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India SMART UTILITY Week 2025

Session: India@100 in 2047: Vision for the Indian Power System
Presentation 17:15 - 17:30

Supporting Ministries



Generation Planning Analysis in India's Evolving Policy Landscape: A Case Study of Uttar Pradesh

Presented By

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➤ India's NDC target

- **Emissions intensity:** Reduce emissions intensity by 45% by 2030 compared to 2005
- **Non-fossil fuel energy:** Increase the share of electricity from non-fossil fuel sources to 50% by 2030
- **Carbon sink:** Plant and maintain 2.5–3 billion tons of CO₂ equivalent in forests and other vegetated areas by 2030
- **Net-zero emissions:** Achieve net-zero emissions by 2070

➤ Renewable Energy (RE) Targets

- A national target of 500 GW of RE capacity by 2030 has been set.
- Decarbonizing the power sector (which contributes 40% of India's GHG emissions) is critical to meet these goals.

➤ Uttar Pradesh - Context

- Uttar Pradesh (UP) is India's second-largest electricity consumer after Maharashtra
- As of Oct 2024, total installed capacity is 33 GW (mostly thermal coal-based power) with only 5.5 GW from renewables
- This means only 18% of UP's 32 GW renewable potential has been utilized

➤ Growing Electricity Needs

- UP's annual electricity demand was 148 BU in FY2023-24, and is projected to reach 230 BU by FY 2029-30.
- Peak demand is expected to rise from 28 GW in FY 2023-24 to 40 GW by FY 2029-30
- Meeting this surge will require substantial capacity additions, especially in clean energy.

➤ Policy Landscape

- Resource Adequacy (RA) guidelines mandate reliability standards (e.g. capping Expected Energy Not Served at 0.05%.
- India is developing a carbon market, impact of these evolving policies in UP – higher Renewable Purchase Obligations (RPOs), RA norms, and potential carbon pricing – form the backdrop for generation planning.

➤ RE Adoption Challenges

- RE growth is uneven across states – e.g. 52% of installed RE is concentrated in Rajasthan, Gujarat, Tamil Nadu, and Karnataka
- RE-deficit states like **Uttar Pradesh (UP)** lag behind in meeting RPOs
- This calls for tailored, state-level generation planning to align with national targets

➤ Policy Impacts

- The introduction of RA guidelines and a carbon credit mechanism brings new constraints (e.g. enforcing minimum reliability, internalizing carbon costs).
- These can significantly impact generation costs and operations, making long-term generation planning more complex

➤ Need for State-Specific Analysis

- UP's situation – high demand growth, low RE installed, new policy guidelines – makes it important to analyze different pathways for its power generation.
- This study addresses how UP can expand its generation capacity optimally while tackling the twin challenges of decarbonization and resource adequacy, under various carbon pricing scenarios.

Key Outcomes

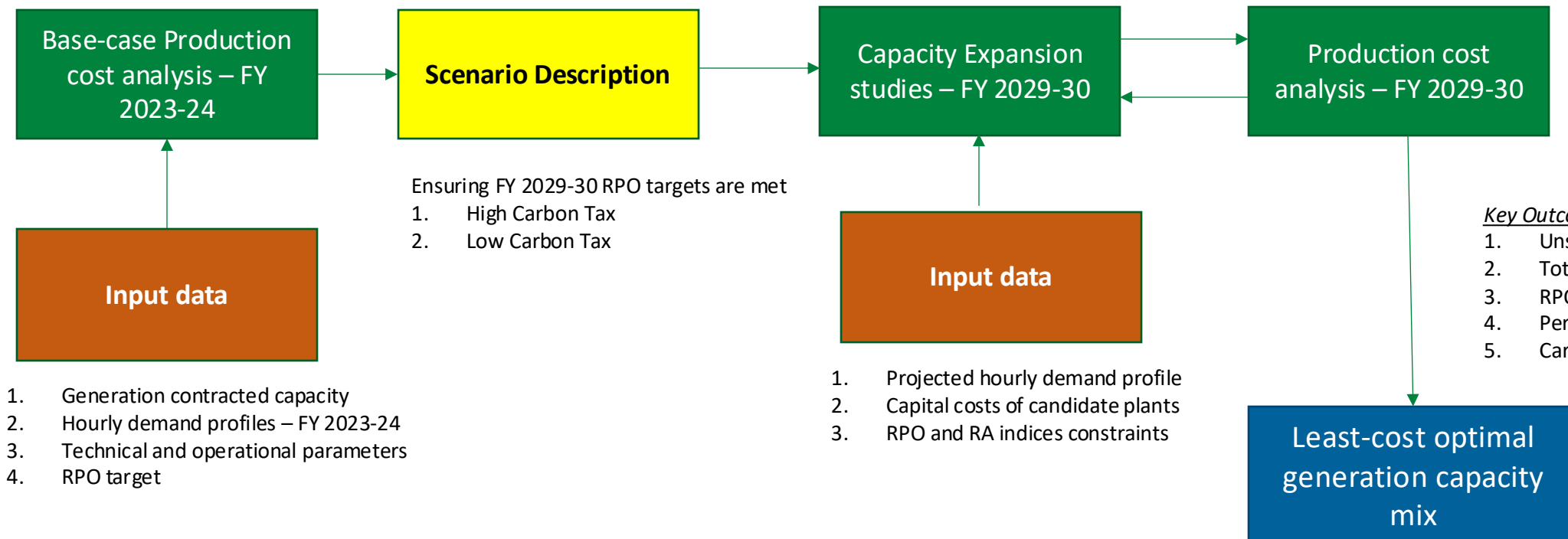
1. Unserved energy
2. Total CO₂ emissions
3. RPO target met
4. Per-unit cost of generation

Key Outcomes

1. RE and ESS capacity required
2. Investment costs

Key Outcomes for different scenarios

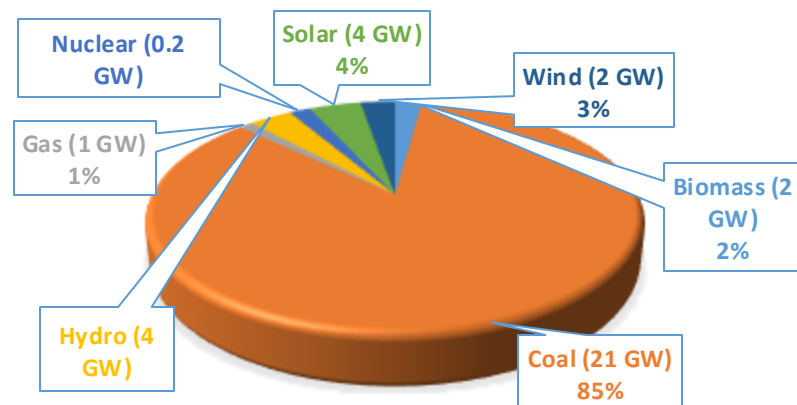
1. Unserved energy
2. Total CO₂ emissions
3. RPO target met
4. Per-unit cost of generation
5. Carbon credits calculation*



* Carbon credits are calculated based on grid emission factor number

KEY OUTCOMES – FY 2023-24 and FY 2029-30

ENERGY DELIVERED (MU) - 1,47,853

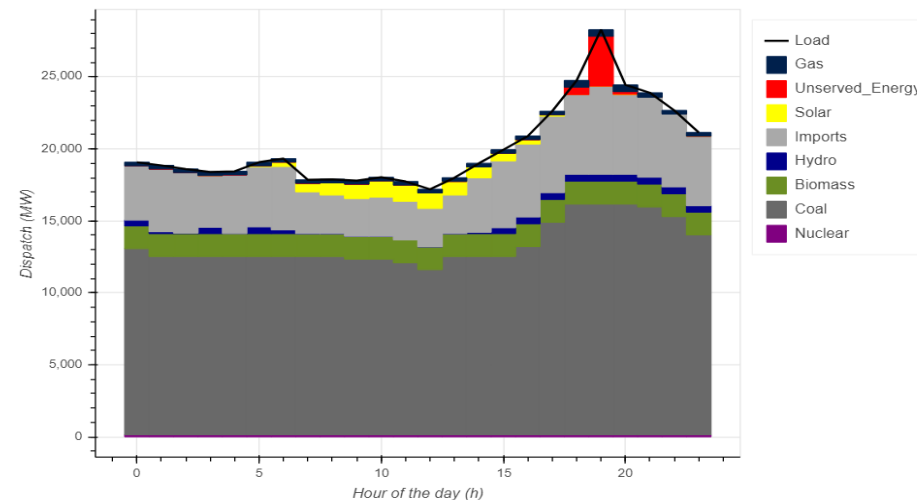


FY 2023-24

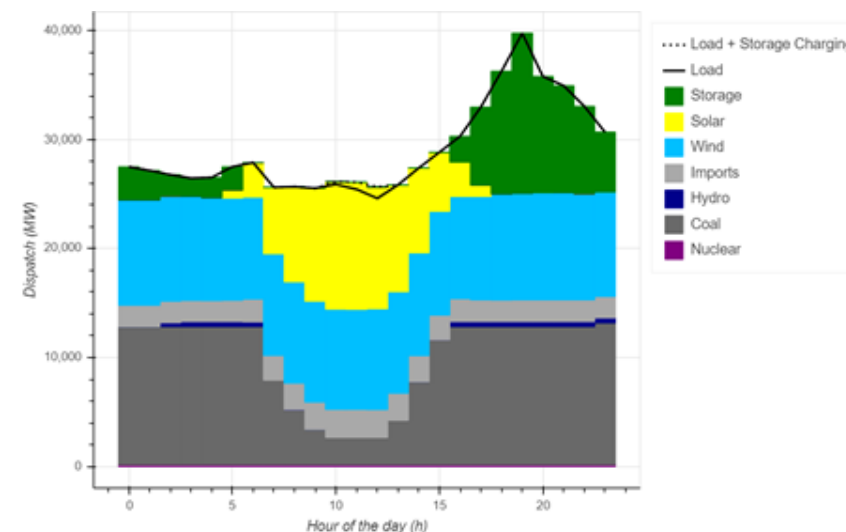
- ✓ Unserved energy – 1,497 MU
- ✓ Total CO₂ emissions – 120 million tons
- ✓ 3 % RPO Target not met
- ✓ Per-unit cost of generation – 5.10 INR/unit

FY 2029-30

Parameters	Scenario 1 (Low Carbon Tax USD 10/ton)	Scenario 2 (High Carbon Tax - USD 50/ton)
Additional RE Capacity	36.3 GW	
Energy Storage (ESS) Capacity	21.9 GW	24.5 GW
Total Installed Capacity (2030)	91 GW	94 GW
Total Energy Requirement (MU)	2,30,122	
Energy Delivered (%)	Coal: 51%, RE: 47%	Coal: 50%, RE: 50%
Surplus RE generation	9,644 MU	12,972 MU
Potential Carbon Credits	7.8 million	10.5 million
Average Cost per unit	₹ 5.23/kWh	₹ 5.25/kWh



Typical 24-hour generation dispatch plot for a peak demand day – FY 2023-24



Typical 24-hour generation dispatch plot for a peak demand day – FY 2029-30

➤ RE and ESS Expansion:

- Uttar Pradesh can achieve a ~50% RE share by FY 2029-30 with targeted investment (36 GW RE, 25 GW ESS).

➤ Emissions Reduction:

- Implementation of carbon taxes significantly reduces emissions from FY 2023-24 levels:
 - ✓ 7% reduction at a lower carbon tax (USD 10/ton)
 - ✓ 10% reduction at higher carbon tax (USD 50/ton)

➤ Financial Gains from Carbon Credits*:

- Surplus RE generation offers substantial revenue potential:
 - ✓ ₹ 649 crore under low carbon tax scenario
 - ✓ ₹ 874 crore under high carbon tax scenario

➤ Ensuring Reliability and Stability:

- RA criteria met (EENS \leq 0.05%).
- Revenues can be reinvested for grid modernization and retrofitting coal-based plants.

* Assuming a carbon credit price of USD 10 per credit

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THANK YOU

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[Links/References \(If any\)](#)