TATA POWER-DDL

Towards a Greener Tomorrow

Innovative Energy Storage Technologies

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13th Mar'24

India's Power Sector at a glance

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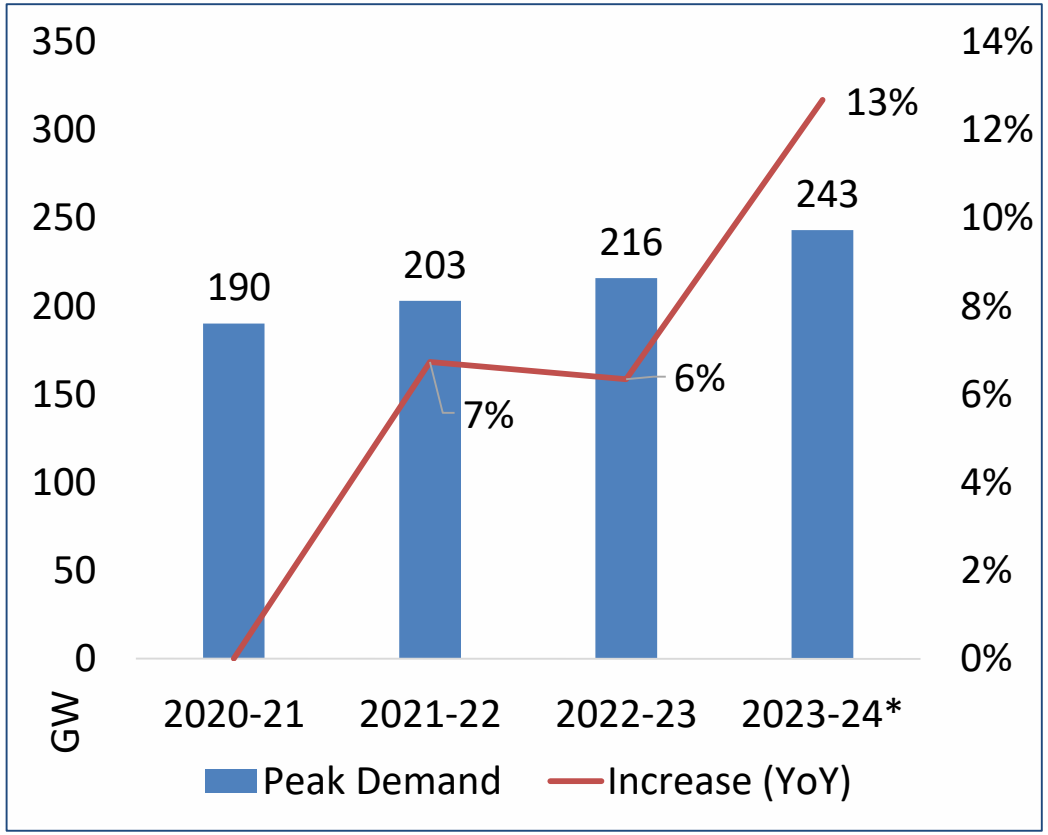
India's Installed Generation Capacity

Fuel Type	Category	Installed Generation Capacity (GW)	% Share in total
Fossil Fuel	Coal	206.8	49%
	Lignite	6.6	2%
	Gas	25.6	6%
Non-Fossil Fuel	Large Hydro	46.8	11%
	Solar	72.3	17%
	Wind	44.5	10%
	Small Hydro	4.9	1%
	Biomass / Cogen.	10.8	3%
	Nuclear	7.4	2%
Total		**426.1***	-

Peak Demand Trend



*Up to Nov'23

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About TATA Power-DDL

Government of
National Capital Territory of Delhi

51:49 Joint Venture
of The Tata Power Company Limited
(Tata Power)
and
the Government of Delhi
Formed on 1st July 2002
in

DELHI

North and North-West Delhi (510 sq. km)

21 years of service

6.34 % Loss level

20.4 lakh consumers

TATA Power-DDL is an ISO 9001 (Quality Management Systems), ISO 14001 (Environmental Management Systems), ISO 45001 (Occupational Health and Safety), ISO 22301(Security and Resilience), ISO 27001(Information Security Management), ISO 31000 (Risk Management), ISO 50001 (Energy Management Systems), SA 8000 (Social Accountability), ISO 10002 (Customer Satisfaction - Guidelines for Complaints Handling), ISO 20400 (Sustainable Procurement) certified organization.

Energy transition is posing challenges to the power sector

- 250 GW Solar & Wind Capacity by FY 27 *(Source - NEP)*
- 24% slots with abnormal frequency in FY 24
- 8,657 MW – gap in India's peak demand and supply (FY 23)
- INR 1.8 lakh crore – revenue loss due to AT&C losses @ 16% (FY 23)
- 40 Lakh annual EV volume in India by FY 27 *(source – Niti Aayog)*

Grid flexibility will be the key to a brighter future

Need to deploy solutions which are smarter as well as scalable

Challenges in Real-time Scheduling of Power

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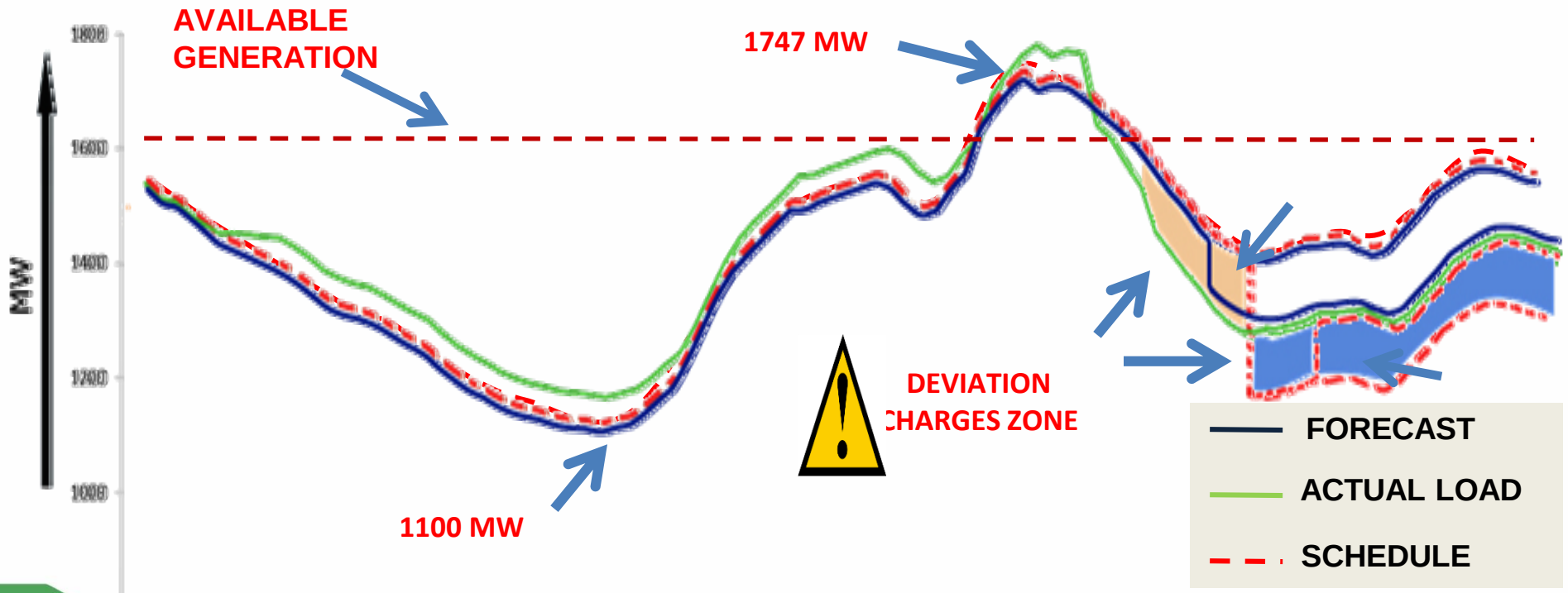
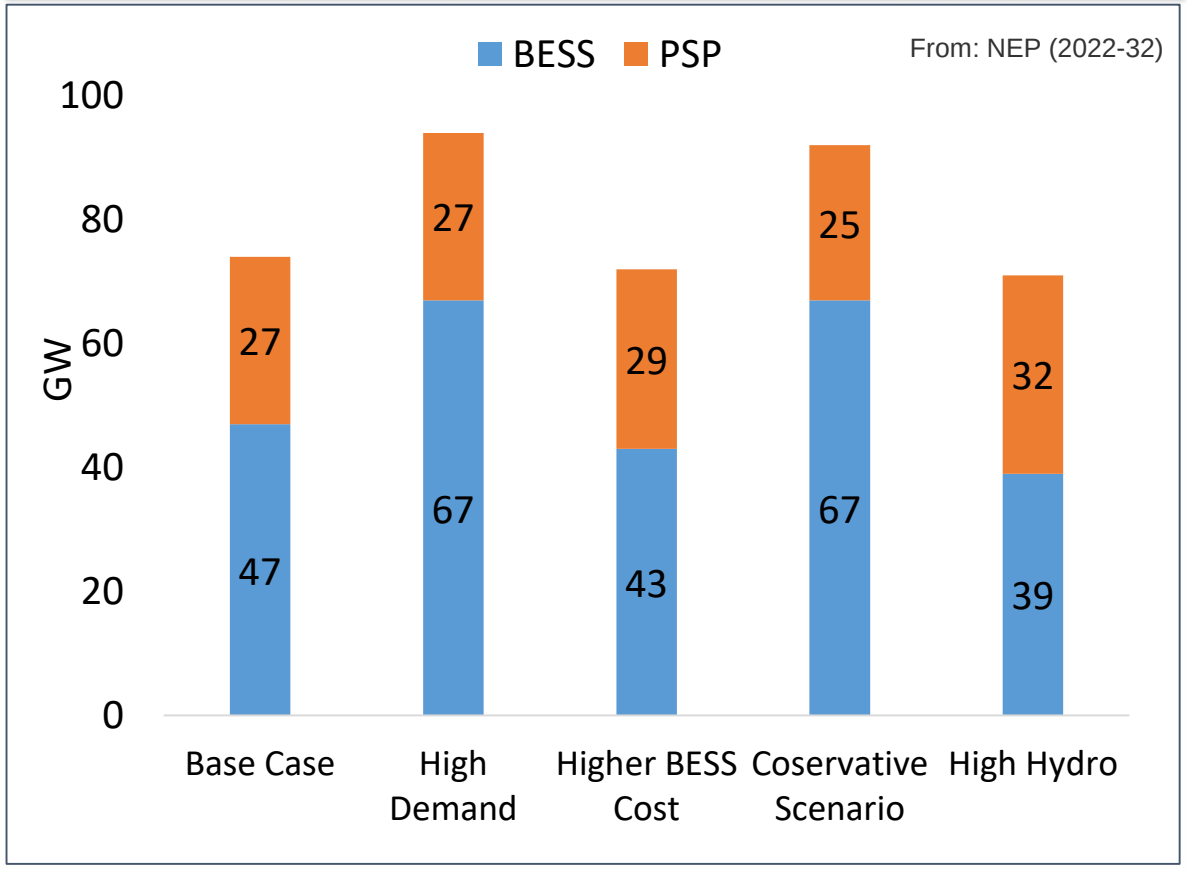
FORECASTED DEMAND	SCHEDULE	ACTUAL DRAWL
INTRA-DAY FORECAST REVISION 	SCHEDULE REVISION ipping. • Curtailment of Bilateral Power due to Transmission Constraints.	'HER SENSITIVE DEMAND perature/ Humidity/ Wind- l/ Rainfall 



Energy Storage is required, but how much and which technology

ESS Projected Requirement by 2032 (India)



*PSP or BESS – Advantages and Challenges

Pumped Storage Plants (PSP)

- Slow response to load variations
- Longer gap in cycles
- High initial cost but lower running cost
- Longer gestation period
- Higher risks in projects due to geography
- Limited flexibility in siting, suitable only for a few locations

Battery Energy Storage System (BESS)

- Responds ultra fast to load variation
- Lower turn-around-time between charge - discharge
- High initial cost (40% drop excepted by 2030)
- Installation time < 1 year due to modular architecture
- Multiple technological options on battery chemistry
- Can be sited easily as space requirement is quite low

** Other energy storage technologies like CAES, Gravitation, Power-to-Gas, etc. are in nascent stages*

Supports by Energy Storage for DISCOM

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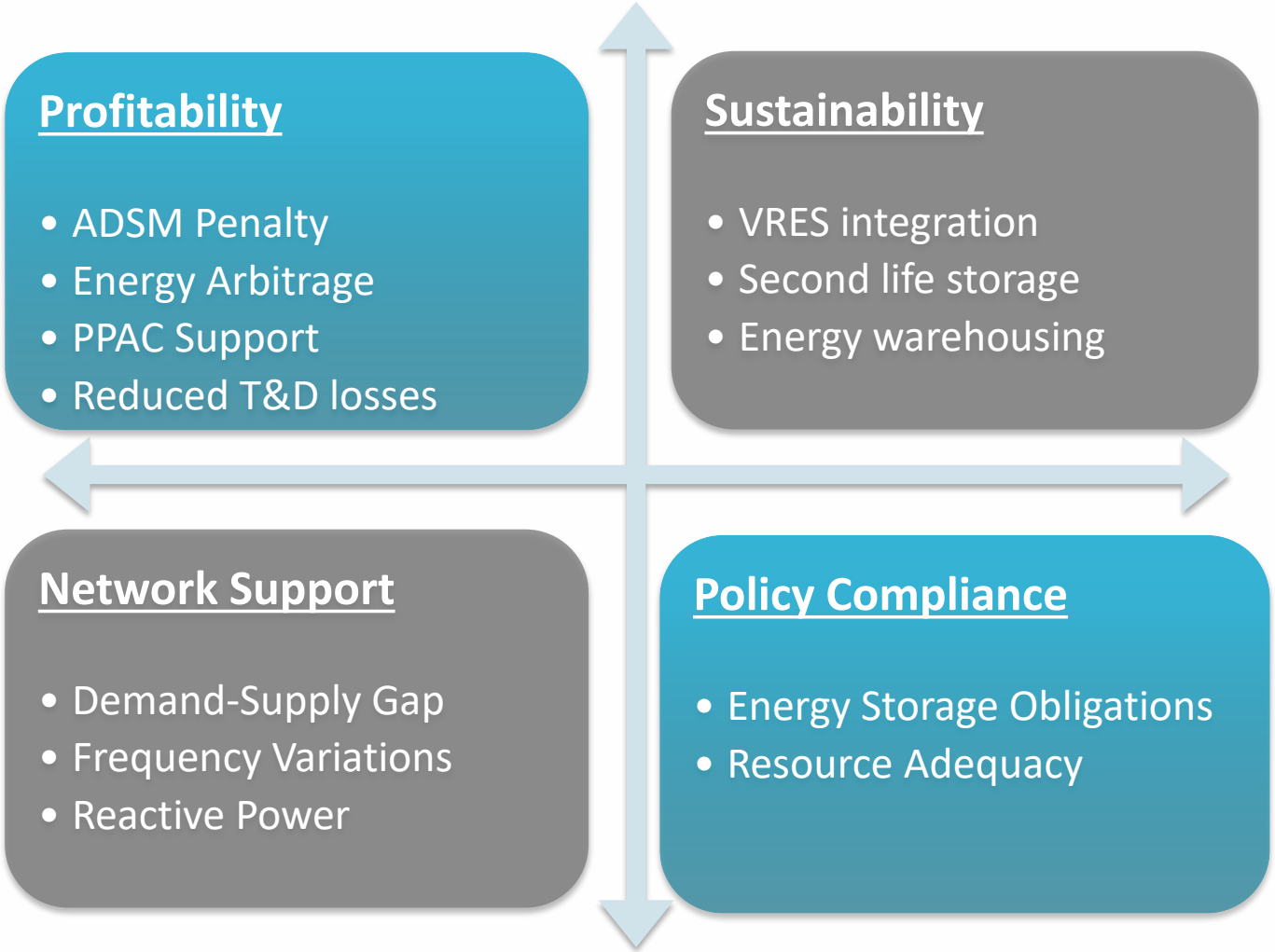


TATA Power-DDL Energy Storage Portfolio

Grid Storage

10 MWh Grid-connected Energy storage system at TPDDL's Rohini Substation. Commissioned in 2019

Community

Community storage: 15-20% of the Distribution Transformer Capacity. 630kVA DT – 150 kW/628 kWh Storage (in partnership with Exide & Leclanche). Commissioned in 2020

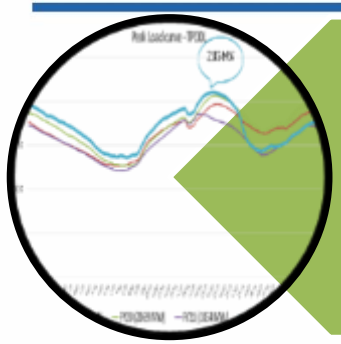
Pole Mounted

First of a kind pilot project on Pole Mounted Battery Energy Storage (20 kW/20 kWh). Commissioned in 2021

Energy Warehousing

Pilot on Energy Warehousing concept. Utilizes spare storage capacity available at a Battery swapping station for supporting the grid. Commissioned in 2023

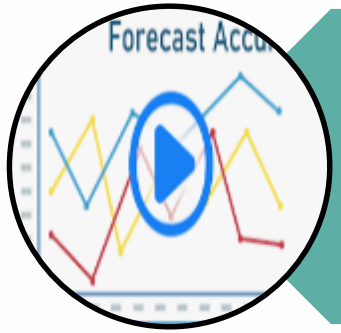
Key BESS Applications Utilized by TATA Power-DDL



BESS can be efficiently used for **Peak Load Management**; this will also ensure the CAPEX deferral for upcoming years.

Replacement to the end-of-life thermal plants

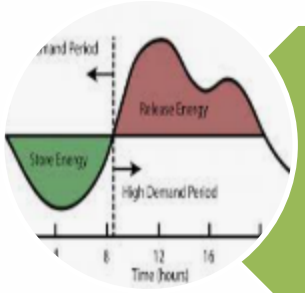
BESS can provide **Dynamic power supply to Public Buses Grid** to support unexpected peak charging requirements due to its fast-ramping feature



Dynamic change in Load behavior due to External factor results in forecast error and which can be catered through BESS thereby **DSM/ADSM penalty** can be reduced and ensure Grid discipline

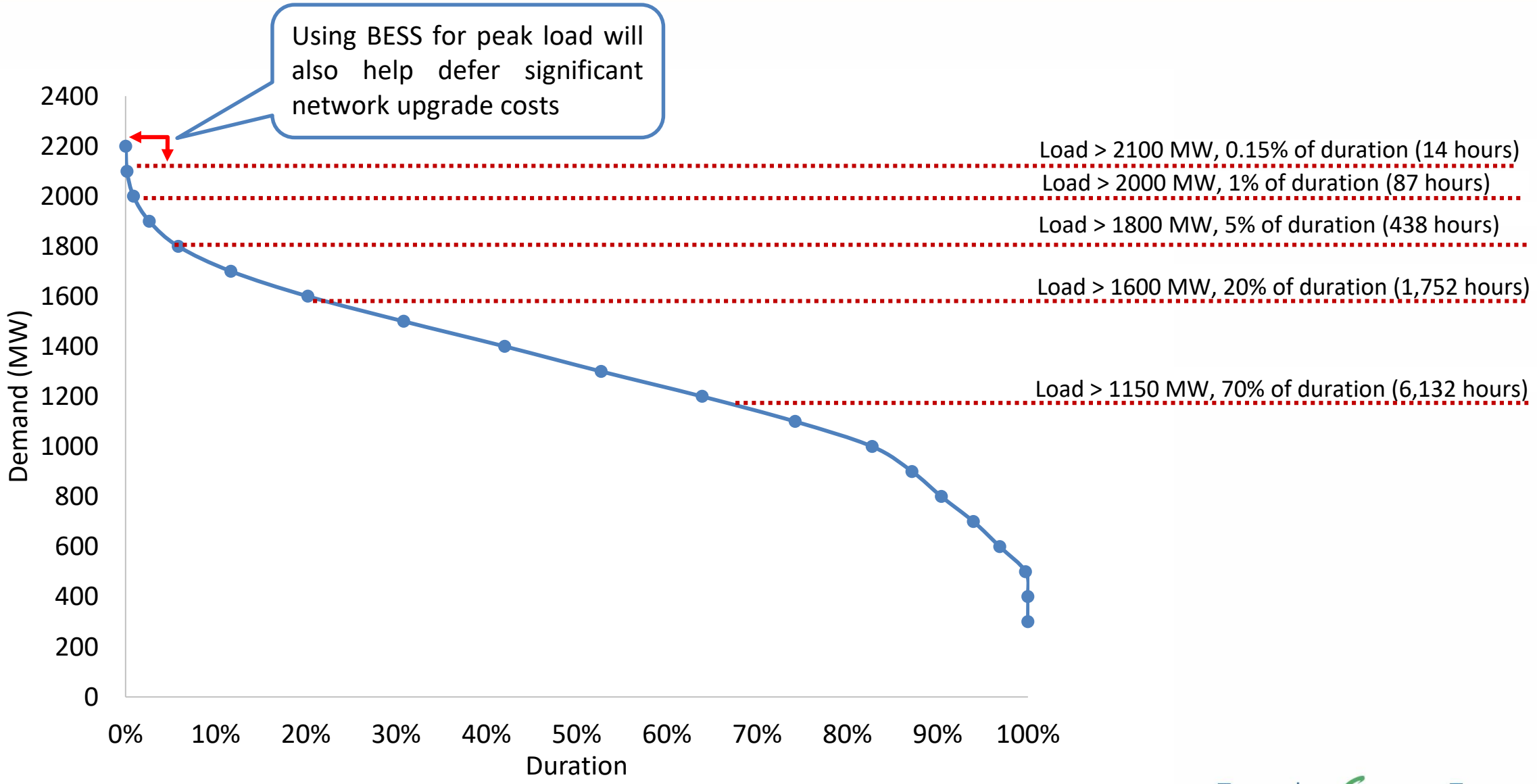
Reactive Support: Provide Volt Var compensation to Maintain Power factor and Power quality in terms of maintaining Grid voltage

Support to Frequency regulation Ancillary market in terms of Second and Tertiary reserve for maintaining frequency of the Grid

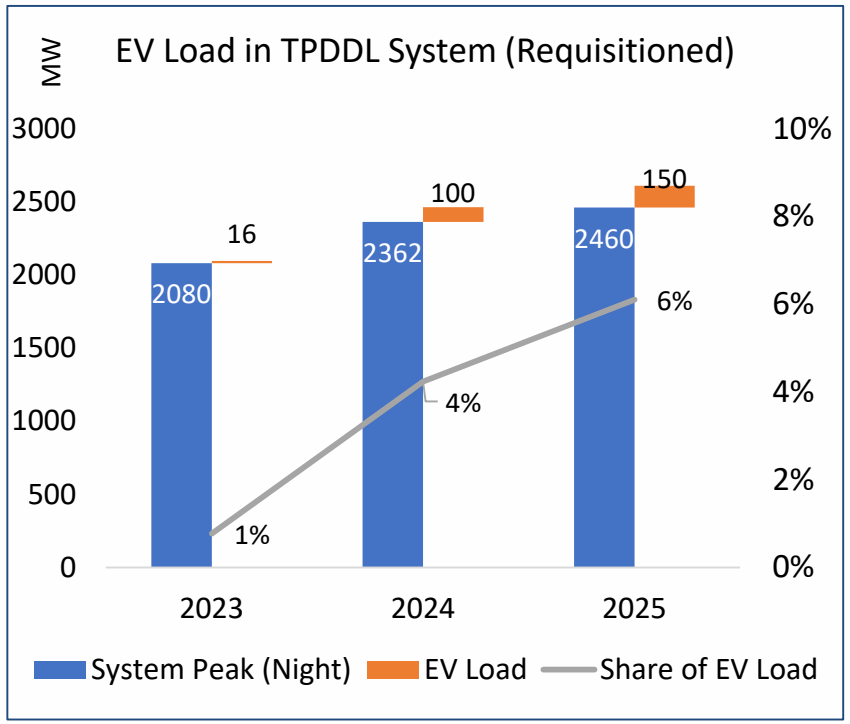


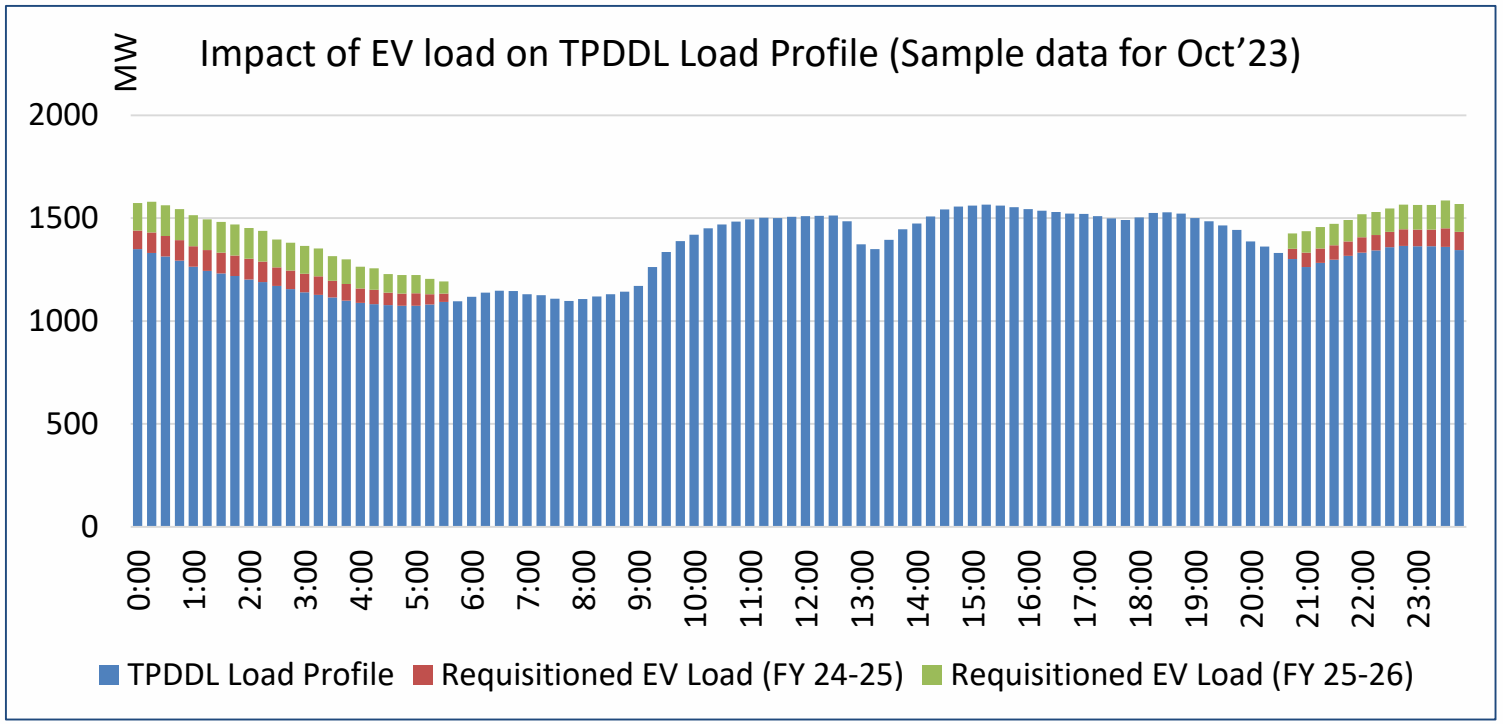
Energy Price Arbitrage: Fill When Cheap, Drain When Price is high. This will reduce the Power Purchase cost during Peak load

Peak lasts for 1% duration but needs 100% preparation



EV load coincides with night peak load



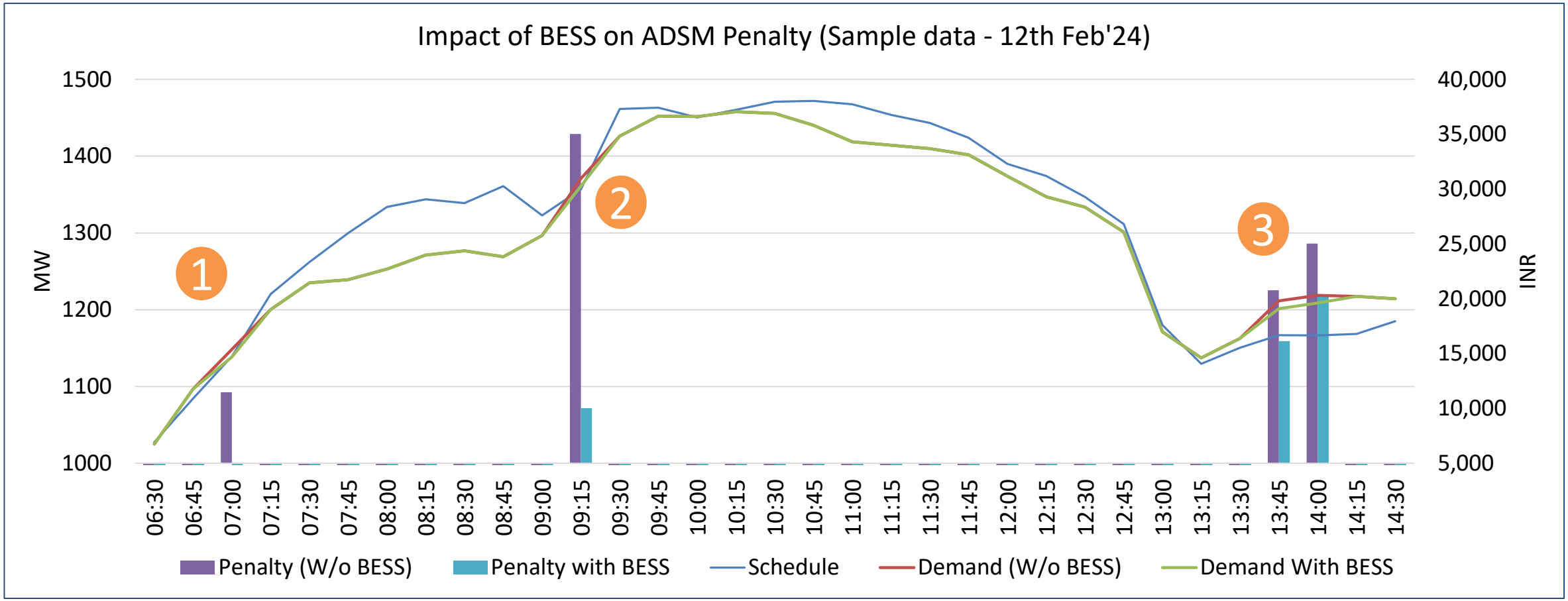


EV load taken above is the load requisitioned to TPDDL by State Govt. Bus department alone, till date

For personal EV alone, further 120 MW to 144 MW load might get added into TPDDL network annually by FY 27

BESS, with sufficient capacity, can help catering to sudden EV load / meeting night peak

BESS Supports avoiding / minimizing ADSM penalty



ADSM penalty **Without** BESS – INR 92,306

ADSM penalty **With** BESS – INR 46,368

Penalty saved through BESS – INR 45,937

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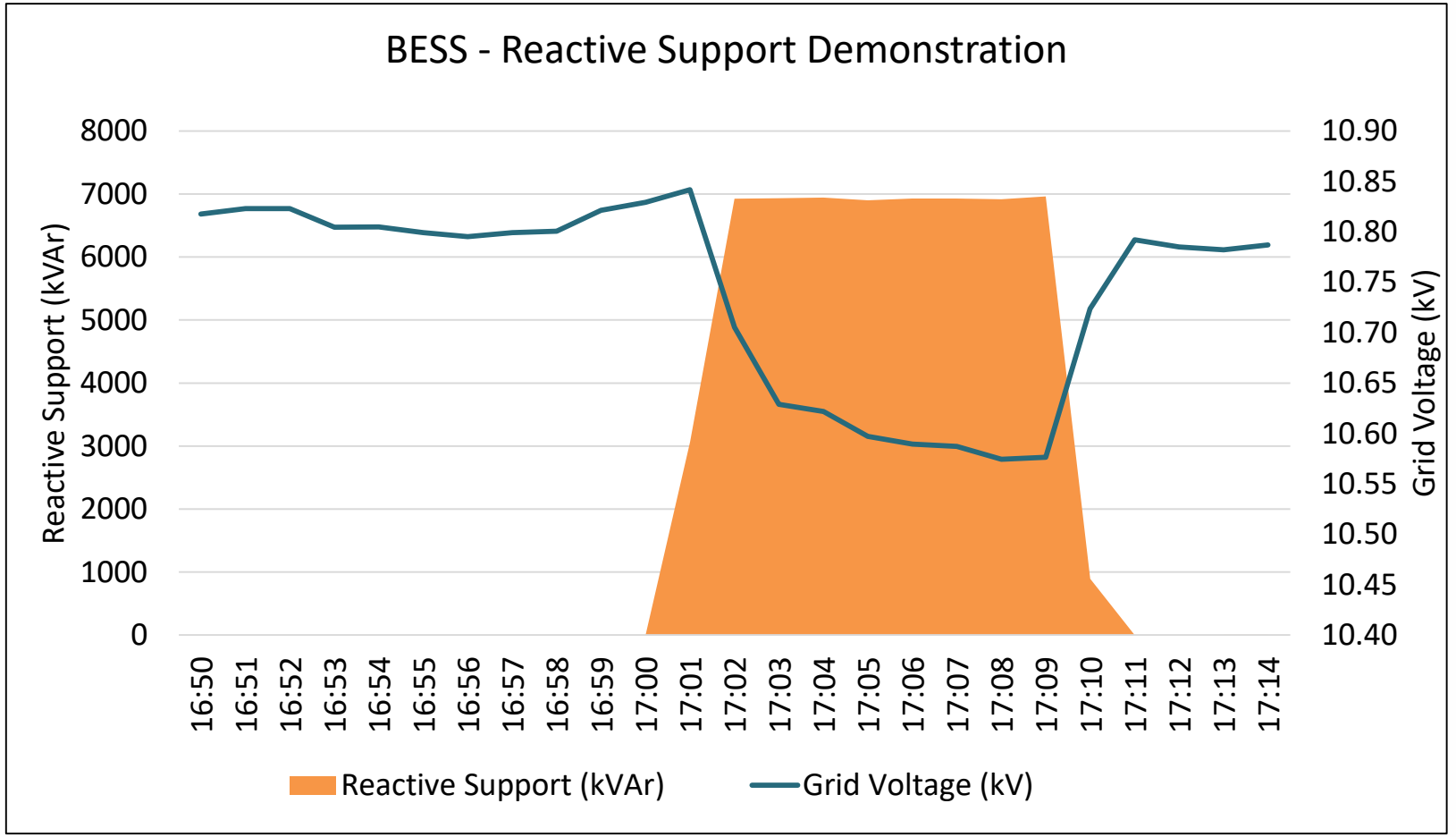
BESS compensates power quality issues

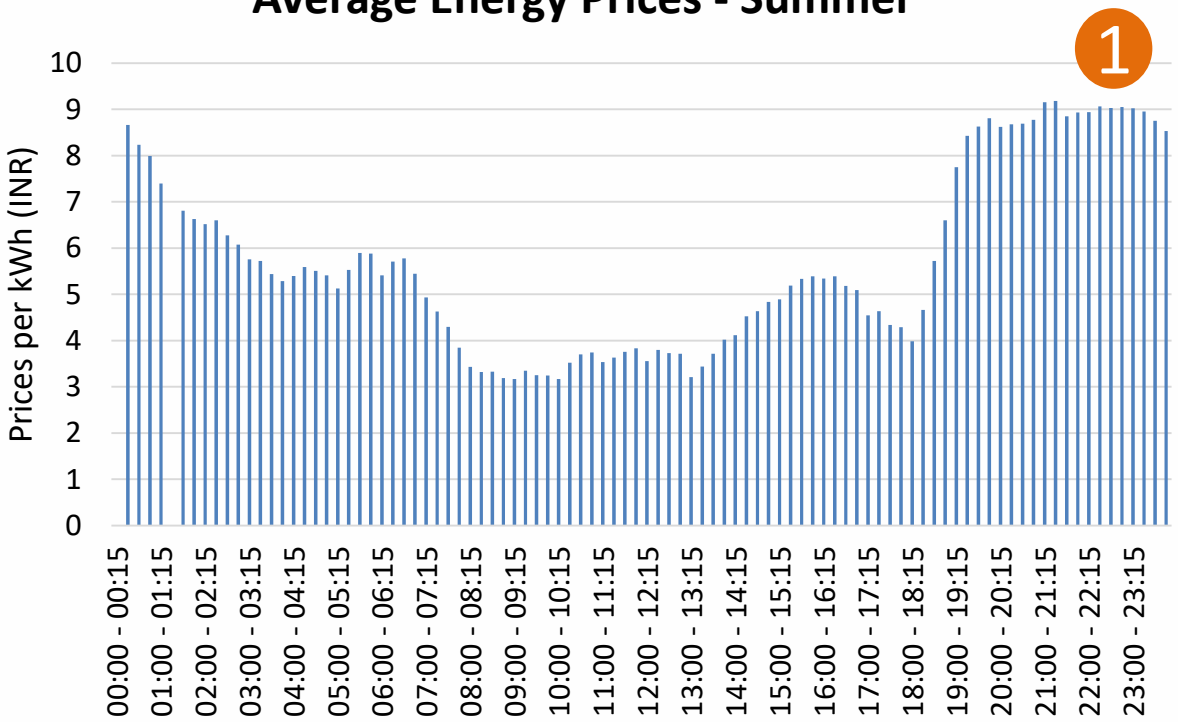


With four quadrant operation, reactive capability available over full real power range

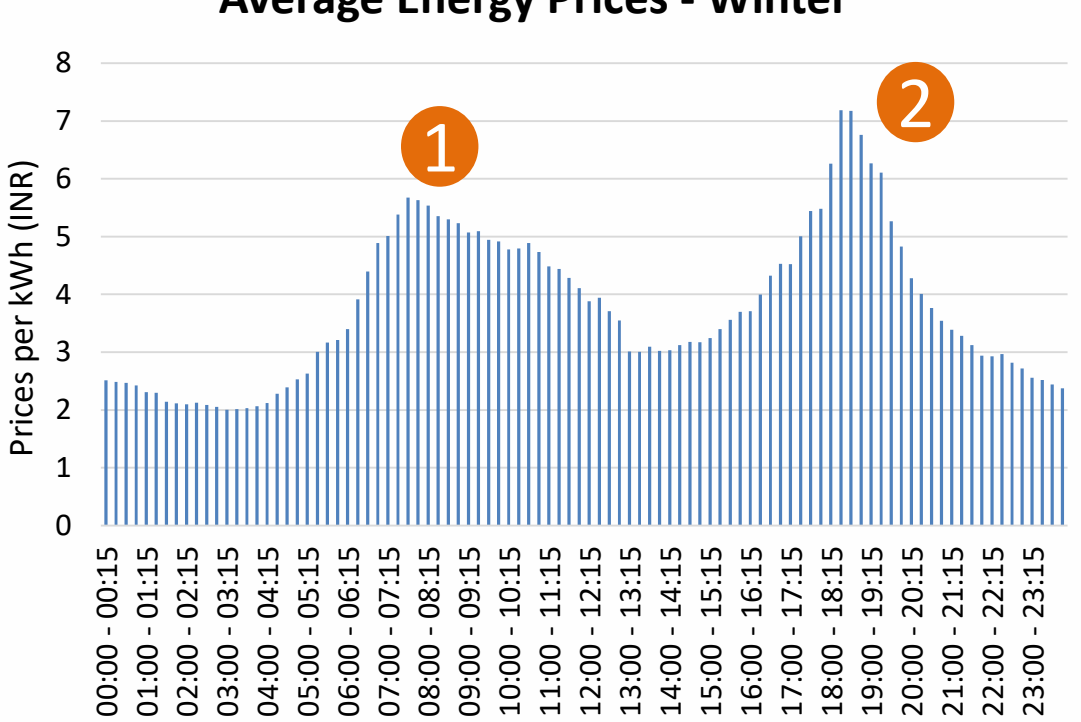
Reactive support is a function at PCS level, so batteries' life is not compromised during the application

May be used for lightly loaded systems (winter / nights) observing power quality issues

BESS can be used for cheap filling and costly draining



- Good to be Cycled (charge and discharge) once a day
- Reserve for peak load support during day-time
- Price arbitrage opportunity of ~INR 6 / unit on average



- Opportunities for TWO cycles a day
- Price arbitrage opportunity of ~INR 4 / unit on average
- Can be planned for savings ADSM penalty as well

Key learnings for TPDDL from operating the BESS

- Develop in-house technical / operational capabilities through trainings from OEM / Integrator
- Architecture should be flexible for cross-integration of different make equipment (batteries, PCS, etc.)
- Sufficient cooling arrangements must be ensured for batteries and other equipment
- System Integrator and Hardware OEM should have locally available support
- Total harmonic distortion of Inverters (PCS) should be looked at
- Plan for end-of-life disposal of batteries should be clear

Thank You