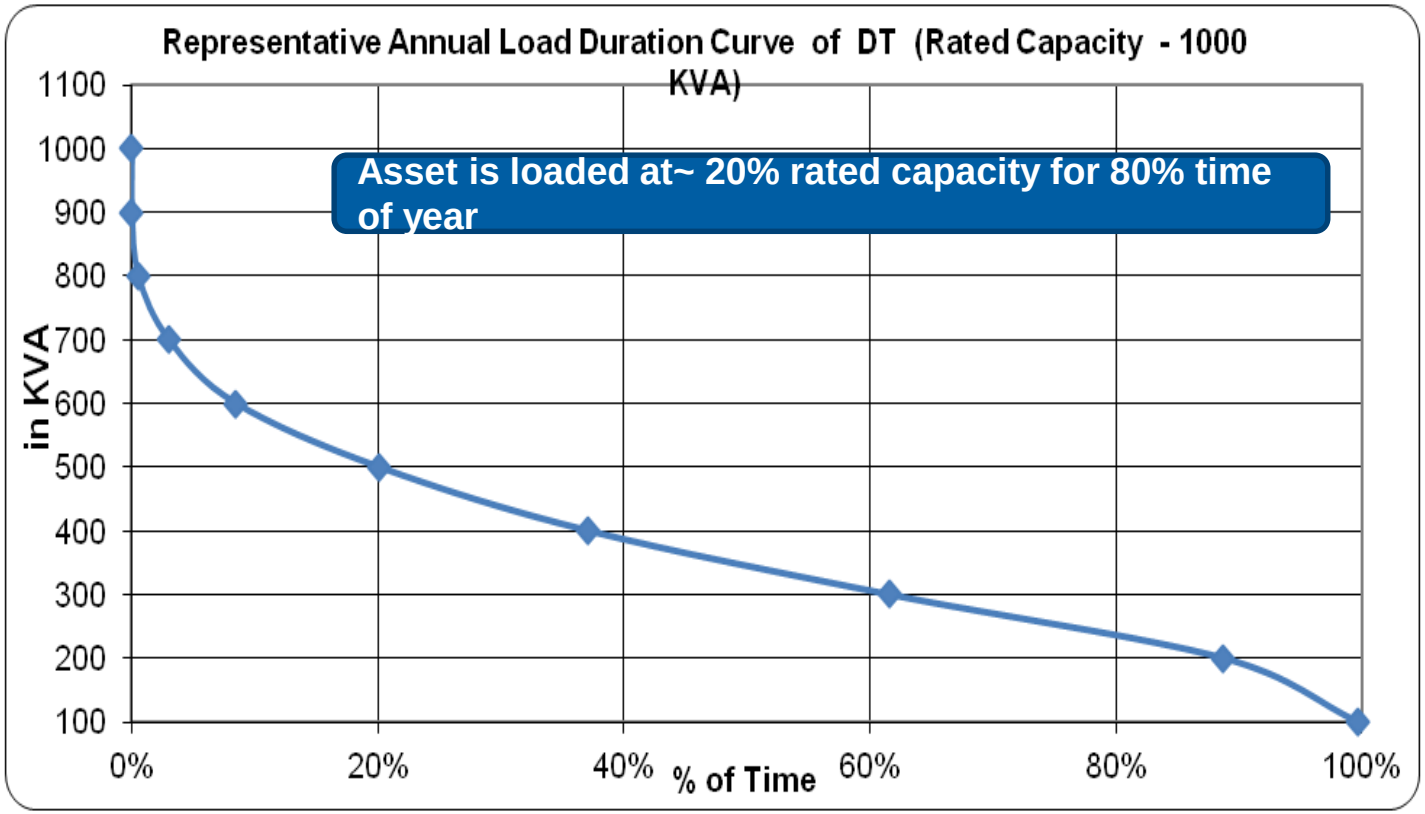
Power Portfolio & Network Landscape (2/2)



- Space constraints for network upgradation
- Overall lower utilization of assets
- Rooftop Solar can help reduce day peak loading of assets

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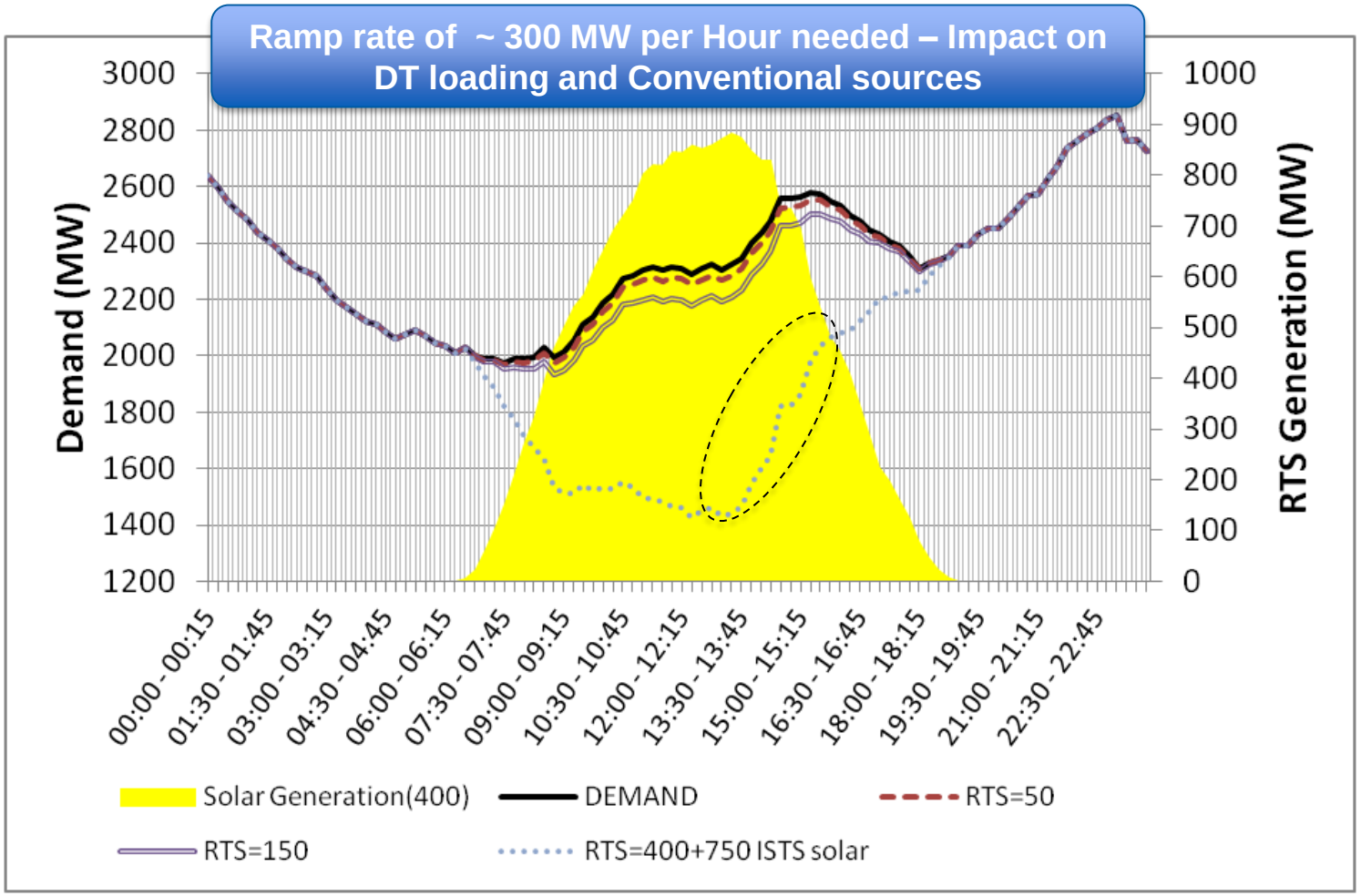
Impact of RTS and ISTS Solar on Demand



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NREL at a Glance

1,850

Employees,
plus more than
600
early-career researchers and visiting scientists

World-class
facilities, renowned technology experts

over 800

Partnerships
with industry, academia, and government

Campus
operates as a living laboratory

$490 M

2019
Business volume

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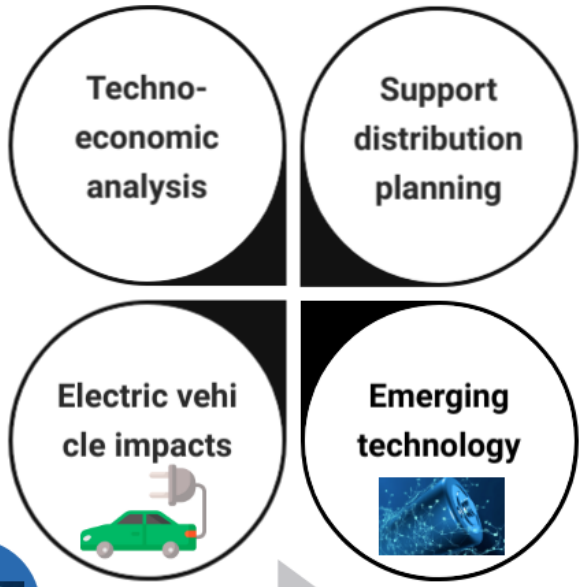
Techno-economic analysis

Delhi

Techno-Economic analysis on emerging technologies



Baseline analysis

Only load growth and classic distribution planning

Electric vehicle growth

Additional to load growth moderate and high electric vehicle growth is modeled

Energy storage for value streams

Comparison of costs and values for choosing energy storage as an alternative for distribution planning upgrades

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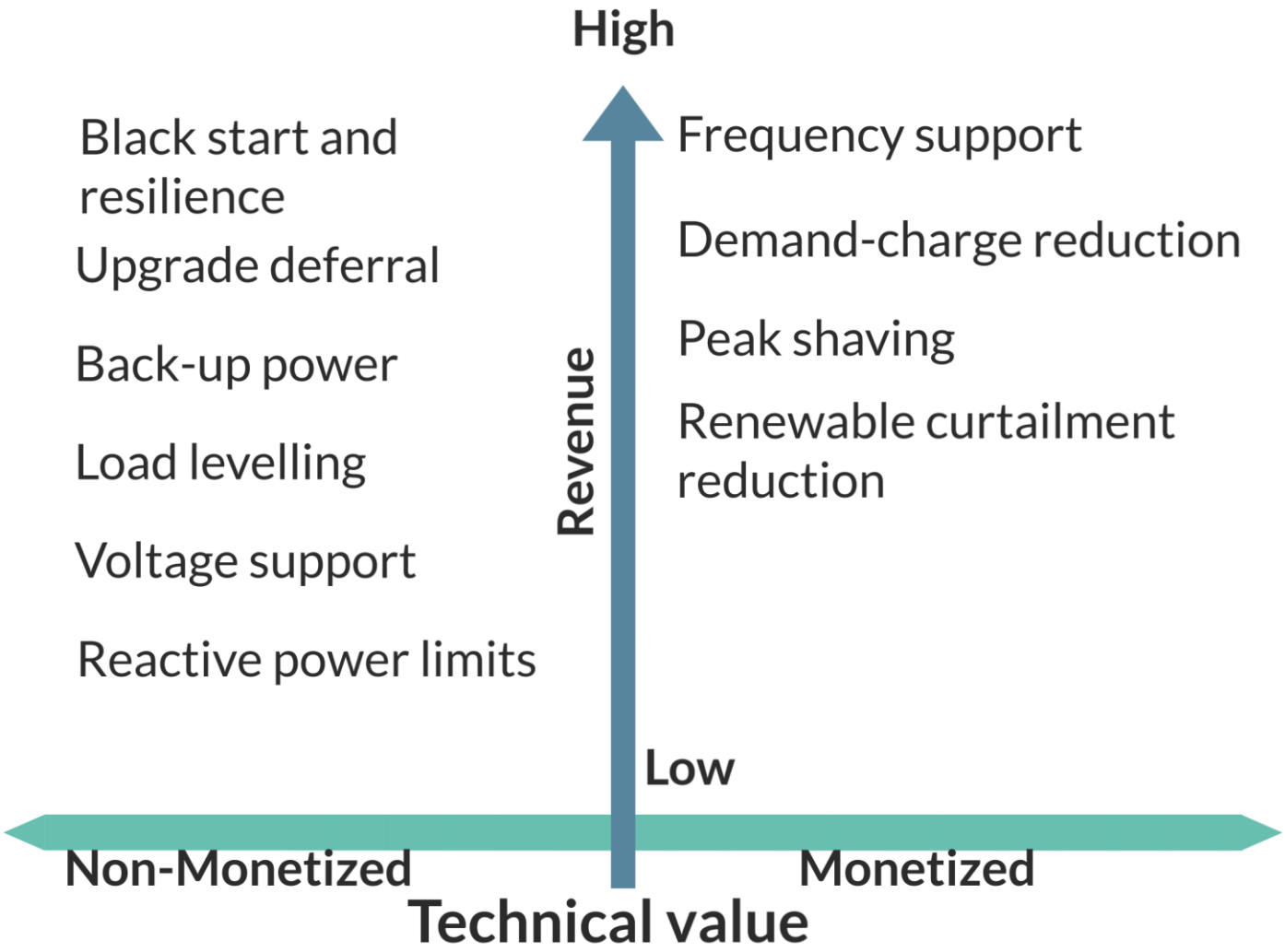
Monetized and non-monetized grid services



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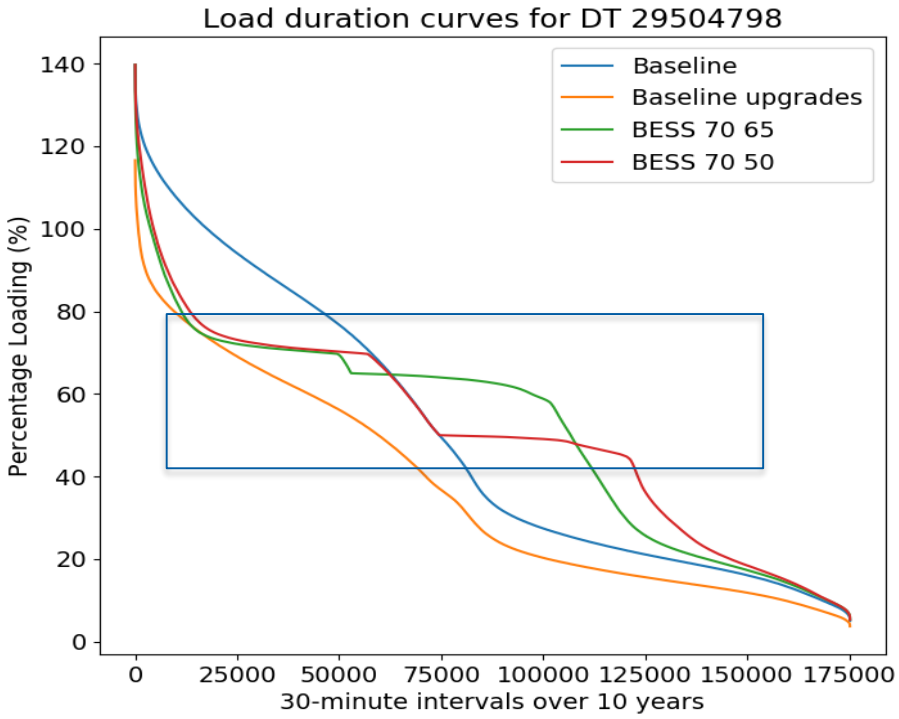
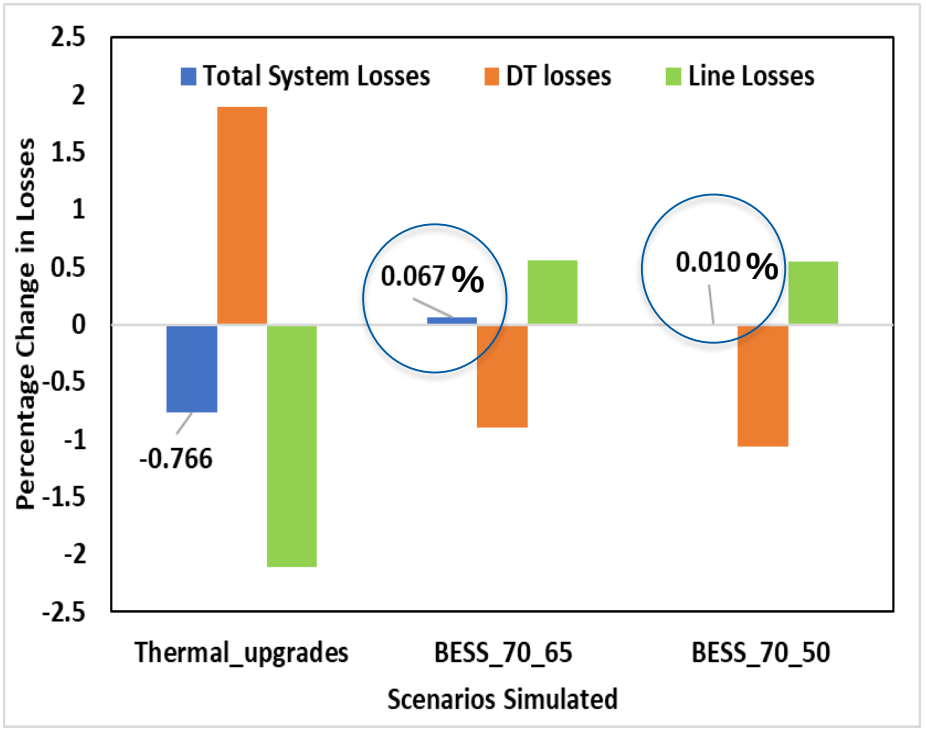
Impact of storage on losses are insignificant

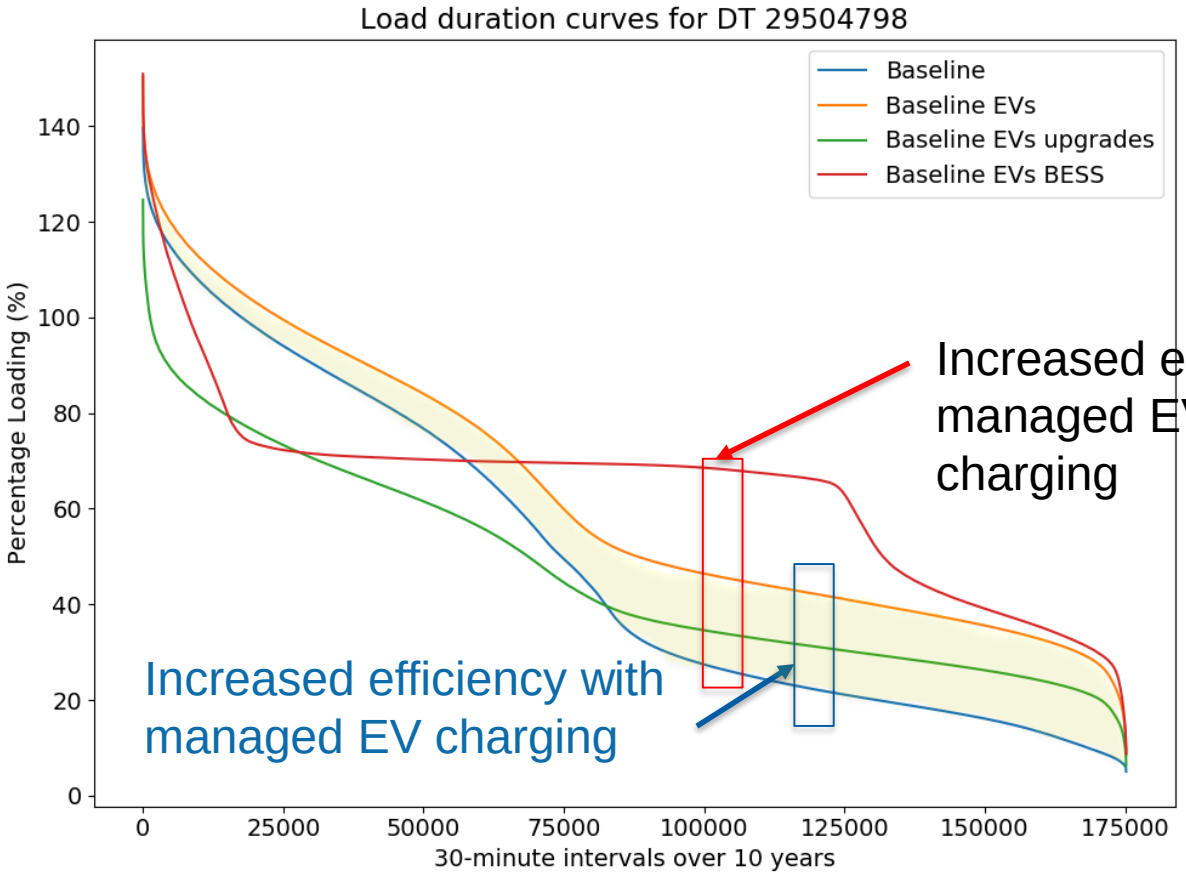
- Due to operation in higher efficiency region DTs with storage generally experience reduction in losses compared with the baseline values.





EV + Energy storage to avoid coincidental peaks

- EVs and BESS fill DT valleys and push operation in higher efficiency region.
- 28% more energy flows through this DT due to EVs



EV + Energy storage to help reduce distribution upgrade

- With EVs 126 line segments experienced greater than 100% overloading.

- BESS reduced line violations to just 19 line segments, an **85% reduction in violations**.

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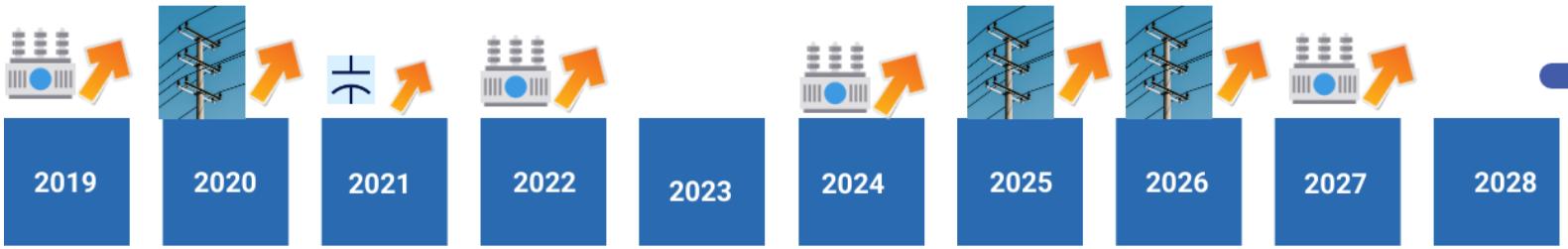
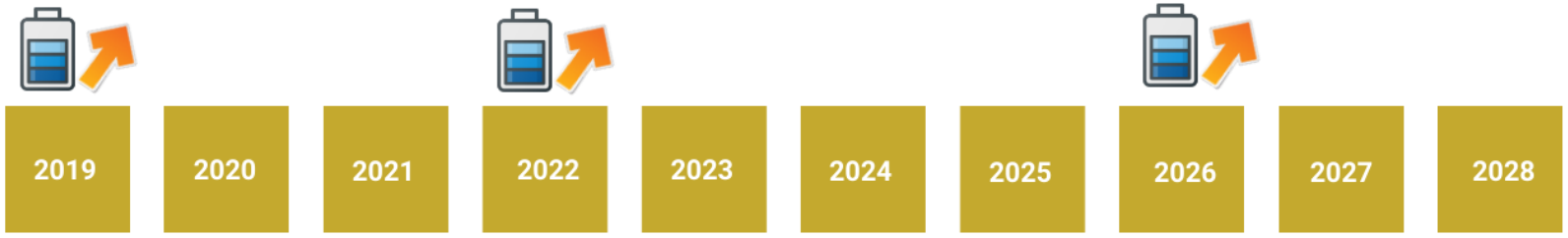
Long Term Distribution Planning Options

- Baseline violations can be corrected by **replacing existing equipment** with higher rating equipment or by operating multiple devices in parallel.
- The other option is to **use emerging technologies** such as battery storage systems to reduce equipment loading.
- **Both options were compared in the simulations.**

Traditional Approach



Emerging Technologies



Cost benefit analysis

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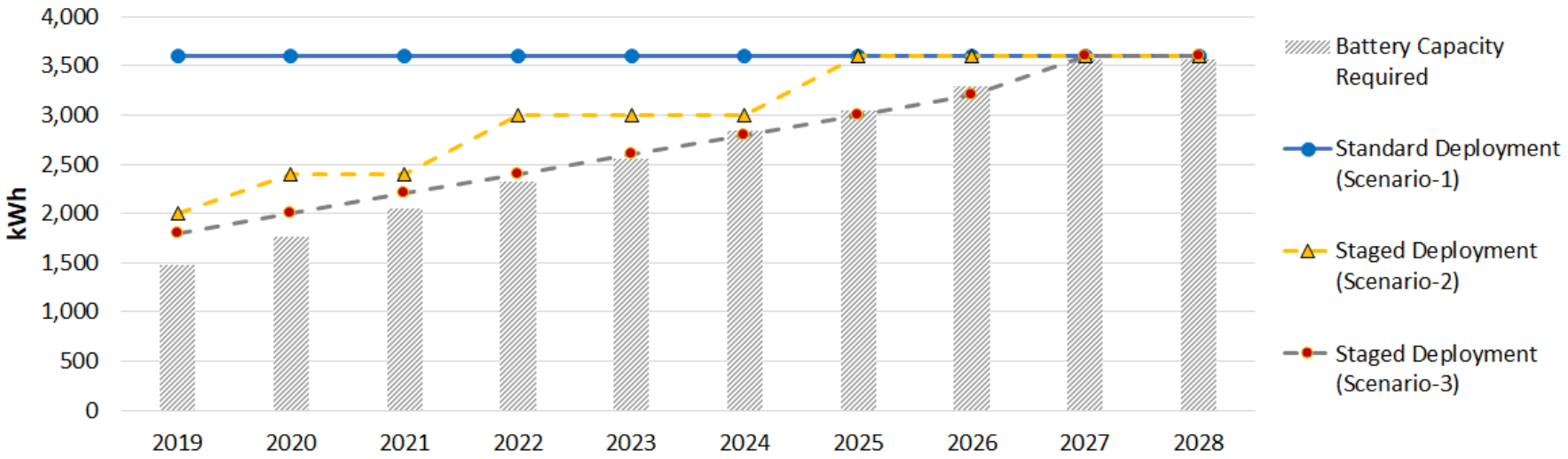
Standard vs Staged Deployment Scenarios

The staged deployment is designed for meeting the capacity requirements from the feeder line / transformer

Total Battery Capacity (kWh)	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Standard Deployment (Scenario-1)	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600	3,600
Staged Deployment (Scenario-2)	2,000	2,400	2,400	3,000	3,000	3,000	3,600	3,600	3,600	3,600
Staged Deployment (Scenario-3)	1,800	2,000	2,200	2,400	2,600	2,800	3,000	3,200	3,600	3,600
Battery Capacity Required (kWh)	**1,474**	**1,760**	**2,055**	**2,329**	**2,556**	**2,840**	**3,054**	**3,287**	**3,560**	**3,560**



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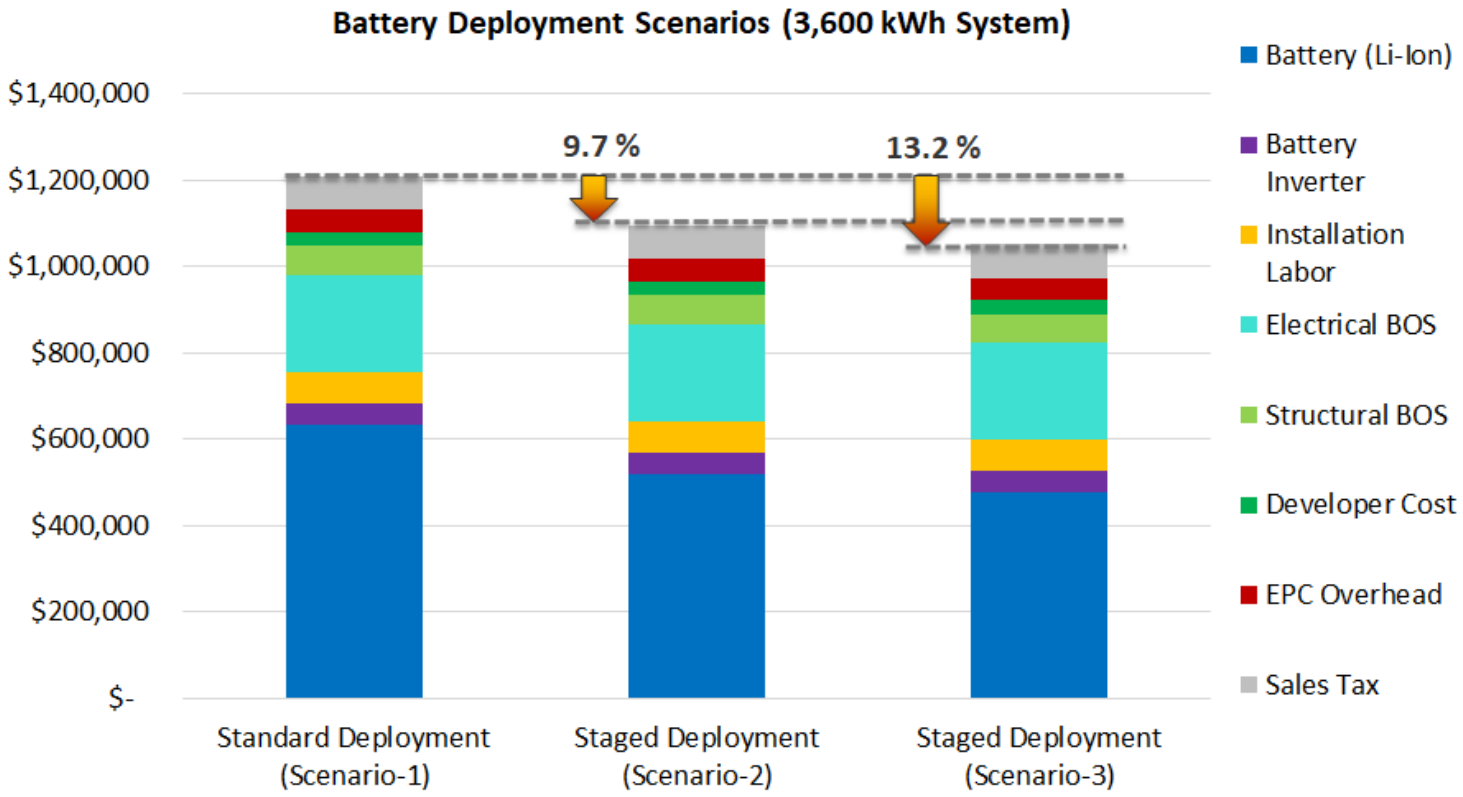
Standard vs Staged Deployment Scenarios



Present Value of Li-Ion Battery System Costs

Key Takeaways

- Managed EV charging for avoiding coincidental peaks
- Storage can bring device upgrade deferrals and yet enables EV penetration
- Staged deployment scenario results in additional cost savings
  - 13.2% savings was shown with a specified deployment scenario
  - This scenario allows for flexibility to the upgrade

Thank you!

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Comparison of BNEF and NREL SAM LCOE Forecast for India

Standard Deployment Model Scenario