"Accelerating India's Energy Transition and Role of Energy Storage in achieving Net-Zero Electricity Sector by 2070"

Presented by:

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Director, Electricity & Renewables Division

The Energy and Resources Institute (TERI), India

Thursday, 11 June 2026

ACEF-2026, Manila, Philippines

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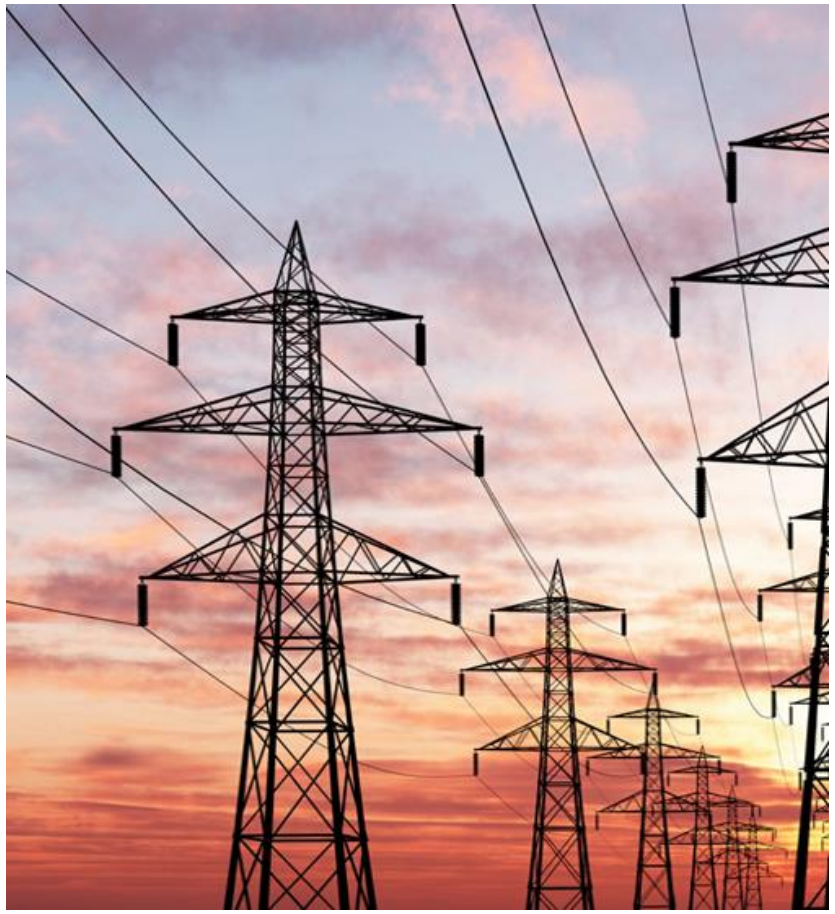


TERI: A Legacy of 50+ Years in Sustainable Development

Key Thematic Areas of TERI

Sustainable Agriculture	Climate Change & Air Quality	Energy	Green Shipping	Sustainable Infra.	Industrial Biotech.	Water Waste & Natural Resources

TERI's Energy Programme

Industrial Energy Efficiency

- Energy audits in large I&C establishments
- Sectoral EE studies
- Studies on industry transition including deep decarbonization options
- EE technology adoption and
- Best operating practices for SMEs
- Capacity building and knowledge sharing

Electricity & Renewables

- Energy transition
- Grid integration studies
- Demand side management & energy efficiency
- Emerging technologies: BESS, smart grids, green hydrogen, etc.
- RE technology applications & assessment studies
- Just transition
- Capacity building and knowledge sharing

Energy Assessment & Modelling

- End-use energy demand estimation
- Demand-supply integration & gap analysis
- Decarbonization scenario planning
- Socio-economic & co-benefit impact analysis
- Energy sector linkages with economy & environment

Energy Programme Mission Statement

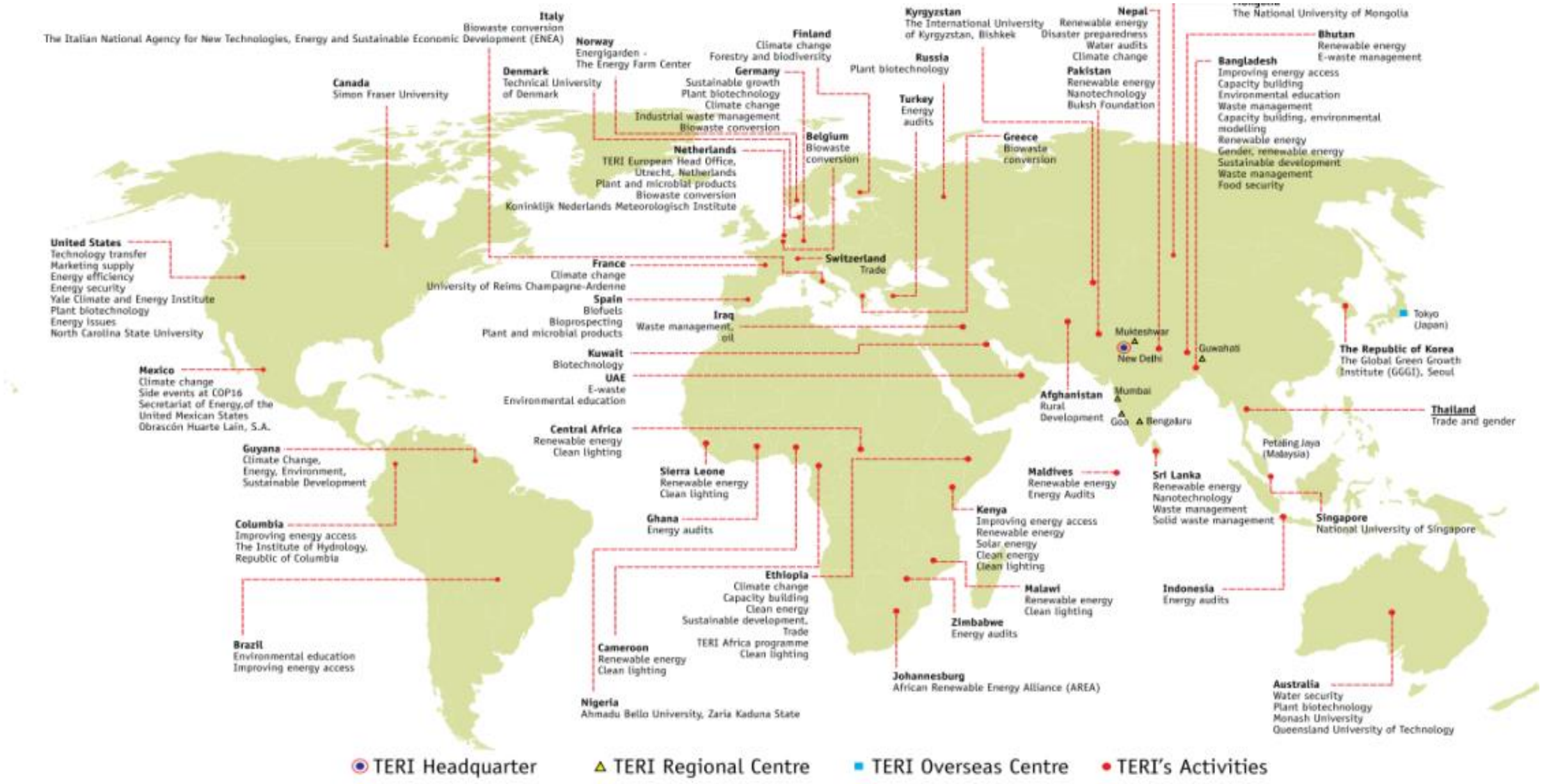
"The Energy Programme aims to accelerate the adoption of energy-efficient and renewable energy-based technological solutions across both demand and supply sides of the energy system"

TERI's Modelling Expertise

National-level electricity sector modelling for 2030, 2050, 2070 (ongoing); Software like TIMES/ MARKEL, PLEXOS, POWERFACTORY etc.

https://www.teriin.org/energy

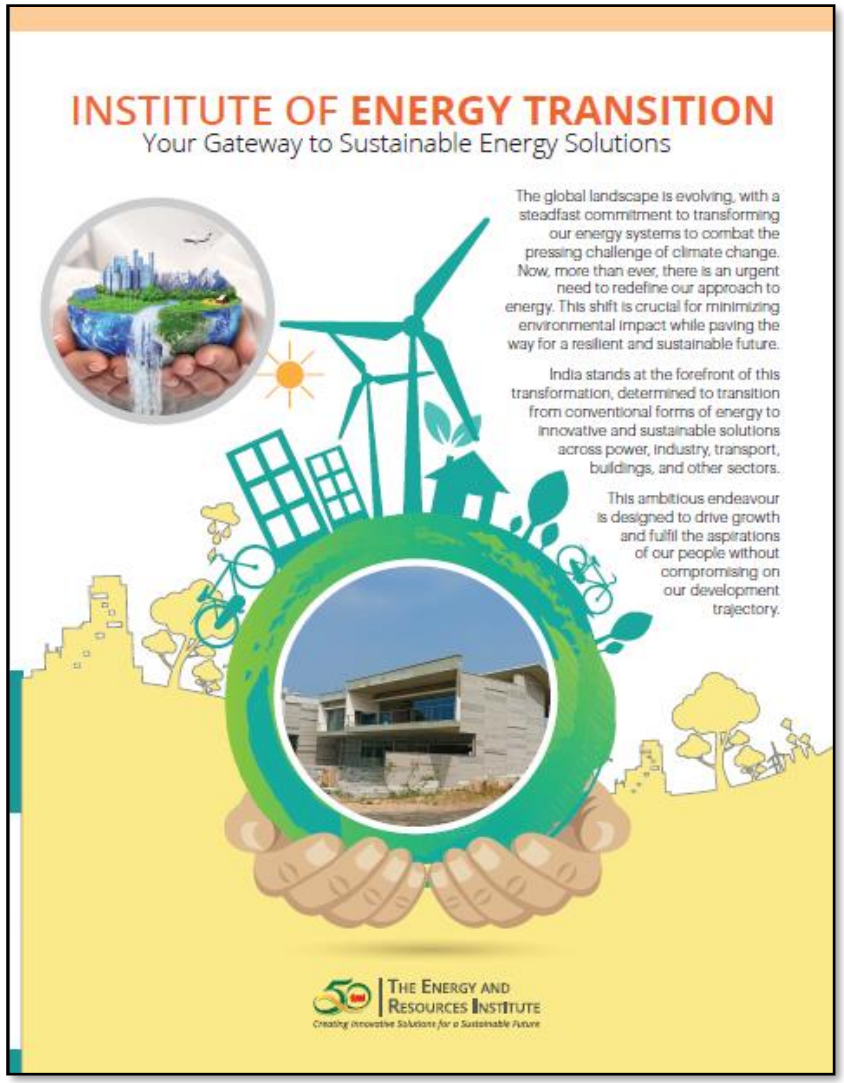
Research and outreach activities in over 50 countries

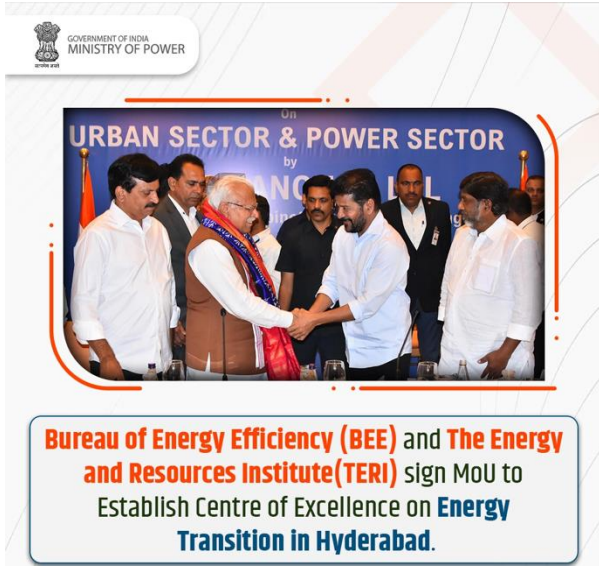


https://www.teriin.org/

TERI's Institute of Energy Transition (IoET)

BUREAU OF ENERGY EFFICIENCY
Government of India, Ministry of Power





Ministry of Power @MinOfPo... · 1d
Replying to @MinOfPower
The CoEET will be housed at TERI's Institute of Energy Transition (IoET) at its campus in Hyderabad.
1 2 5 84

Ministry of Power @MinOfPo... · 1d
The MoU signing ceremony took place at Hyderabad, in the esteemed presence of Shri @mlkhattar , Union Minister of Power and Housing & Urban Affairs, and Shri @revanth_anumula , Chief Minister of Telangana.
4 2 6 664

Ministry of Power @MinOfPo... · 1d
Senior officials from the Ministry of Power, BEE, TERI, and the Government of Telangana were also in attendance.

https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=2095900&reg=3&lang=2

India’s Energy Transition – Scale & Speed

539 GW

Total installed capacity (2026)

51%

Non-fossil share of installed capacity

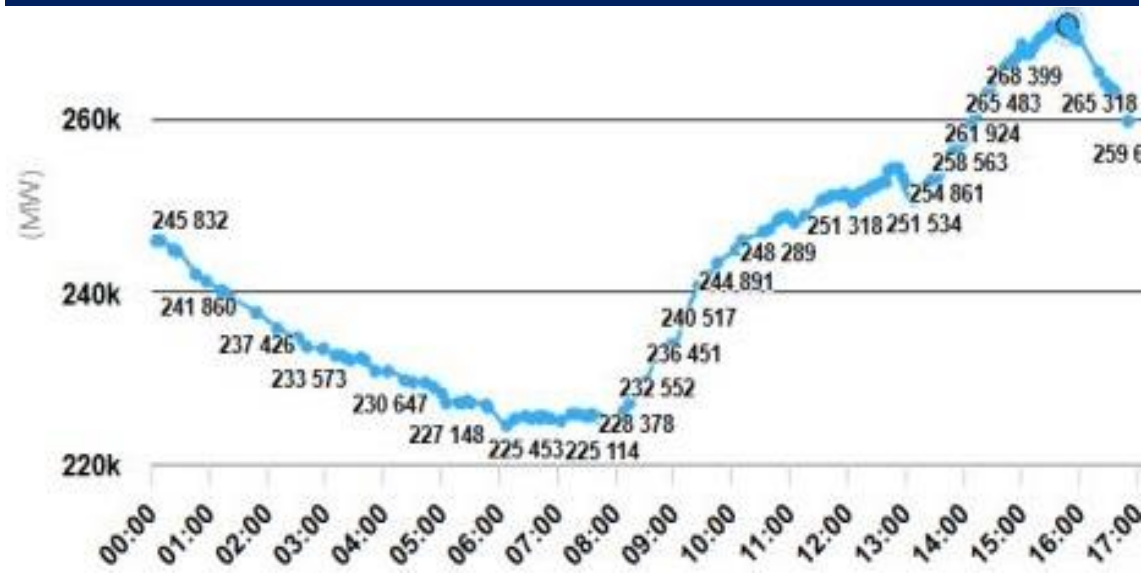
55.3 GW

RE capacity added in FY2025–26

$350 B

Investment needed to reach 500 GW

Maximum All India Demand Met on 21 May’26 (Thursday) at 15:47



Accelerating Demand and Changing Supply Mix

- **Peak demand rose 68%**

  148 GW → 250 GW

- **New peak demand met**

  ~270 GW on 21 May 2026

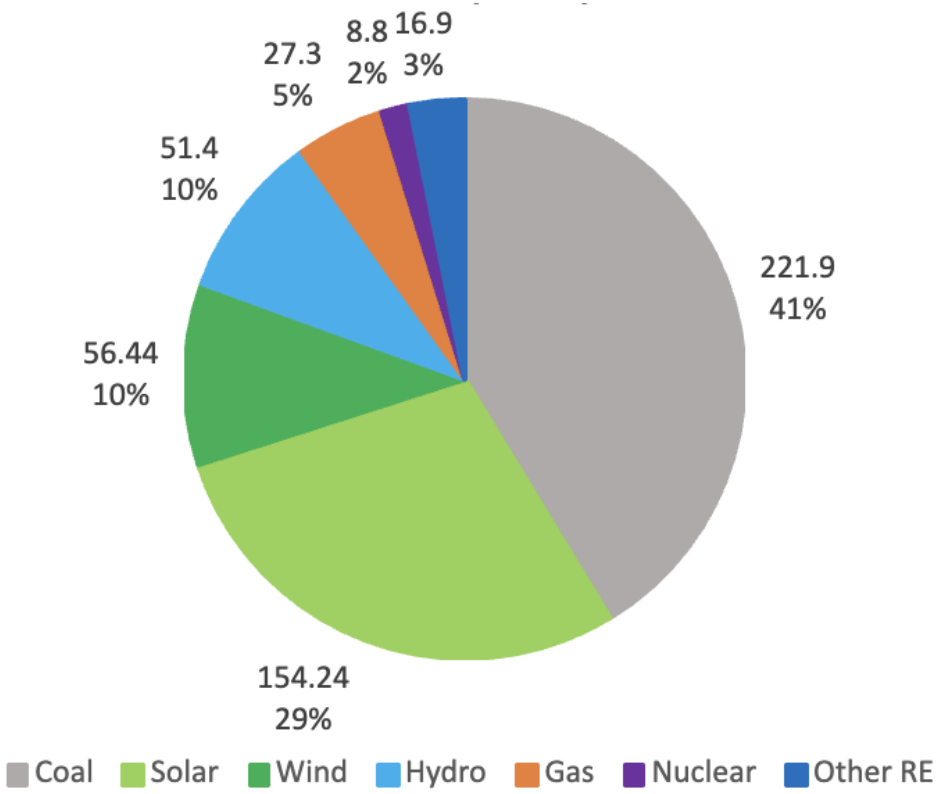
- **Supply mix**

  Thermal 62.8% | Solar 22.0% | Hydro 5.8% | Wind 5.0%

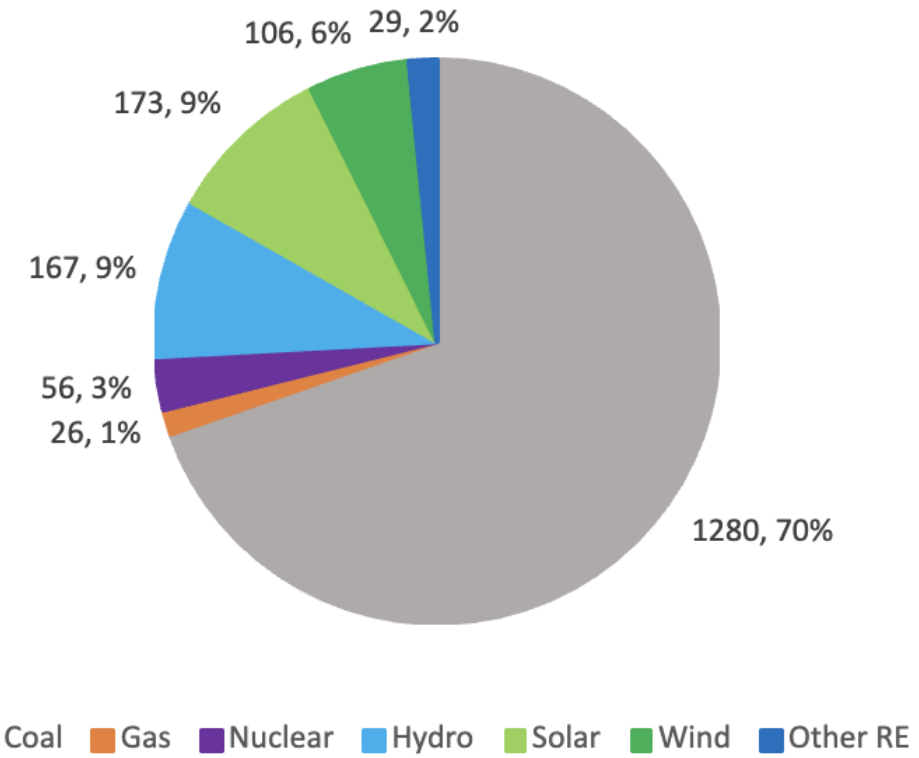
- **Renewables are reshaping daytime generation**

Power Supply Position of India

Installed Capacity (In GW)



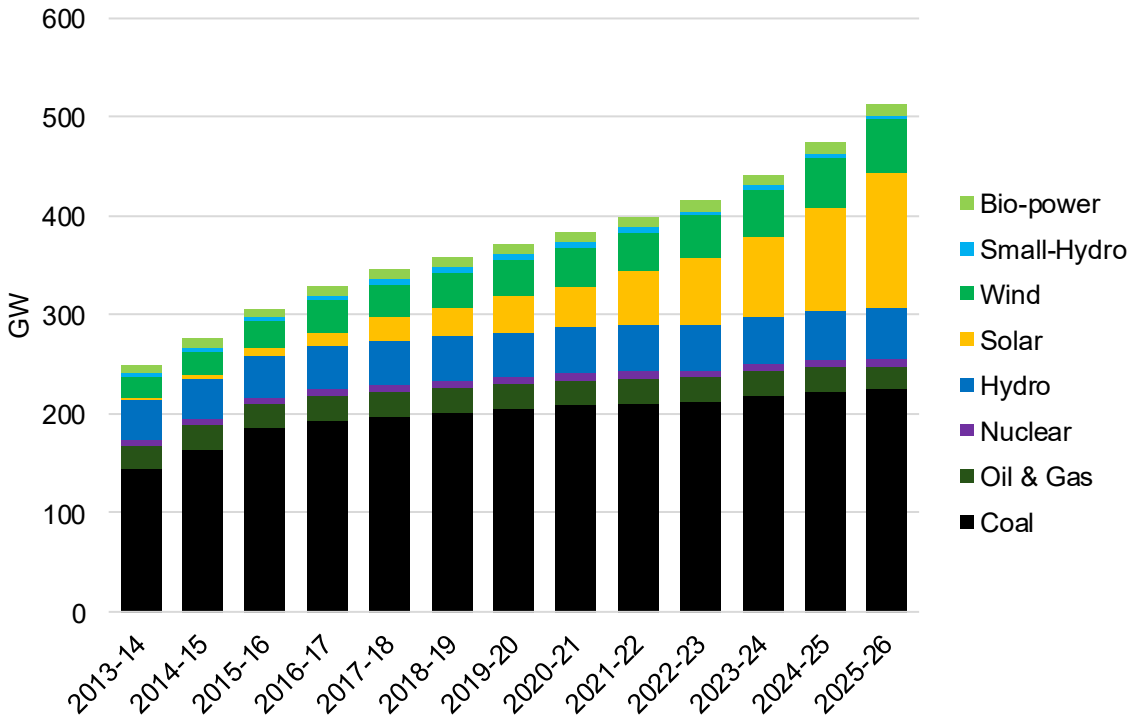
Generation Mix (In BU)



India Climate & Energy Dashboard (March. 2026)

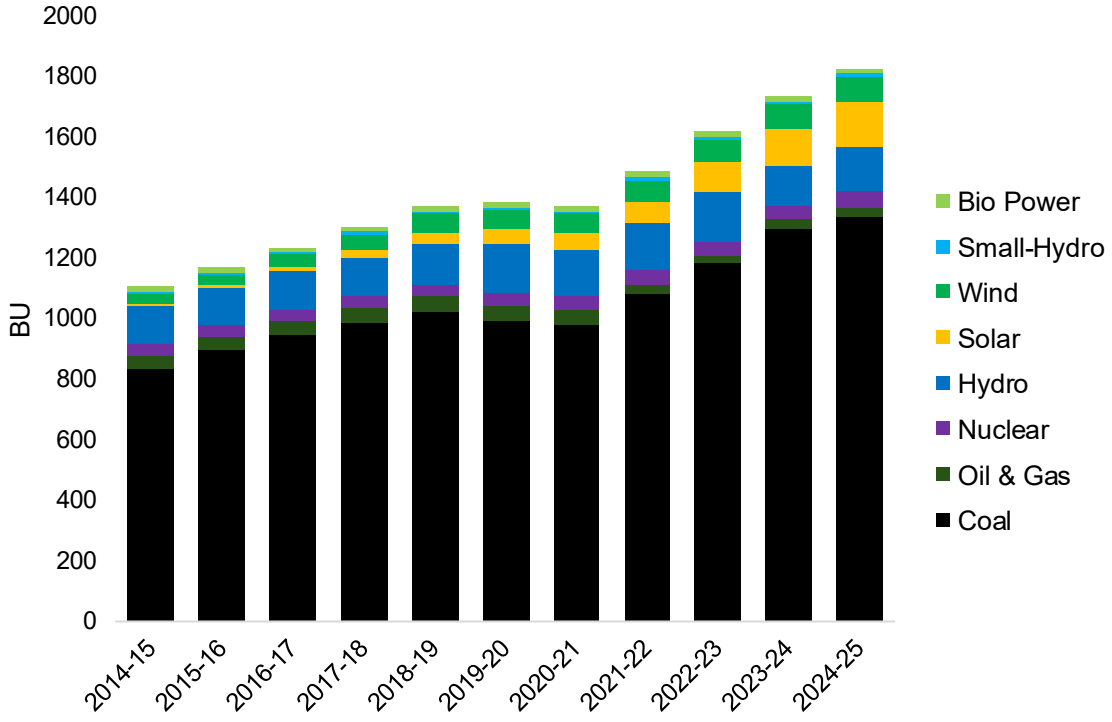
Power Supply Position of India

Installed Capacity Trend (In GW)



1. Solar Revolution: 2.82 GW → 135.81 GW (47x scale-up)
2. Wind: 21.04 GW → 54.51 GW (2X — with room to run)
3. Coal: Losing Share From 145.27 GW → 226.23 GW (1.5X)

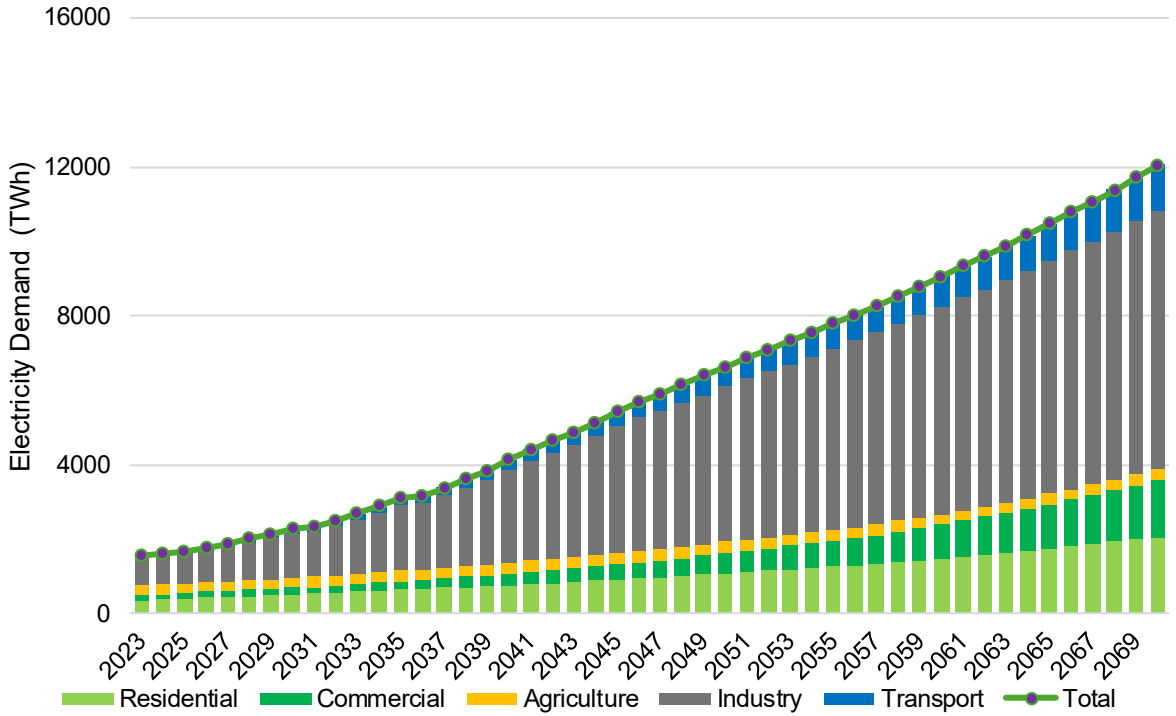
Generation Mix Trend (In BU)



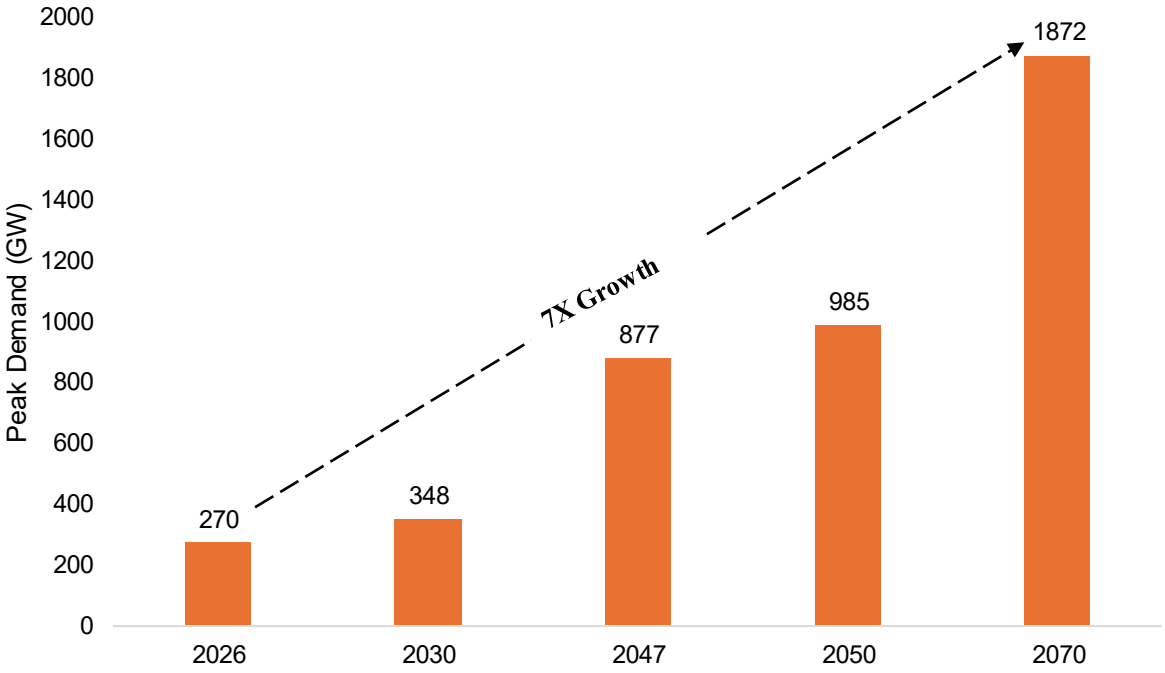
1. Solar: 5 BU → 144 BU (+3,034% generation growth)
2. Wind: 34 BU → 88 BU (+147% generation growth)
3. Coal: 835 BU → 1332 BU (+60% generation growths)

India's Electricity Consumption Projections for 2070

Electricity Consumption Growth by Sector



Peak Demand Growth



Sectoral Outlook

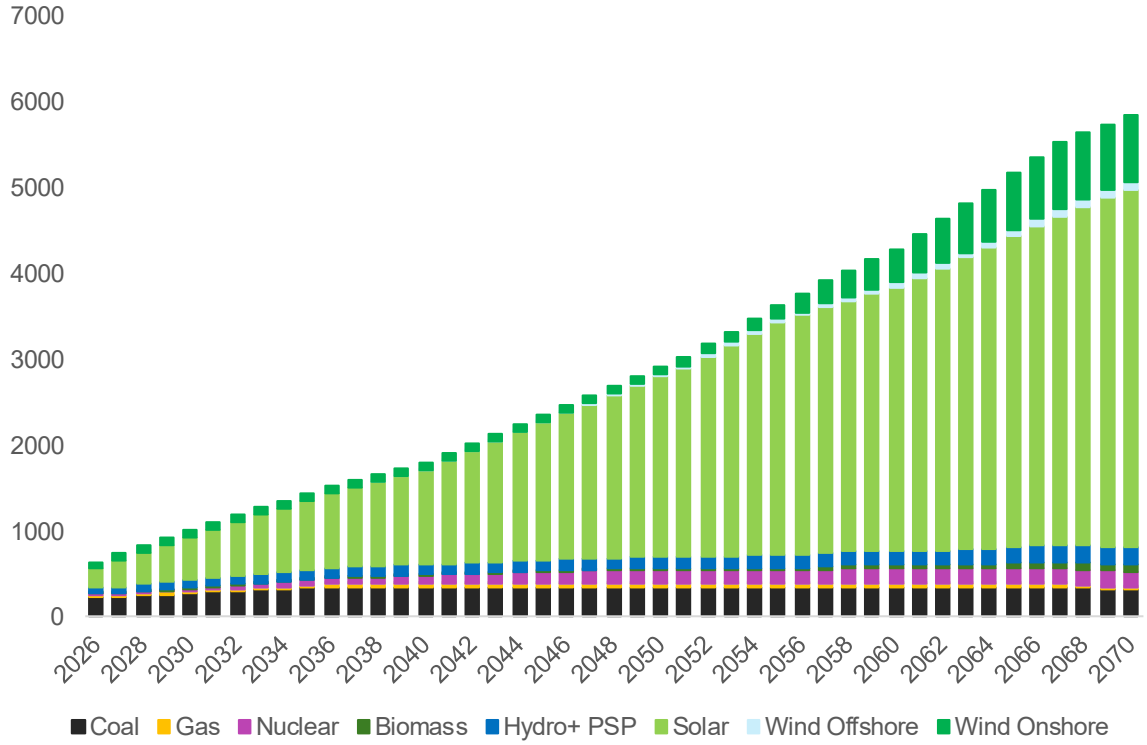
1. **10X demand by 2070** driven by economic growth and electrification
2. **Industry remains dominant**, contributing ~50% of total demand
3. **Commercial demand grows fastest**, driven by urbanization and services expansion
4. **Transport electrification accelerates**, becoming a major demand source

Peak Demand Outlook

1. Peak demand grows 7X by 2070
2. Crosses 1000 GW by 2050
3. Reaches almost 1900 GW by 2070
4. Flexibility and storage become critical for system adequacy

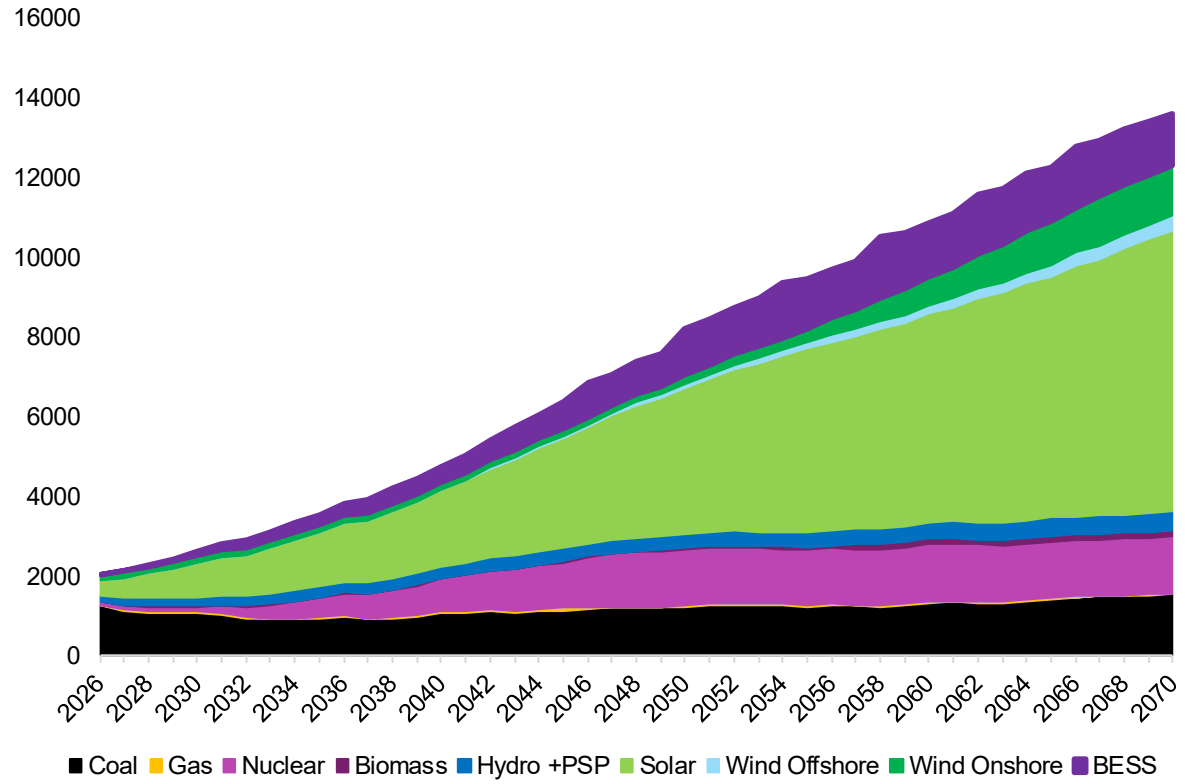
India’s Electricity Capacity & Generation Projections for 2070

Projected Installed Capacity



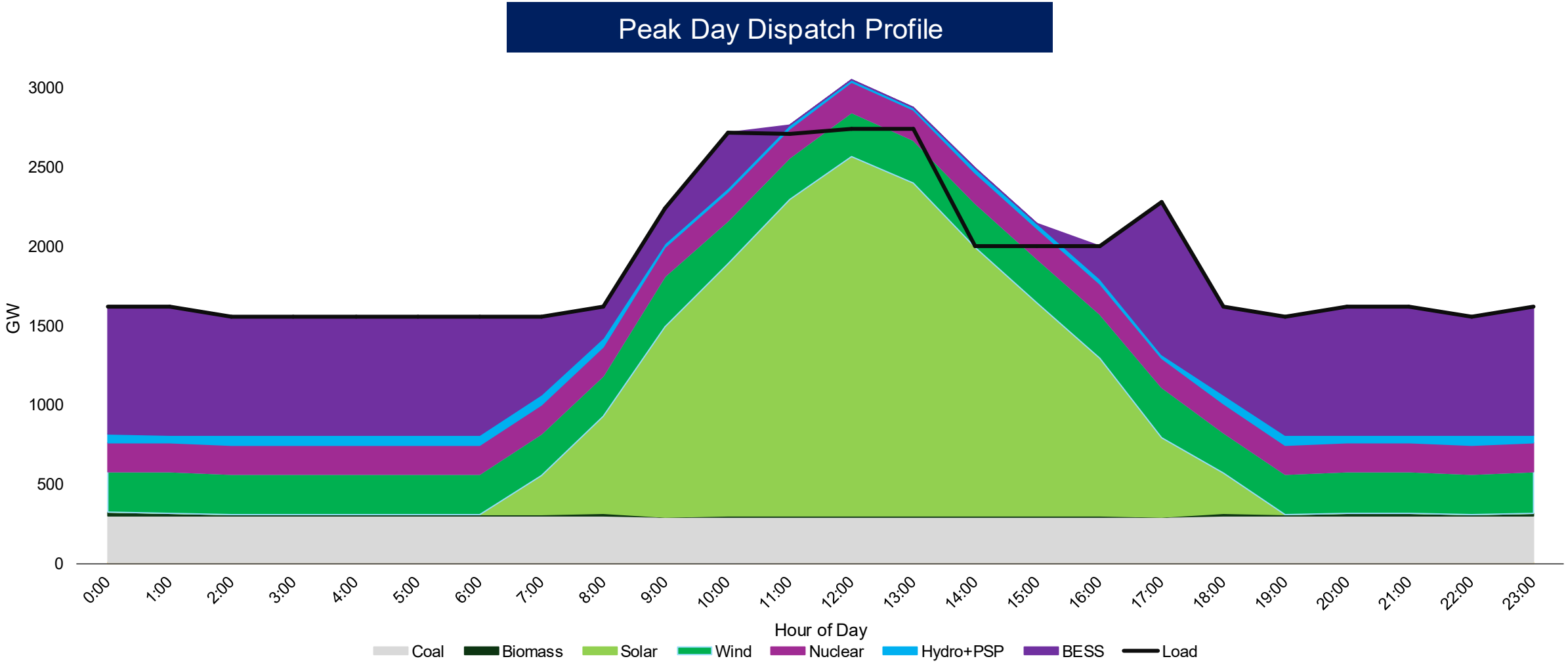
1. 15× Expansion by 2070 from 2026 levels
2. Solar dominates: Grows from 150 GW in 2025 to 4,170 GW in 2070
3. BESS scales rapidly: Reaches 3,150 GW and becomes central to system flexibility
4. Coal peaks early: Capacity declines gradually as renewables expand

Projected Generation Mix (TWh)



1. Solar acts as primary energy source by mid-century
2. Coal transitions to residual role: Share declines steadily through 2050 and beyond
3. Firm low-carbon generation strengthens: Nuclear & Hydro support reliability
4. High-RE system enabled by storage & wind to balance variability and maintain stability

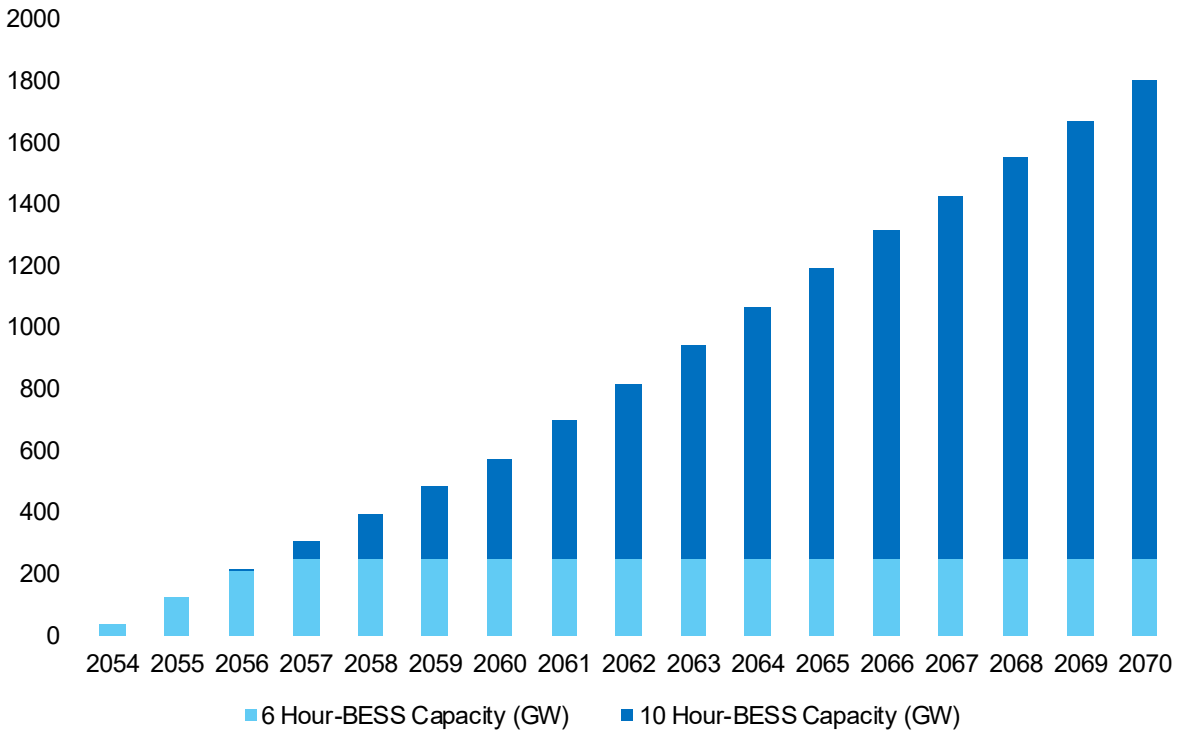
Peak Load Day Dispatch (May 2070)



1. Peak load reaches approximately 2,750 GW around 12:00–13:00.
2. Solar dominates: Solar contributes 1,900–2,000 GW during the midday hours, accounting for nearly 70% of total generation.
3. Coal and nuclear plants operate largely as firm baseload resources, providing system reliability and grid stability throughout the day.
4. Wind and hydropower complement solar generation and help manage variability.
5. BESS discharge exceeds 300 GW during evening and night hours.

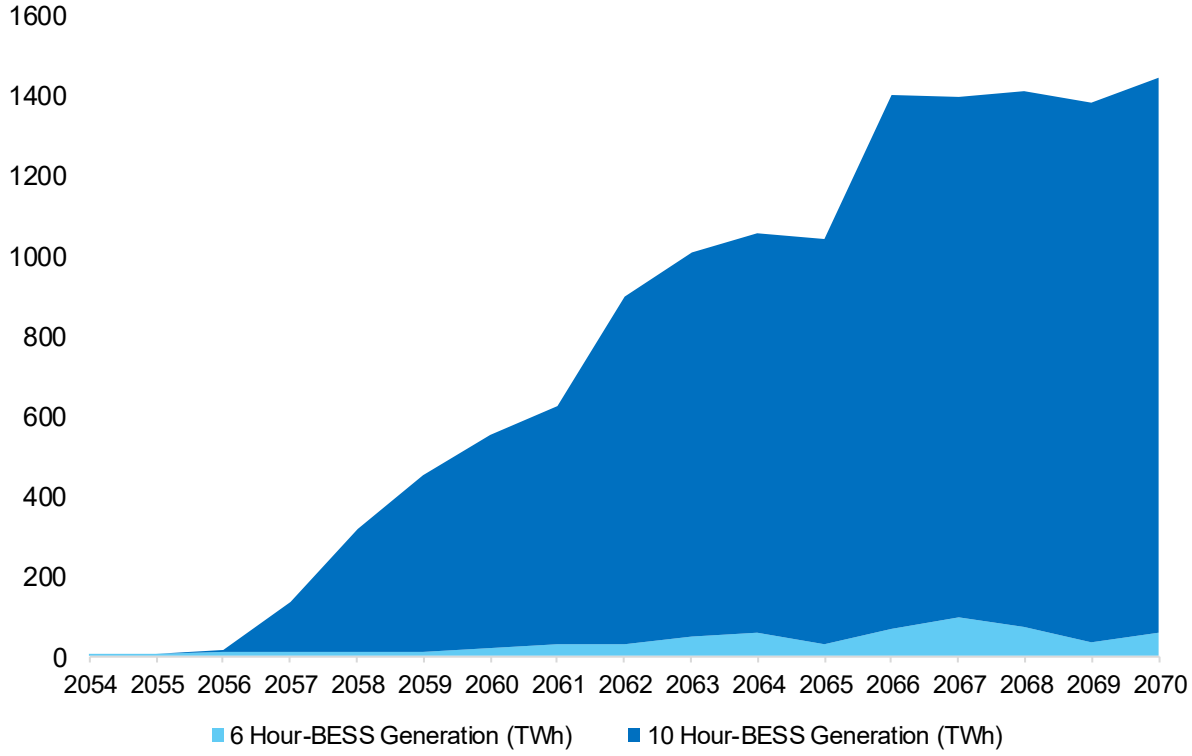
2070 LDES Capacity and Generation Mix

LDES Installed Capacity



1. **Significant scale-up of LDES:** Installed capacity increases from 50 GW in 2054 to over 1,800 GW by 2070
2. **10-hour BESS drives growth:** Around 85% of total storage capacity by 2070 is contributed by 10-hour systems, indicating a shift towards longer-duration flexibility

LDES Generation Mix

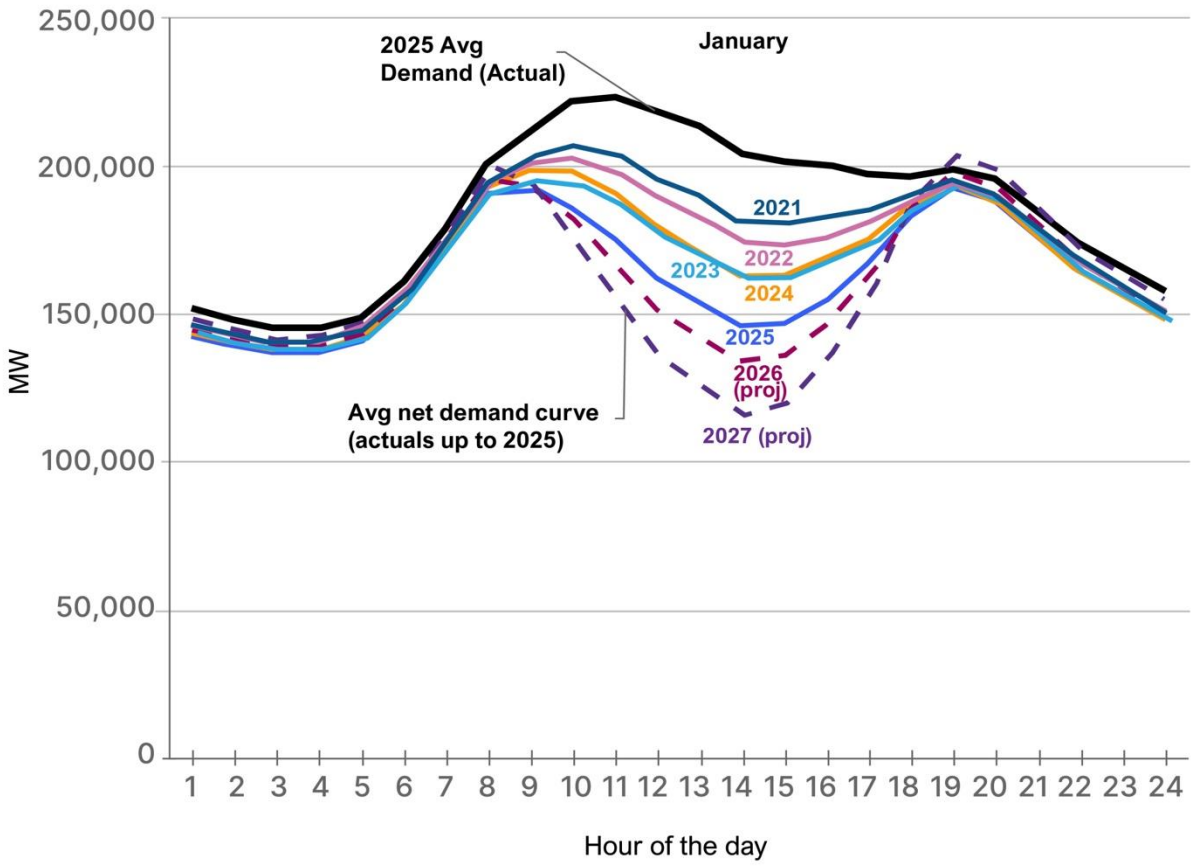


1. **Storage generation expands rapidly:** Annual LDES generation rises from negligible levels to over 1,400 TWh by 2070
2. **10-hour BESS dominates output:** More than 90% of storage generation is supplied by 10-hour systems, highlighting their central role in renewable energy balancing.

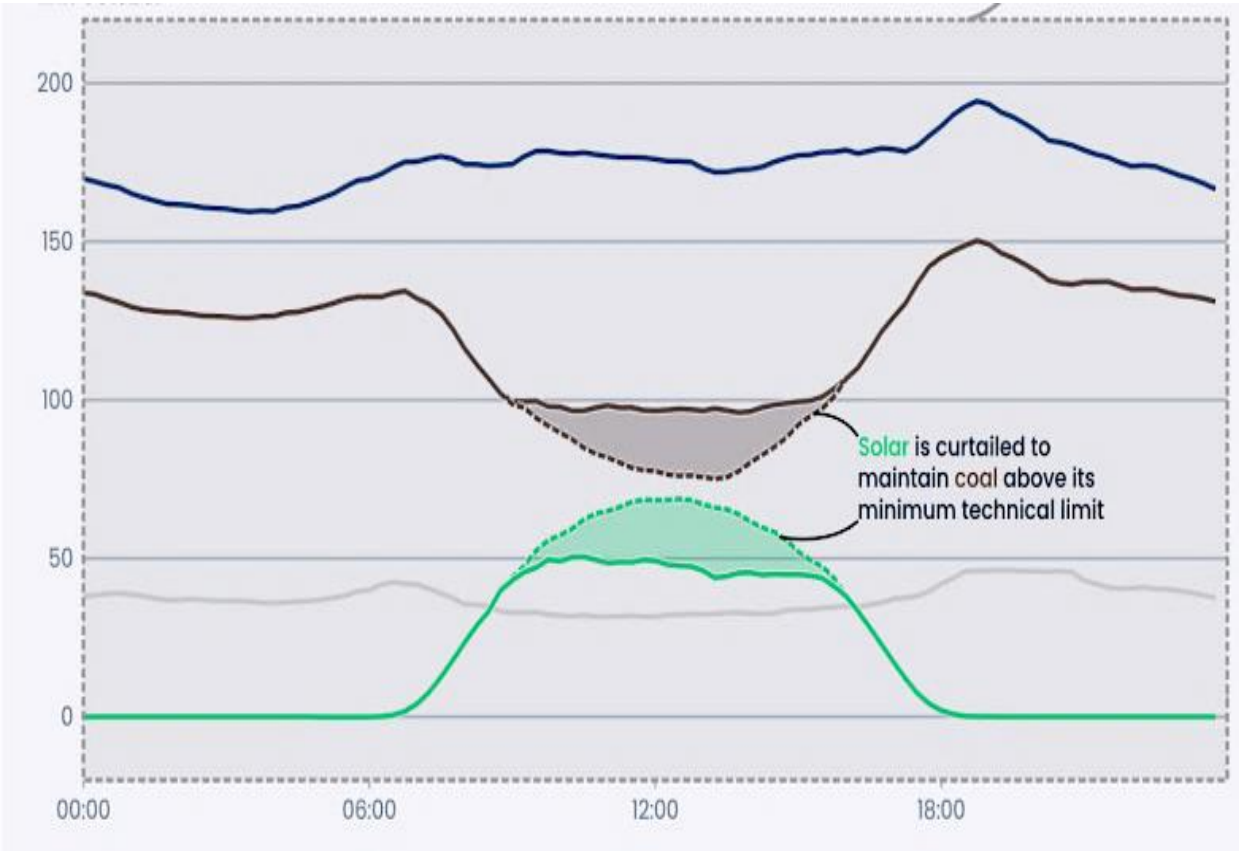
"Storage portfolio progressively shifts towards 10-hour BESS, reflecting growing requirements for deep energy shifting and system flexibility"

Storage Imperative | RE Curtailment

Widening Belly of Load Curve



Midday solar curtailed to keep coal online for evening ramp (12 Oct 2025)

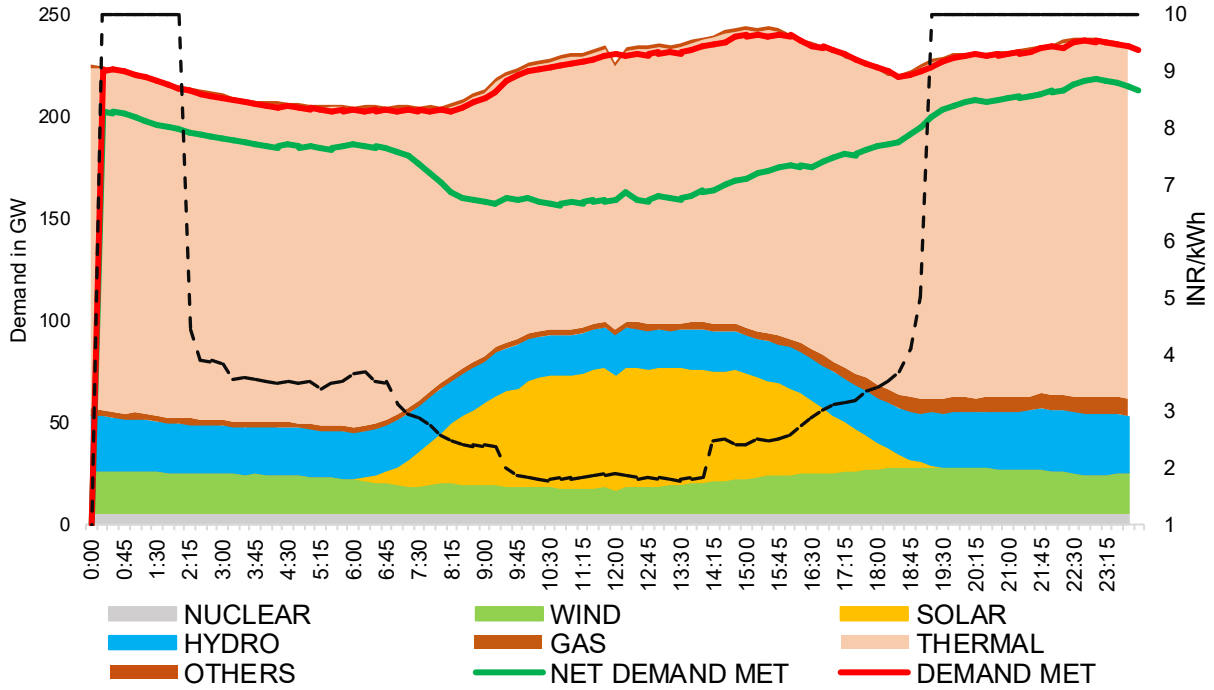


"India curtailed 2,300 GWh of Solar in 2025"

India's deepening duck curves, Prof Nikit Abhyankar, EMBER

Storage Imperative | Grid Balancing

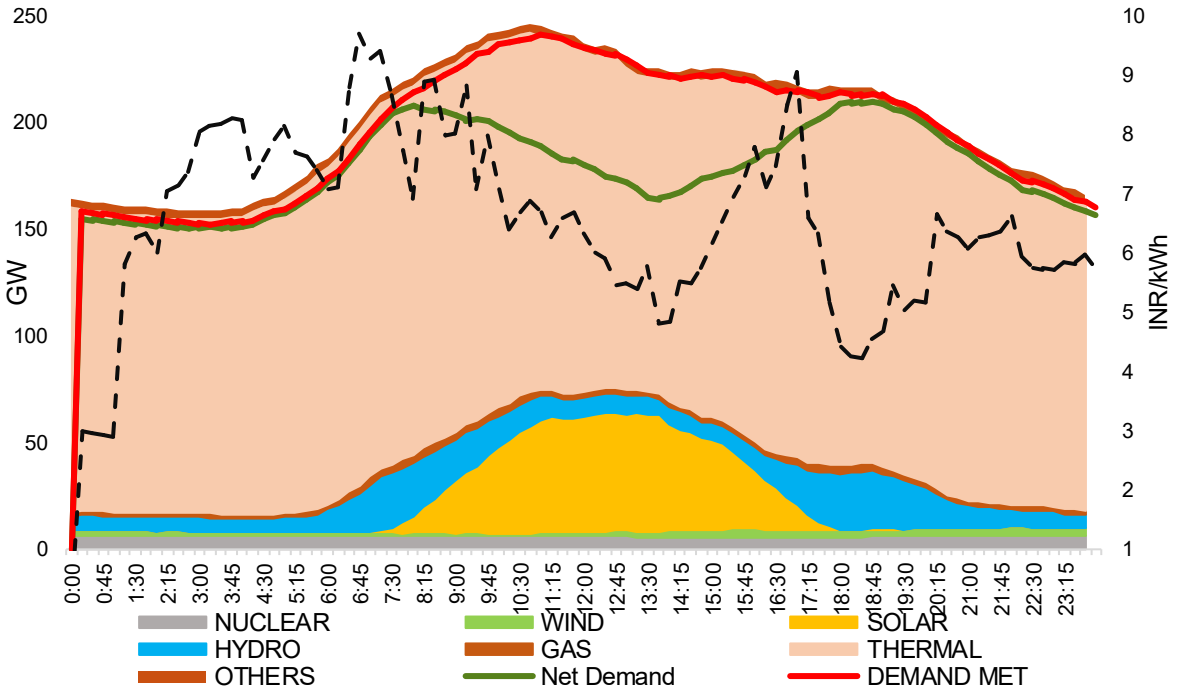
All India Generation (9 June 2025)



	Demand	Time	Net Demand	Nuclear	Thermal	Gas	Hydro	Wind	Solar	% RE
Peak (solar hrs)	240	15:30 PM	175	5	149	4	19	19	46	35%
Peak (non-solar hrs)	238	22:30 PM	217	5	174	8	30	20	0	21%

Demand & Generation are in GW. Time is in hh:mm, solar hrs:0600-1800 and non-solar hrs:0000-0600 & 1800-2400

All India Generation (31 Dec 2025)



	Demand	Time	Net Demand	Nuclear	Thermal	Gas	Hydro	Wind	Solar	% RE
Peak (solar hrs)	241	10:45 AM	189	6	169	4	12	1	50	26.54%
Peak (non-solar hrs)	213	18:30 PM	210	5	173	4	27	3	0	14.30%

Demand & Generation are in GW. Time is in hh:mm, solar hrs:0600-1800 and non-solar hrs:0000-0600 & 1800-2400

"Low RE-generation periods tighten RA margins, necessitating availability of adequate firm capacity and reserves"

Sources: Grid-India and IEX

India’s Energy Storage Landscape

4.8 GWh

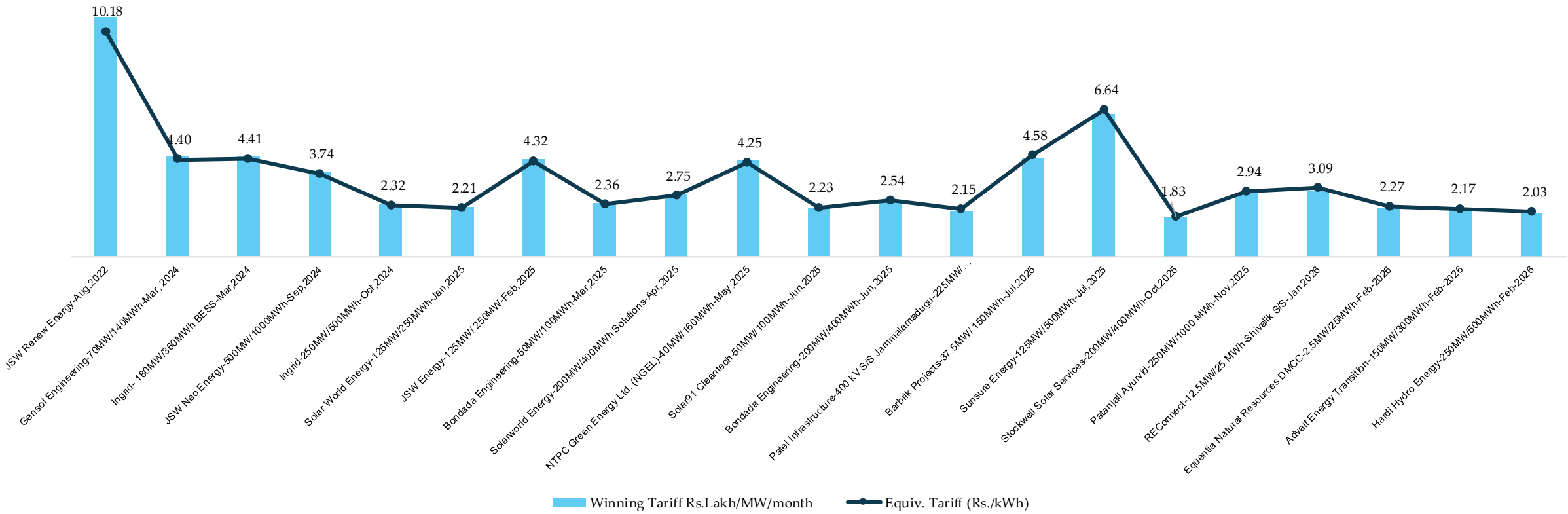
Operational BESS Capacity

3 GWh

BESS Capacity by Dec’26

7.4 GW

Operational PSP Capacity



“India’s energy storage landscape is rapidly scaling, driven by growing BESS/PSP capacity and increasingly competitive storage tariffs”

India’s Energy Storage Policy Landscape

DEMAND-SIDE & MARKET DEVELOPMENT

COST RELIEF

ISTS charge waiver for co-located BESS

Transmission charges waived for projects commissioned up to June 2028.

ANCILLARY SERVICES

CERC: BESS in secondary & tertiary reserves

Storage-based resources enabled to support real-time grid balancing. **Jan 2022**

PROCUREMENT

TBCB guidelines for BESS by DISCOMs

Tariff-based competitive bidding for large-scale storage procurement. **Mar 2022**

CONSUMER MANDATE

DG sets to shift to clean backup solutions

Electricity (Rights of Consumers) Rules amended to include ESS. **Dec 2022**

MARKET ACCESS

BESS participation in HP Day-Ahead Market

BESS responds to peak price signals similar to gas-based generation. **Mar 2023**

VGF SUPPORT

Two VGF schemes for ~43 GWh BESS

Viability gap funding to accelerate early-stage BESS deployment. **Jun 2025**

SUPPLY-SIDE & MANUFACTURING

MANUFACTURING PLI

₹18,100 Cr PLI for 50 GWh ACC cell manufacturing

Ministry of Heavy Industries scheme; 10 GWh earmarked for grid-scale storage.

GRID CONNECTIVITY

CERC: separate grid connectivity in non-solar hours

Enables additional RE capacity; facilitates storage-based power shifting to evening/night.

OWNERSHIP MODELS

ESS ownership expanded to consumers

Electricity Rules amended Sept 2025: storage can be developed, owned, leased or operated by consumers. **Sep 2025**

CO-LOCATION ADVISORY

CEA advisory: ≥10% storage with solar projects

February 2025: storage capacity of at least 10% of solar for minimum 2 hours to improve dispatchability. **Feb 2025**

“Policy momentum across demand creation and manufacturing support is positioning energy storage as a core enabler of India’s clean power transition”

TERI's Contributions to Advancing Energy Storage Solution

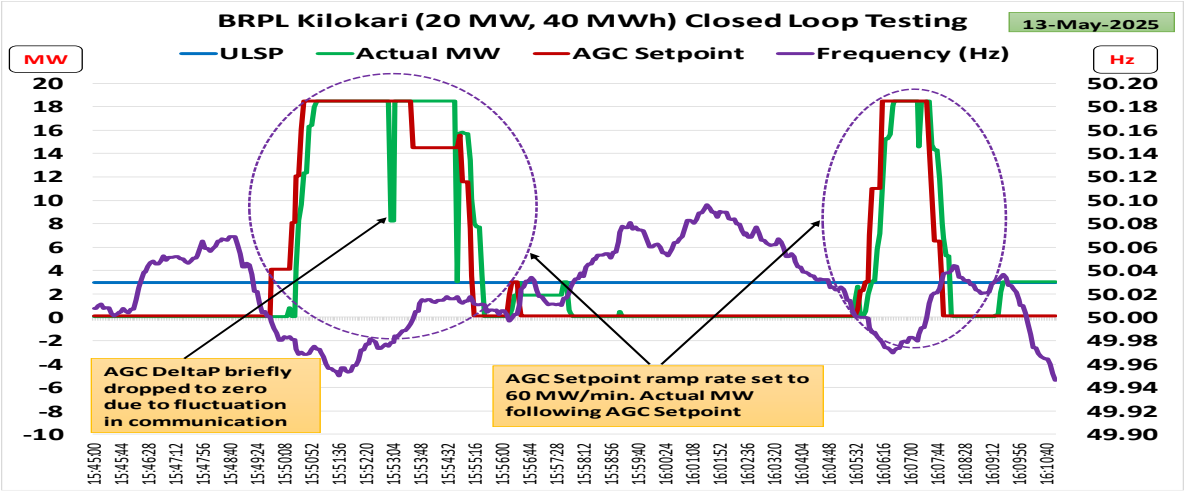
BRPL, NCT of Delhi | Kilokari BESS 20MW/ 40MWh

Project Details

- Developer: Kilokari BESS Pvt. Ltd. — a consortium of IndiGrid Ltd. and Ampere-hour Solar Technology Pvt. Ltd.
- Concessional Funding: 70% concessional debt support from GEAPP
- Business Model: Build–Own–Operate–Transfer (BOOT)Concession Tenure: 12 years
- Cycling Requirement: 8,760 cycles over the concession period, equivalent to 2 cycles/day
- Revenue / Value Stacking Opportunities: Reactive power support, blackout support, energy arbitrage, isolated SRAS, and bidirectional SRAS

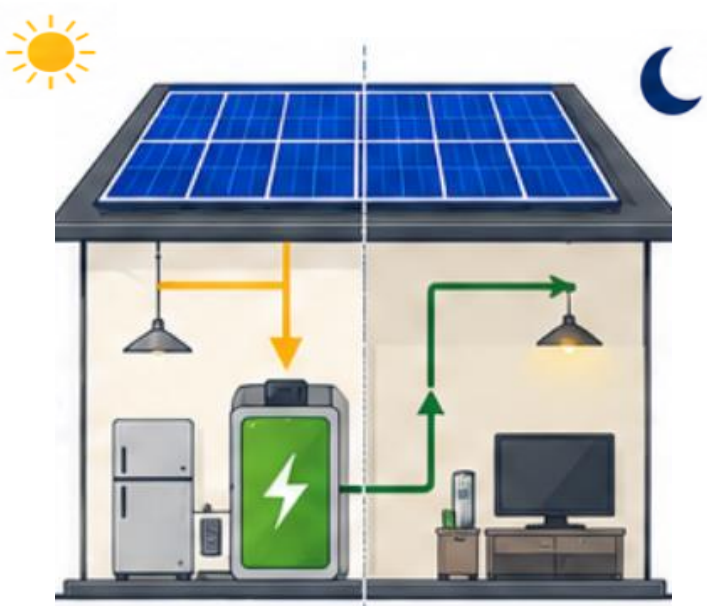
Key Highlights

Month	Average Availability	Round Trip Efficiency	Number of Cycles	Auxiliary Power %	Charging MU's	Discharging MU's	Weighted Average Rate based on DAM (Rs/Unit) Charging	Discharging
Apr-25	86.70%	88.90%	41.8	4.90%	1.88	1.67	2.8	8.27
May-25	94.90%	89.20%	31.7	5.60%	1.42	1.27	1.46	8.69
Jun-25	98.00%	89.20%	31.1	5.80%	1.39	1.24	1.51	8.38
Jul-25	95.40%	89.00%	40.1	4.88%	1.8	1.6	2.37	7.88
Total/Average	**93.80%**	**89.10%**	**36.2**	**5.30%**	**6.49**	**5.78**	**2.04**	**8.31**



"Largest in South Asia – Grid Connected (Dist.) & India's First Commercially Approved BESS Project"

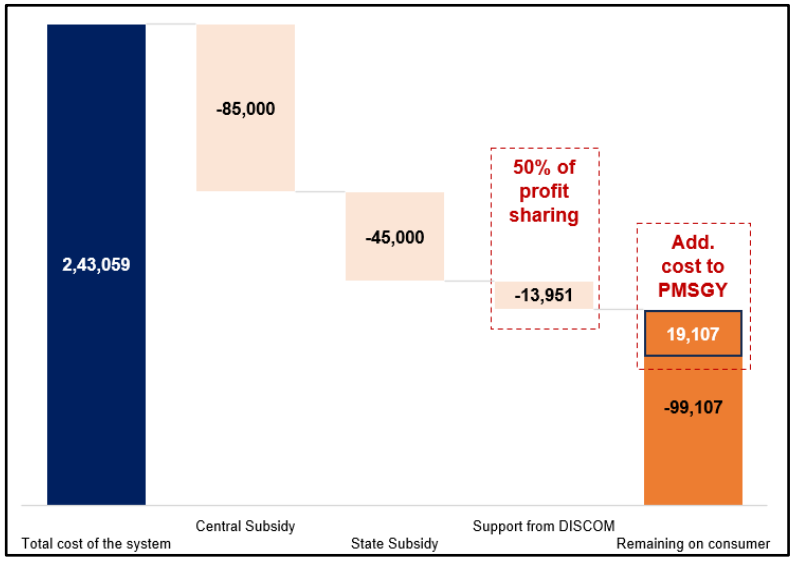
Assam & Bihar DISCOMs | BTM Storage with RTS



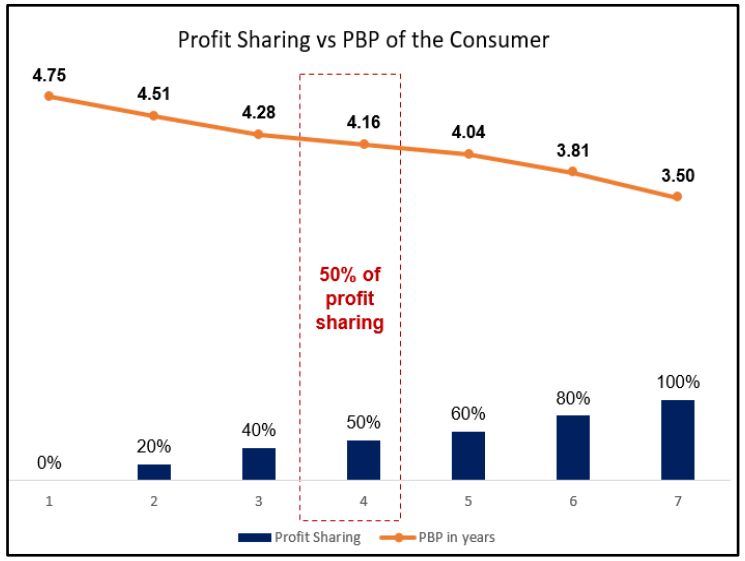
Charging BESS from excess solar

Discharge from battery during peak demand

Study Results



Net cost to a consumer (after Central, State, and DISCOM Support)

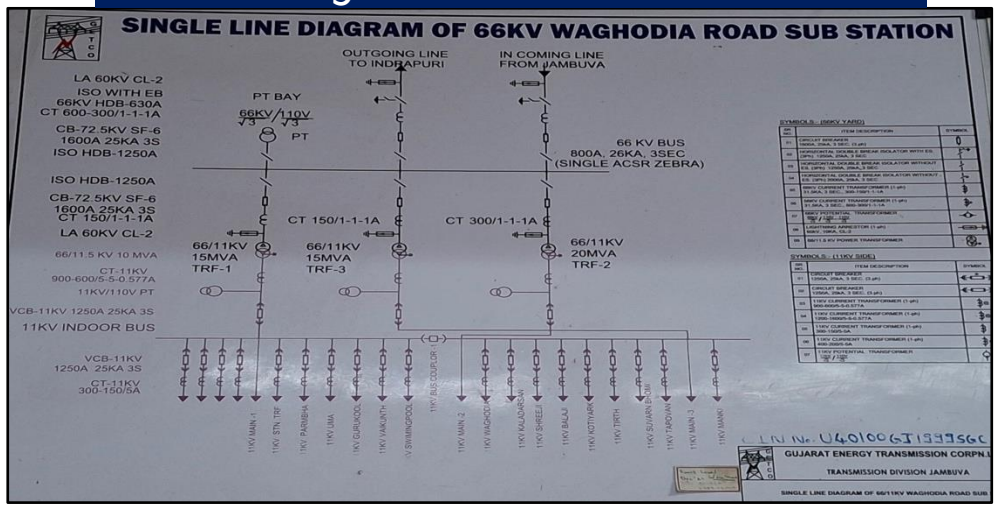


Reduced Consumer Pay Back Period Through DISCOM Benefit Sharing with consumers

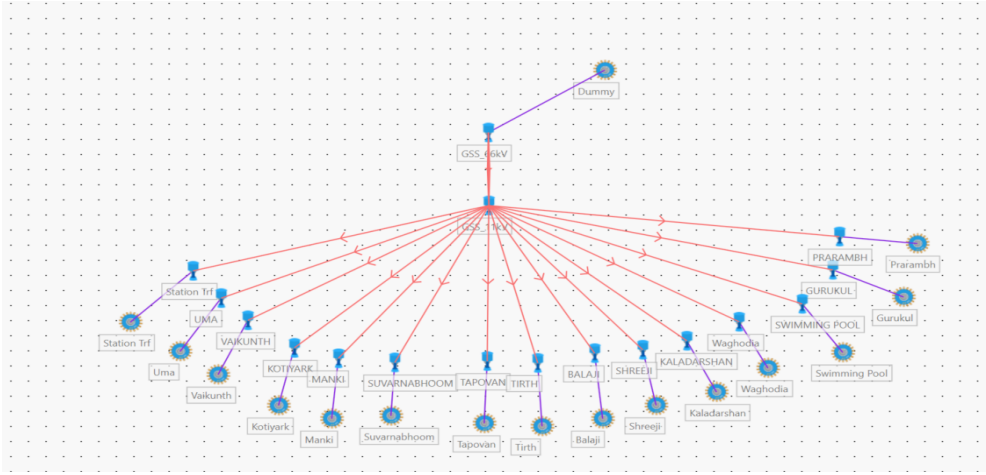
"Sharing of partial DISCOM's realized benefits can materially improve consumer economics"

GUVNL, Gujrat | Grid-Scale BESS for Reverse Power Flow Mitigation

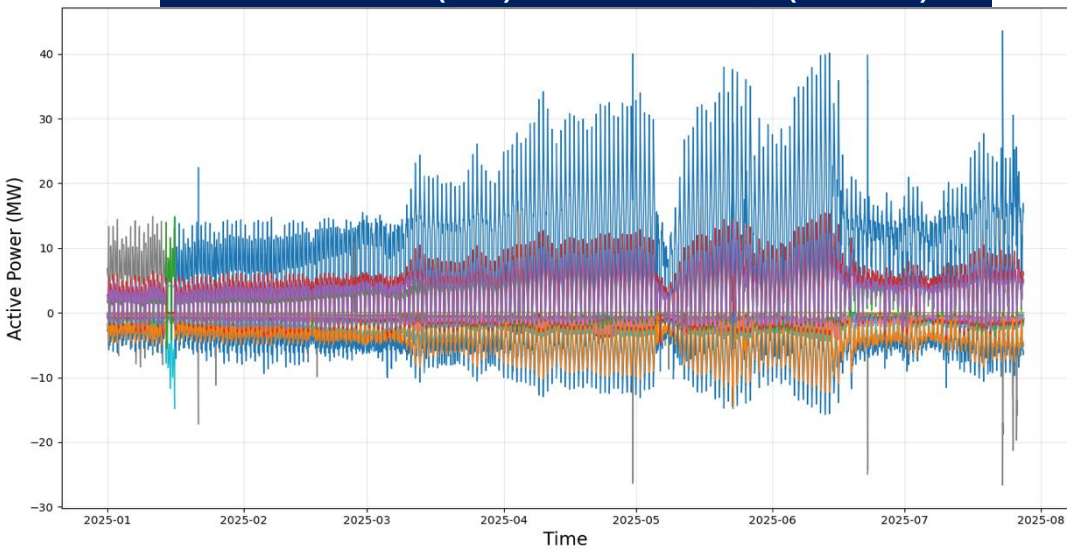
Waghodia Substation SLD



Equivalent PLEXOS Model



Active Power (MW) -11 kV Feeders (17 Nos.)



Optimal BESS Capacity for RPF Mitigation

Scenario 1

Hard Constraint Optimization
(No reverse power flow to grid)
1 MW / 2 MWh

Total Capacity
20 MW / 40 MWh

2023: 12 units | 2024: 8 units

Scenario 2

Soft Constraint Optimization
(Some reverse power may flow to grid)
1 MW / 2 MWh

Total Capacity
12 MW / 24 MWh

2023: 2 units | 2024: 1 unit | 2028: 1 unit | 2029: 3 unit | 2030: 5 unit

Scenario 3

Hard Constraint Optimization
(No reverse power flow to grid)
1 MW / 4 MWh

Total Capacity
11 MW / 44 MWh

2023: 7 units | 2024: 4 unit

Scenario 4

Soft Constraint Optimization
(Some reverse power may flow to grid)
1 MW / 4 MWh

Total Capacity
8 MW / 32 MWh

2027: 2 unit | 2028: 2 units | 2029: 2 units | 2030: 2 units

Acknowledgements

Government of India
Ministry Of Power

BUREAU OF ENERGY EFFICIENCY
Government of India, Ministry of Power

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IKI INTERNATIONAL CLIMATE INITIATIVE

GOVERNMENT OF INDIA
MINISTRY OF NEW AND RENEWABLE ENERGY

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