

Power System Operations

| Availability Based Tariff

| Electricity Markets

Electricity as a Commodity and Indian Power Market Framework

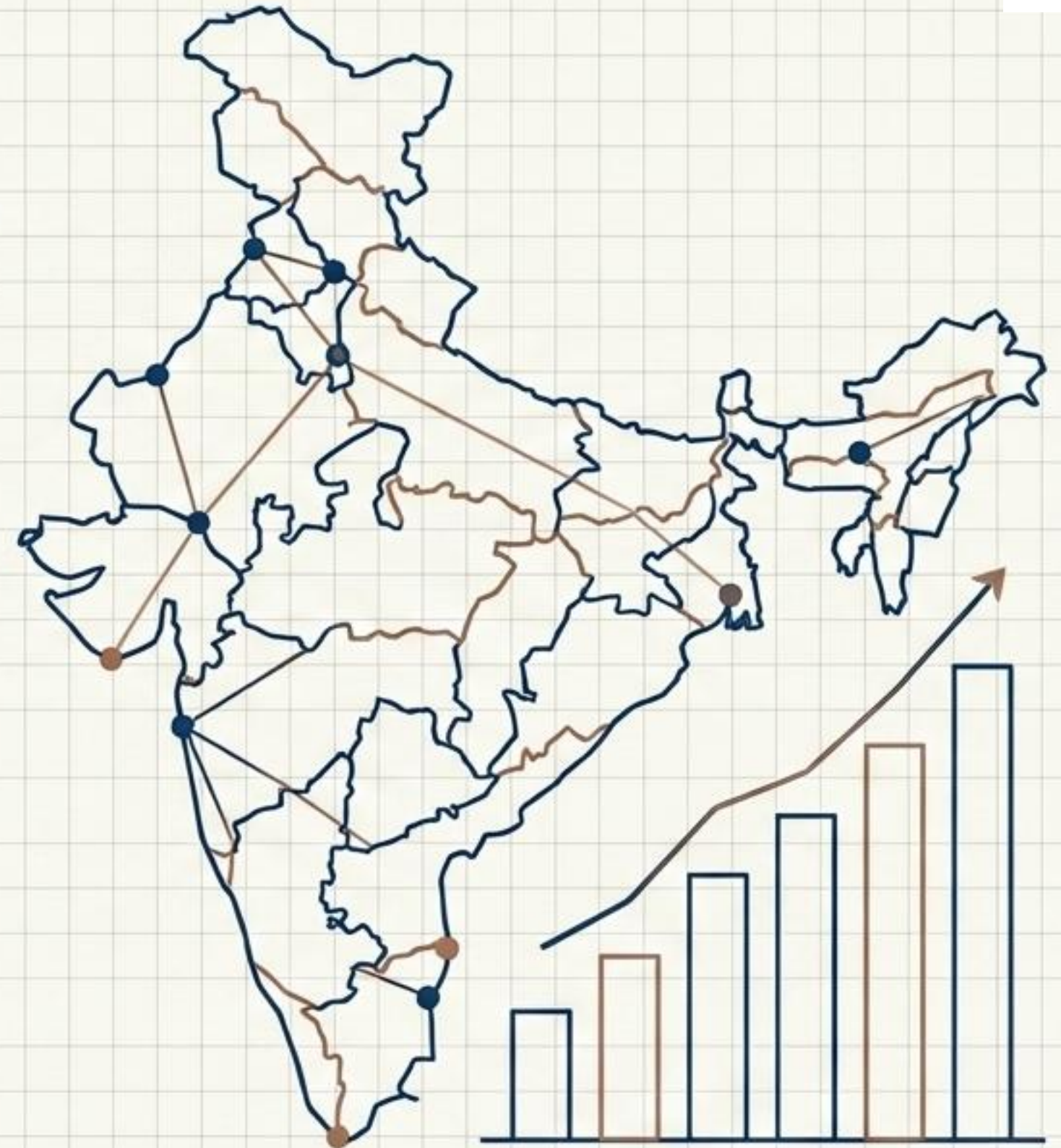
Understanding Electricity Markets, Power
System Operations, and Availability Based Tariff

Module-4: Energy Conservation and Audit

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The Anomaly of Electricity: A Comparative Diagnostic

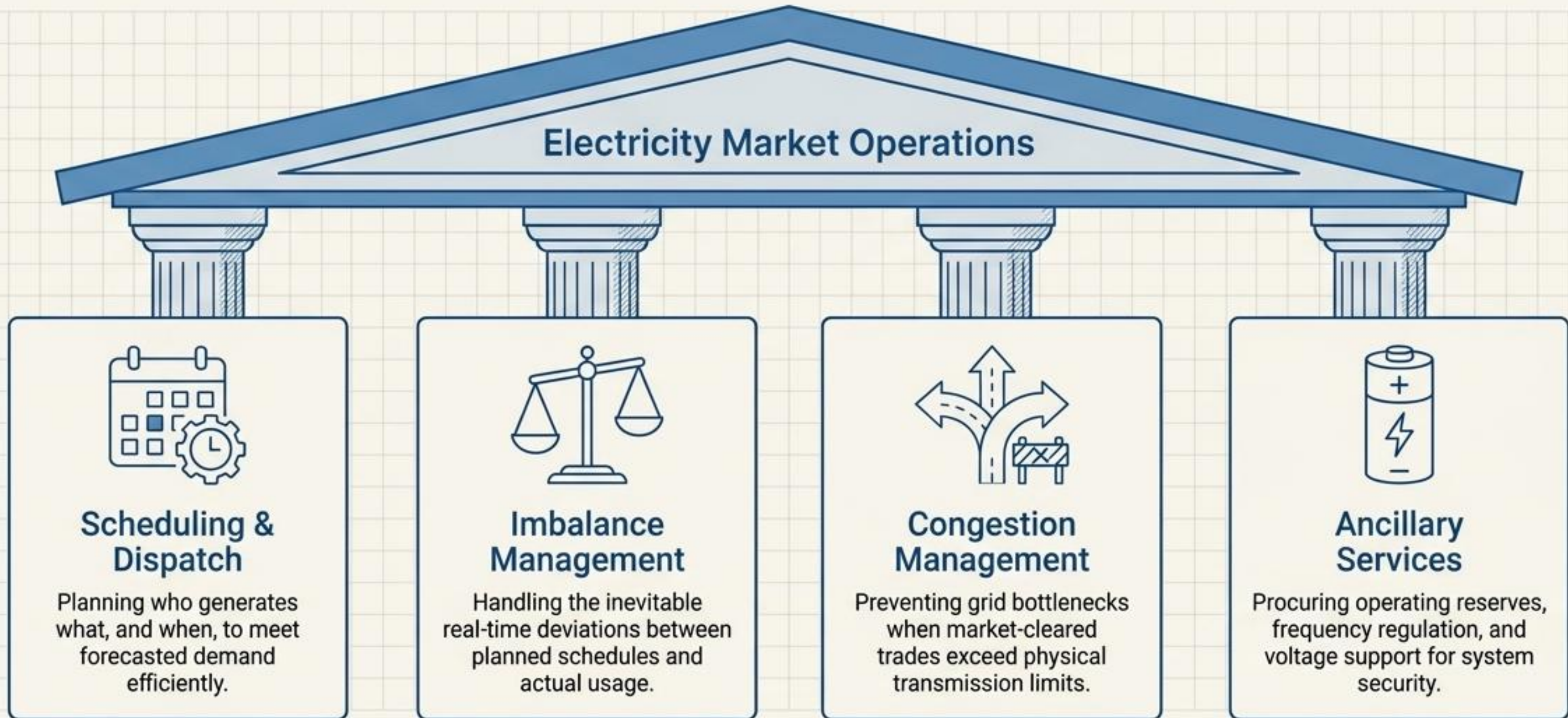
Understanding why electricity requires specialized market frameworks compared to standard traded goods.

	Conventional Commodities 	Electricity 
Storability	Can be stockpiled in warehouses or tanks for future use.	Must be consumed the exact millisecond it is generated. Highly perishable. Non-storable
Balancing	Supply and demand resolve over weeks, months, or years.	Perfect real-time physical balance required to maintain 50.00 Hz grid frequency. Real-time balance
Transport	Delivered globally via flexible, multi-modal logistics networks.	Strictly constrained by the physical thermal limits of transmission lines. Network dependency
Demand Variability	Relatively predictable, smoothed consumption patterns.	Wild, instantaneous fluctuations based on weather, time of day, and human behavior.

Electricity is the ultimate perishable good. This single physical anomaly dictates all complex economics and market rules.

The Four Pillars of Electricity Market Design

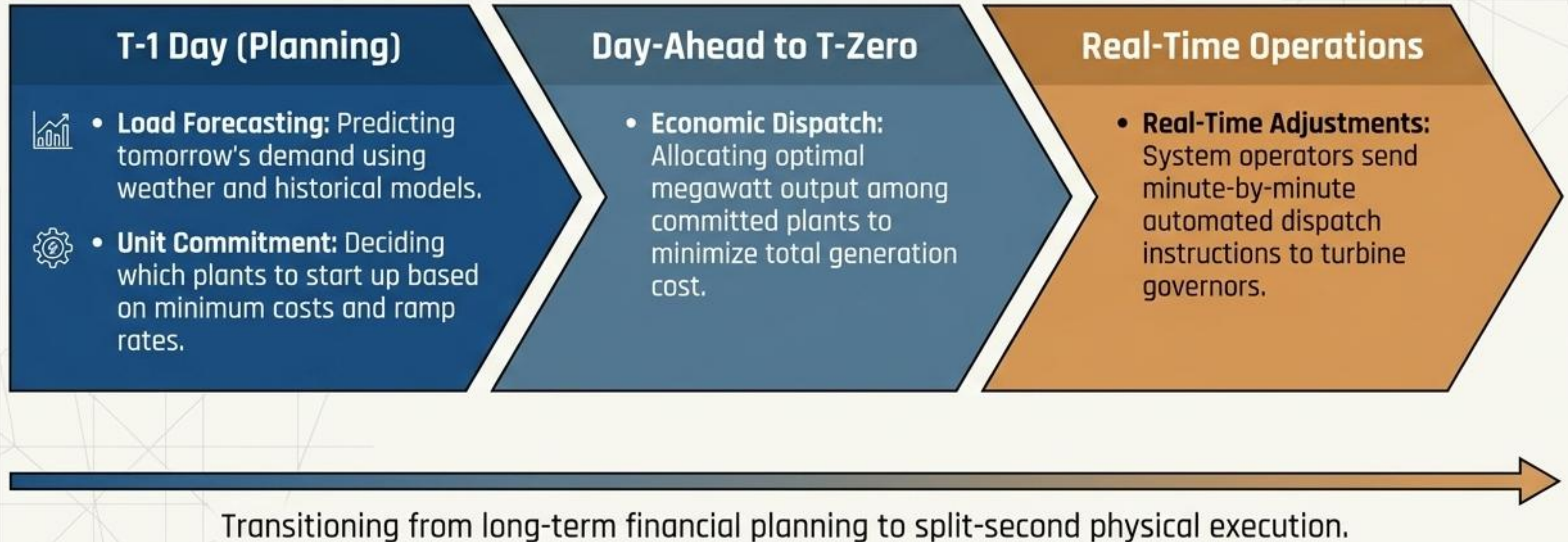
The core operational functions required to run a stable and competitive electricity market.



A power market cannot function on financial trading alone. These pillars ensure financial contracts are physically deliverable without collapsing the grid.

From Forecast to Flow: The Operations Timeline

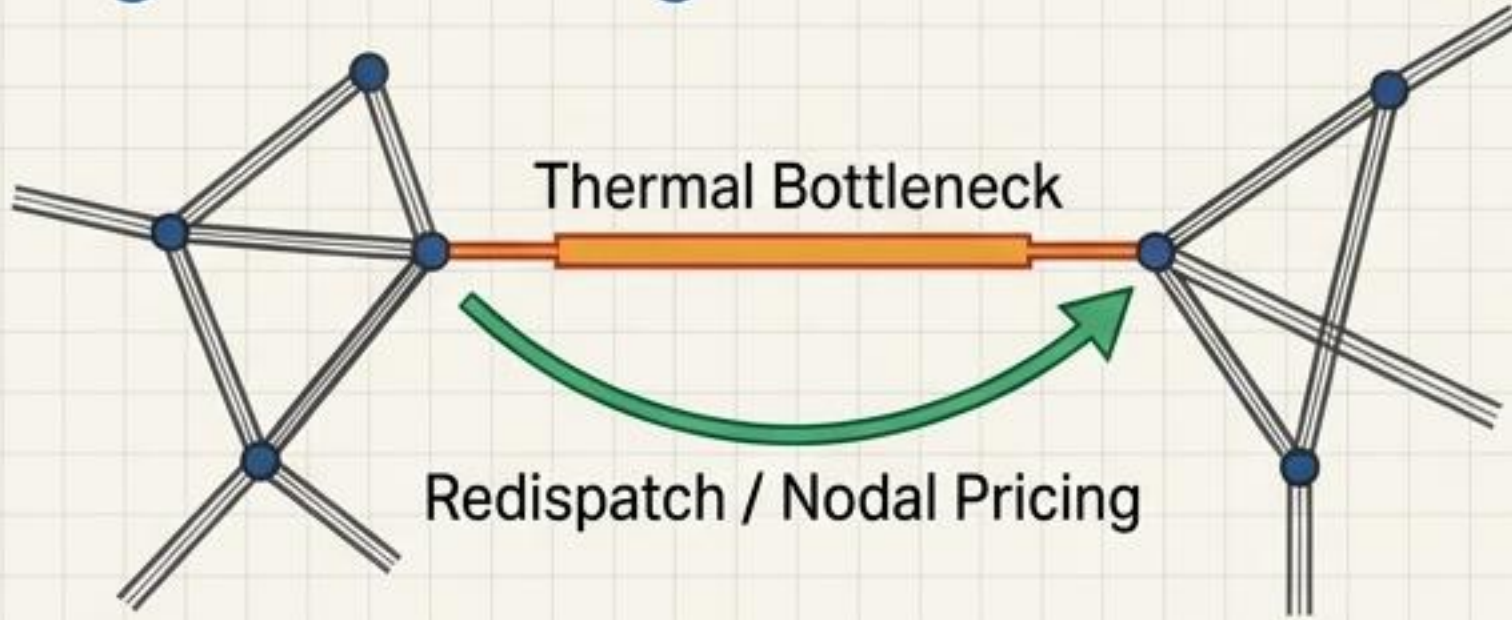
Visualizing the chronological sequence of power system scheduling.



Navigating Bottlenecks & Grid Security

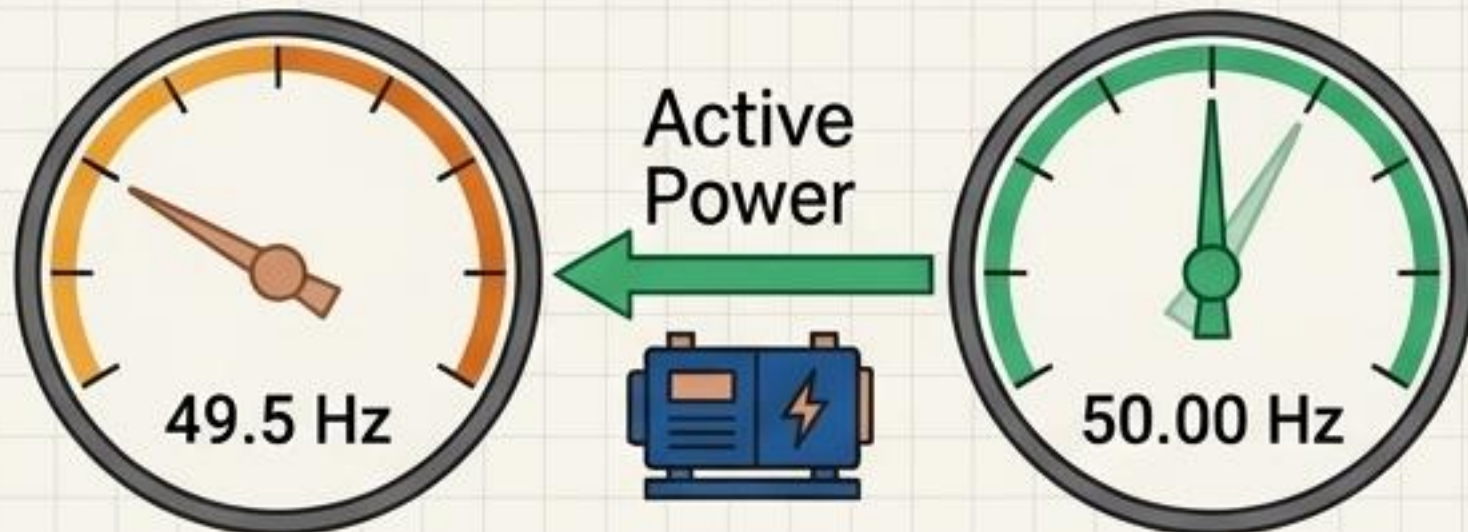
How system operators mitigate transmission constraints and maintain power quality.

Congestion Management



- **Problem:** Market-cleared power flows exceed the physical safety limits of transmission lines.
- **Solution:** Instructing a generator closer to the load to increase output, and one further away to decrease, effectively bypassing the bottleneck.

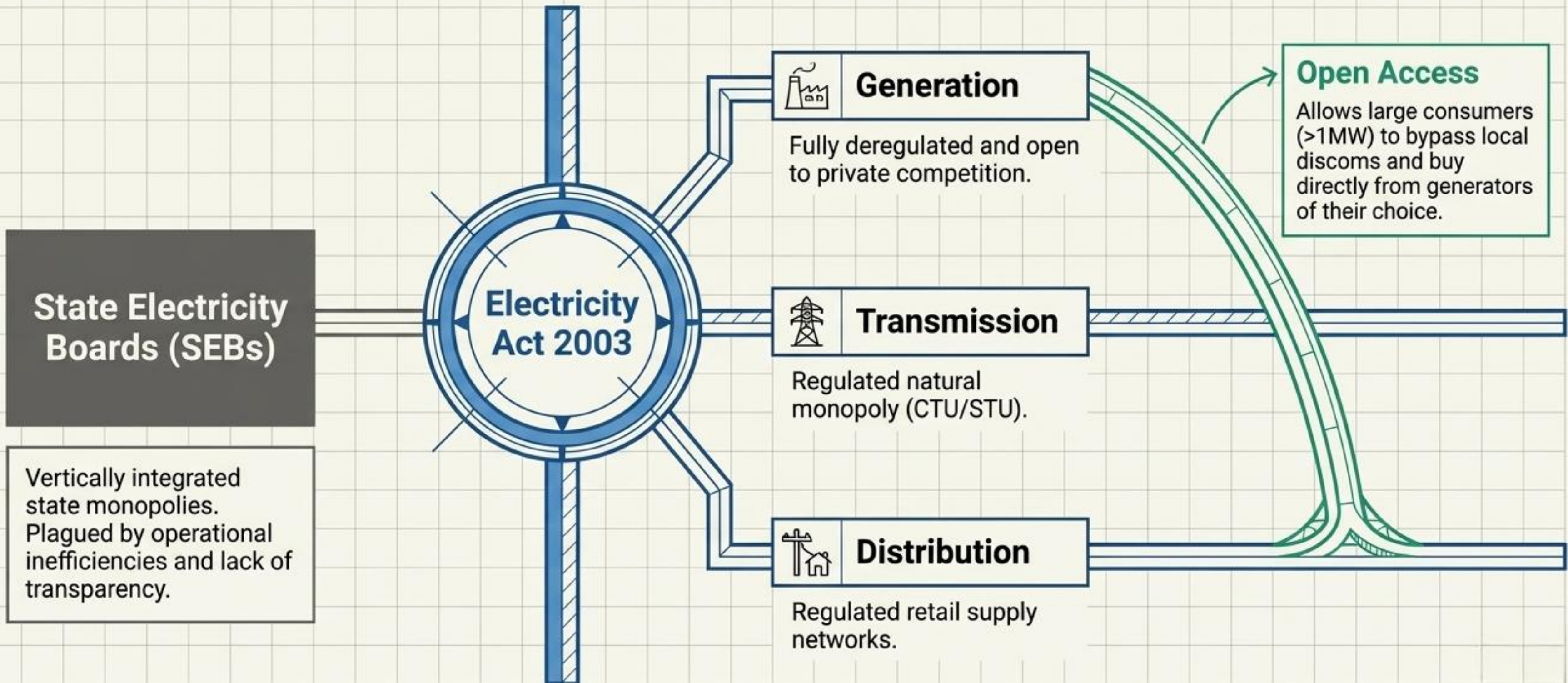
Ancillary Services



- **Frequency Support:** Injecting active power from spinning reserves to arrest sudden frequency drops.
- **Voltage Support:** Supplying reactive power to maintain local voltage stability and prevent regional collapse.

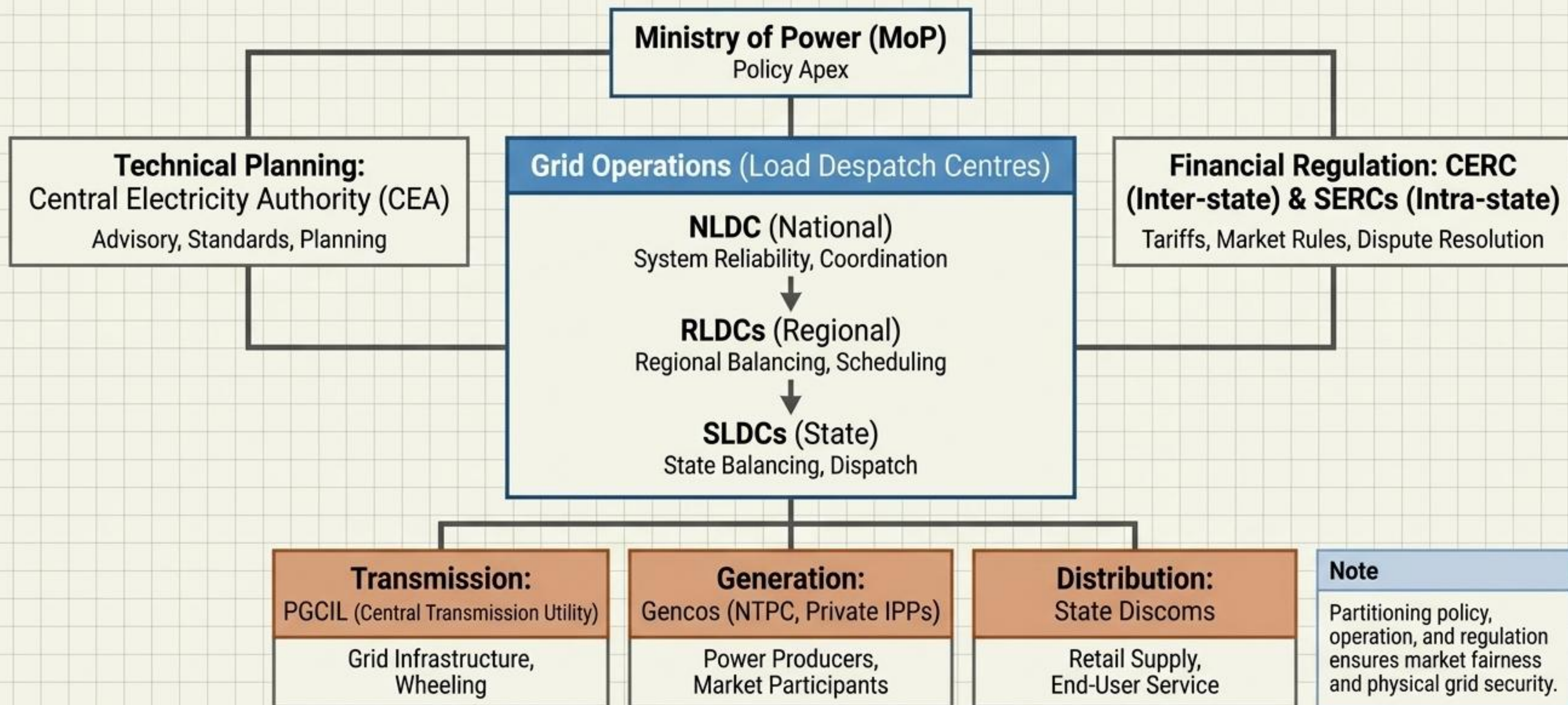
Regulatory Evolution: The Electricity Act 2003

Tracing the historical shift from state monopolies to a competitive Indian power market.



Institutional Framework of the Indian Grid

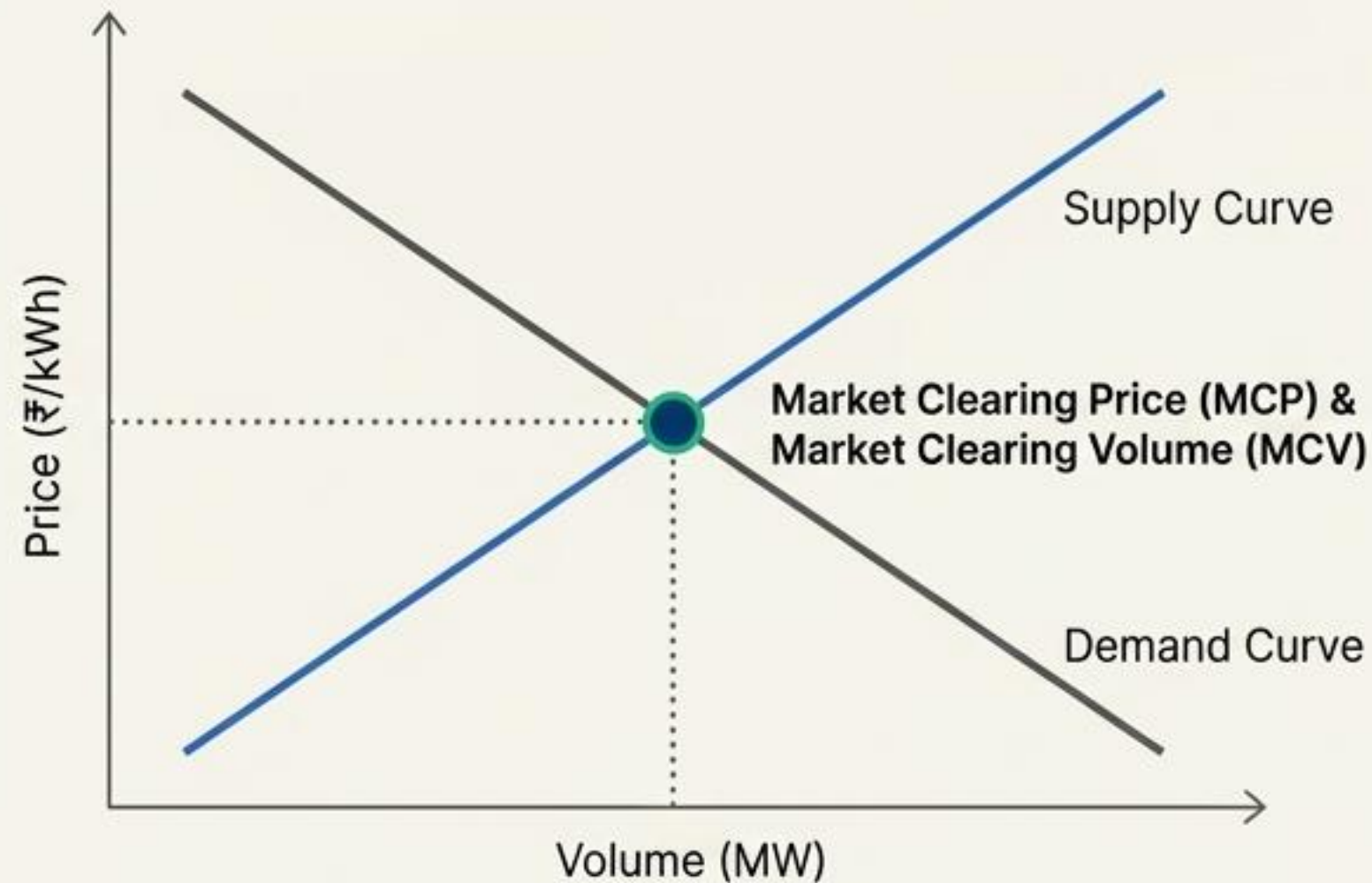
Mapping the regulatory, planning, and operational hierarchy.



Power Trading Platforms: DAM & RTM

Mechanics of short-term power trading on Indian exchanges (IEX & PXIL).

The Economics



A double-sided closed auction determines the exact equilibrium price where aggregate supply meets demand.

The Workflow

Day Ahead Market (DAM)

Delivery of electricity for the next day.
Provides the primary volume of short-term traded liquidity.

Real Time Market (RTM)

Trading permitted just 1 hour before physical delivery.

Crucial for integrating unpredictable renewable energy and correcting last-minute generation shortfalls.

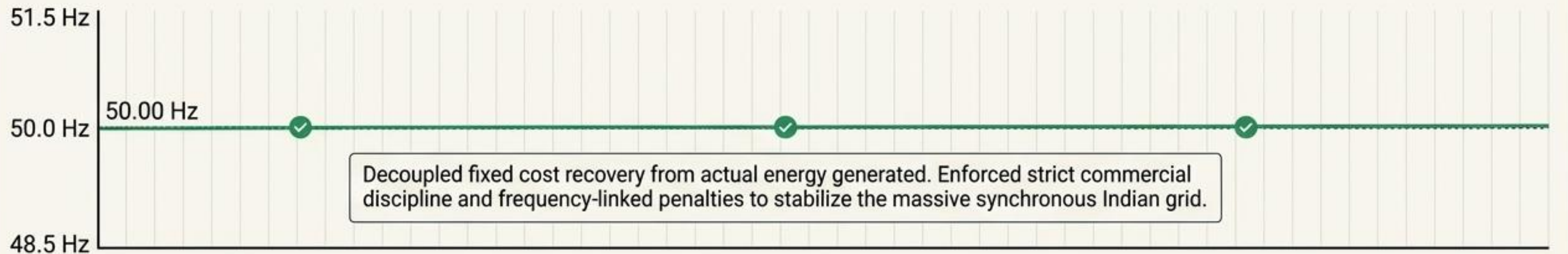
The Need for Grid Discipline: Enter ABT

How the Availability Based Tariff (ABT) solved the physical chaos of the Indian Grid.

Pre-ABT: Grid Indiscipline



Post-ABT: Engineered Stability



The Architecture of Availability Based Tariff

Deconstructing the three foundational pillars of the ABT pricing mechanism.



[Component 1: Capacity Charges]

The Fixed Cost component. Paid to the generator merely for declaring their plant “available” to generate. Covers debt, return on equity, and O&M regardless of actual dispatch instructions from the grid operator.



[Component 2: Energy Charges]

The Variable Cost component. Paid strictly based on the scheduled energy generation, not actual output. Covers variable fuel costs (e.g., coal, gas).



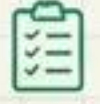
[Component 3: Unscheduled Interchange (UI) / Deviation]

The Penalty/Incentive mechanism. Applied when actual generation deviates from the committed schedule. The price is linked directly to real-time grid frequency.

This structure ensures generators don't go bankrupt if instructed to back down, while introducing severe commercial penalties for ignoring grid dispatch instructions.

Paradigm Shift: Traditional Tariff vs. ABT

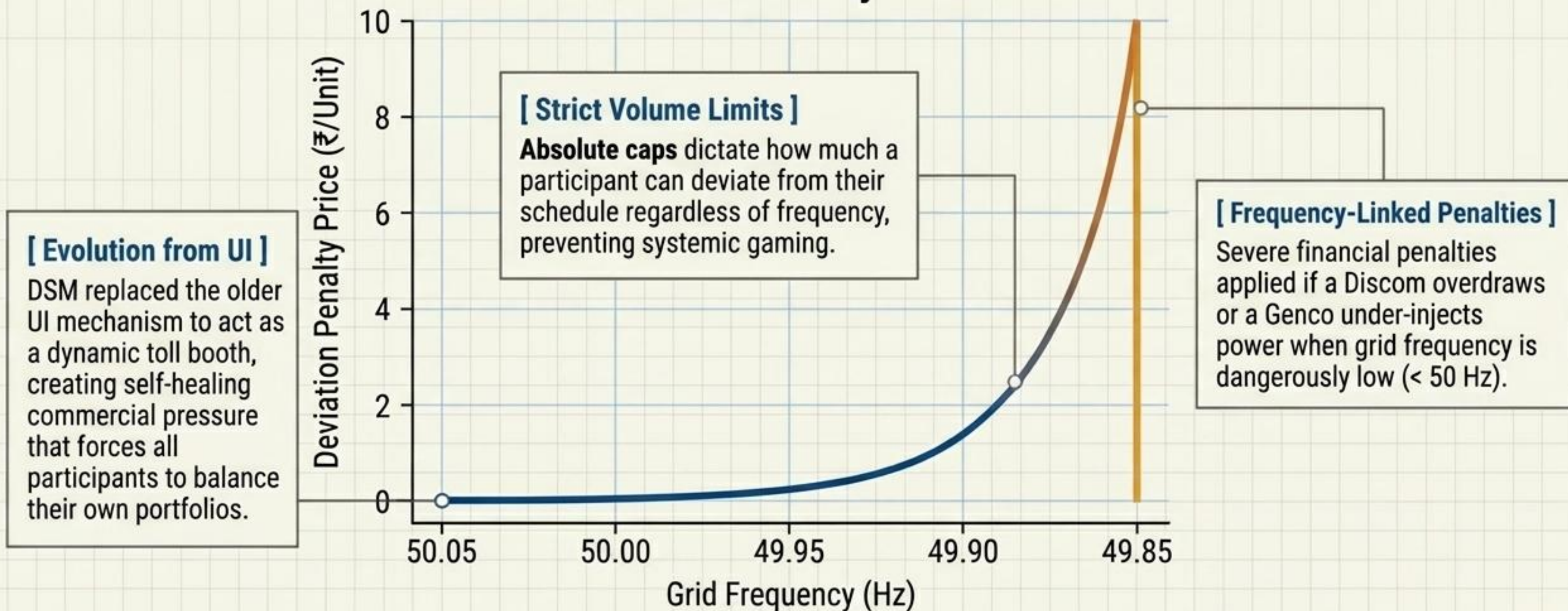
Contrasting the flawed traditional structure with the modernized ABT approach.

	Traditional Tariff Framework	Availability Based Tariff (ABT)
Fixed Cost Recovery	 Tied strictly to actual energy generated and pumped into the grid.	 Tied solely to plant availability declaration , removing the pressure to over-generate.
Operational Focus	 Blindly maximizing Plant Load Factor (PLF) for profit.	 Strict adherence to dispatch schedules and prioritizing grid discipline.
Frequency Control	 No commercial mechanism existed. Generators actively exacerbated grid fluctuations.	 Built-in commercial policing via UI/DSM mechanism directly linked to frequency.
Economic Efficiency	 Distorted merit order dispatch due to single blended tariff rates.	 Facilitates strict economic dispatch based transparently on variable fuel costs.

Modern Grid Policing: The DSM Framework

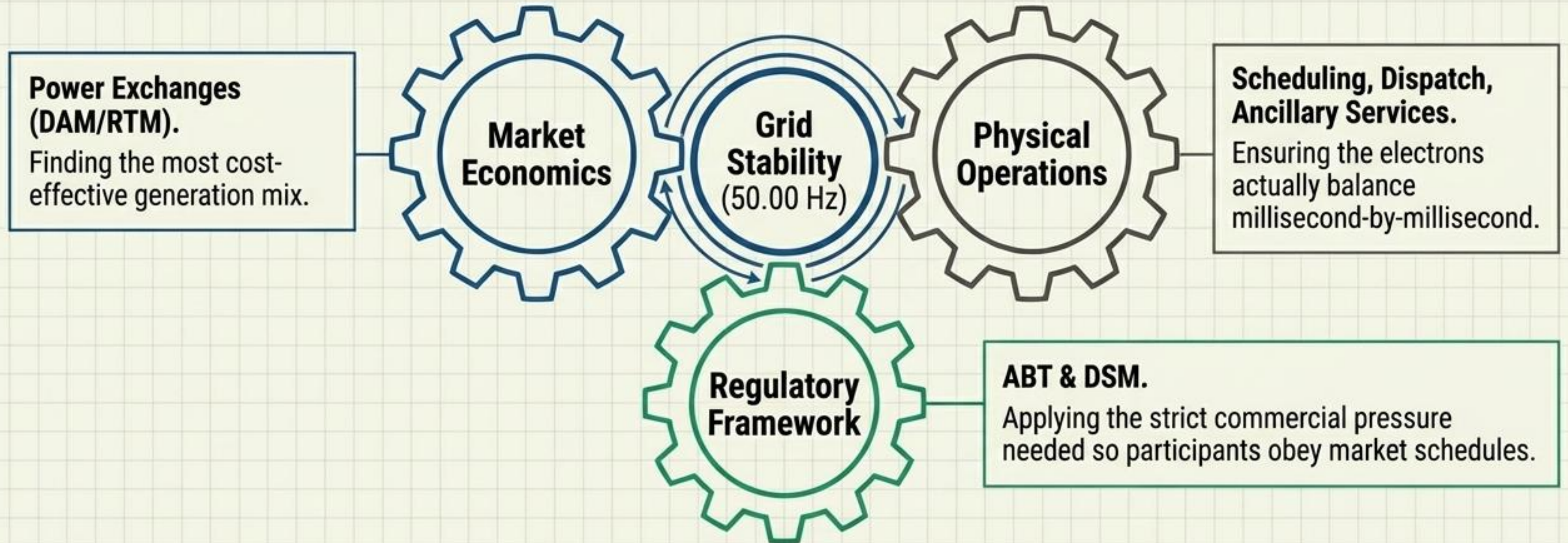
How the Deviation Settlement Mechanism enforces strict grid discipline.

Deviation Penalty Matrix



Synthesis: The 50 Hz Balancing Act

How physical engineering, market economics, and regulatory frameworks interlock.



The Physics Constraint (non-storable electricity) is solved by Market Efficiency, which is strictly enforced by Regulatory Policing.

Disruptions and Future Market Developments

How emerging technologies are forcing legacy market designs to adapt.



Renewable Integration

The inherent intermittency of wind and solar makes exact day-ahead scheduling and strict DSM compliance highly challenging.



Energy Storage Systems (ESS)

Utility-scale batteries fundamentally challenge the golden rule that electricity is "non-storable", requiring entirely new ancillary capacity markets.



Demand Response

Smart grids shift the paradigm from "supply following demand" to "demand following supply" via dynamic, real-time consumer pricing.

Conceptual Summary & Key Takeaways

A distilled executive summary and study guide for Module 1.



The Commodity Context

Electricity's absolute lack of storability mandates complex, real-time market clearing and precise, millisecond-by-millisecond balancing.



The Market Pillars

Scheduling, Imbalance Management, Congestion Management, and Ancillary Services are non-negotiable mechanisms for grid survival.



Indian Regulatory Sector

The Electricity Act 2003 unbundled vertically integrated state monopolies, enabling Open Access and competitive power exchanges (DAM/RTM).



The Enforcers: ABT & DSM

Separating fixed/variable costs and linking deviation penalties directly to real-time grid frequency saved the Indian grid from indiscipline.